

ACADEMIC REGULATIONS - 2021

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES (With exit option of Diploma)

(Choice Based Flexible Credit System)

Approved in 48th Academic Council resolution # 26th March 2022

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu, India

Contents

<u>No</u>	<u>Regulations</u>	<u>Page No</u>
	Vision and Mission of SRMIST	3
	Preliminary Definitions and Nomenclature	3
	Objectives	4
	Academic Council	4
	Faculty Board	5
	Department Board of Studies	5
	Office of Dean, College of Engineering and Technology	5
	Academic Session	5
	Academic Calendar	6
R.1.0	Admission	6
R 1.1	Number of Seats	6
R 1.2	Eligibility for Admission	6
R 1.3	SRM Joint Engineering Entrance Examination - UG	6
R 1.4	Seat Allocation and fulfilment of Admission requirements	6
R 1.5	Admission under Lateral Entry Scheme	6
R 1.6	Medical Standards for Admission	7
R 1.7	Fees for Admission	7
R 1.8	Authority for Admission	7
R 1.9	Revoking / Cancellation of Admission	7
R.2.0	Structure of B.Tech., Programme	7
R 2.1	Curriculum	7
R 2.2	Category of Courses	8
R 2.3	Structure of credits and courses:	8
R 2.4	Classification and Numbering of courses	9
R 2.5	Professional Electives and Open Electives	9
R 2.6	Project work	9
R 2.7	Major Project / Semester Internship	10
R 2.8	Specialization Project	10
R.3.0	Registration and Enrolment for Courses	11
R 3.1	Course Registration for a semester	11
R 3.2	Semester Enrollment Requirements	11
R 3.3	Late Registration / Enrollment	11
R 3.4	Termination of Registration / Enrollment	11
R 3.5	Summer Semester	11
R 3.6	During the Break of Studies	12
R 3.7	Adding and dropping courses	12
R 3.8	Guided study / Self-Learning:	12

R.4.0	Teaching and Assessments	13
R 4.1	Medium of Instruction	13
R 4.2	Mode of Instruction	13
R 4.3	Teaching and Assessment in 5th year	13
R 4.4	Assessment Design	13
R 4.5	Types of Learning Assessments	13
R 4.6	Learning Assessment Weightage	14
R.5.0	Programme Requirements	17
R 5.1	Semester Duration	17
R 5.2	Temporary withdrawal from the programme	17
R 5.3	Exit option and award of Diploma	17
R.6.0	Conduct and Discipline	17
R 6.1	Expected Conduct and Discipline	17
R 6.2	Act of Indiscipline	17
R 6.3	Suspension	18
R 6.4	Appeal	18
R.7.0	Attendance	18
R 7.1	Attendance Definition	18
R 7.2	Attendance Percentage & Code	18
R 7.3	Minimum Attendance	18
R 7.4	Attendance Shortage and Examination	18
R 7.5	Condonation of Attendance	19
R 8.0	Examination and Award of Degree	19
R 8.1	Course Wise Grading of Students	19
R 8.2	Method of Awarding Letter Grades	19
R 8.3	Declaration of Results	19
R 8.4	Re-view of Answer scripts	20
R 8.5	Grade Card	20
R 8.6	Computation of CGPA / SGPA	20
R 8.7	Equivalent Percentage Calculation	20
R 8.8	Class / Distinction:	20
R 8.9	Academic Dishonesty	22
R 8.10	Eligibility for Award of the M.Tech(Integrated) Degree	22
R 8.11	Eligibility for Award of the B.Tech Degree	22
R 8.12	Eligibility for Award of the Diploma	22
R 8.13	Minor certification	22
R 8.14	B.Tech Honors Degree	23
R 8.15	Deviation in Procedure	23
R 8.16	Change of Regulations	23

Vision

To emerge as a World - Class University in creating and disseminating knowledge, and providing students a unique learning experience in Science, Technology, Medicine, Management and other areas of scholarship that will best serve the world and betterment of mankind.

Mission

MOVE UP through international alliances and collaborative initiatives to achieve global excellence.

ACCOMPLISH A PROCESS to advance knowledge in a rigorous academic and research environment.

ATTRACT AND BUILD PEOPLE in a rewarding and inspiring environment by fostering freedom, empowerment, creativity, and innovation.

Regulations – B. Tech/M.Tech(Integrated) Programmes (Full Time)

These regulations are applicable to the students admitted in M.Tech (Integrated) from the Academic Year 2021-22 onwards, B.Tech from the academic year 2022-2023.

The regulations for the Diploma/B.Tech/M.Tech(Integrated) Degree programs are prepared with the recommendation, guidelines and directions from the National Knowledge Commission, University Grants Commission (UGC) and All India Council for Technical Education (AICTE) on:

- Outcome Based Education Framework (OBE)
- Evaluation Reforms in Higher Education Institutions in India
- Examinations Reform Policy
- National Education Policy

In addition to the above documents, the best practices of SRMIST such as promoting enhanced learning and research capabilities through (a) Critical Thinking (b) Problem Solving (c) Analytical Reasoning (d) Scientific Reasoning (e) Reflective Thinking (f) Design thinking etc., are integrated into the Curricula.

Preliminary Definitions and Nomenclature

In these regulations, unless the context otherwise requires:

- “Degree”** means that academic award conferred upon a student on successful completion of a four-year programme designed to achieve the defined attributes. It is referred to as Under-Graduate (UG) Degree, that is “Bachelor of Technology” also known as “B.Tech. Degree”. **“Diploma”** means an academic award conferred upon a student upon successful completion of the first SIX semesters of a 4-year B.Tech degree programme. When he / she is not able to pursue his / her fourth year of studies for whatsoever reason and willing to discontinue / exit, shall be awarded **“Diploma”** in the relevant major branch of study (without any specialisation), provided he satisfies all conditions laid out for the award of the Diploma. **Direct admission to**

a Diploma is not permitted. This exit option will be allowed only under exceptional circumstance and not as matter of rule. The institution intends that all students graduate with a minimum of an undergraduate degree

- ii. **‘Integrated Post Graduate Degree’** means that academic award conferred upon a student on successful completion of a Five-year programme designed to achieve the defined attributes. It is referred to as Integrated Post-Graduate (PG) Degree, that is “**Integrated** Master of Technology” also known as “**Integrated** M.Tech. Degree”
- iii. **‘Programme’** means cohesive arrangement of courses, co-curricular and extracurricular activities to accomplish predetermined objectives leading to the award of a degree. It also means branch or discipline of B.Tech./M.Tech(Integrated) Degree programme like Civil Engineering, Mechanical Engineering, etc. Some Degree programmes also provide options to specialize in a specific domain of interest. Such B.Tech. Degree programmes are titled as the *Degree along with its specializations* like Biotechnology with specialization in Regenerative Medicine, etc.,
- iv. **‘Course’** means a combination of theory, tutorials and practice sessions of a subject studied in a semester, like Mathematics, Physics, etc.,
- v. **‘Minor’** is an optional secondary concentration of courses that often complements the Degree Programme.

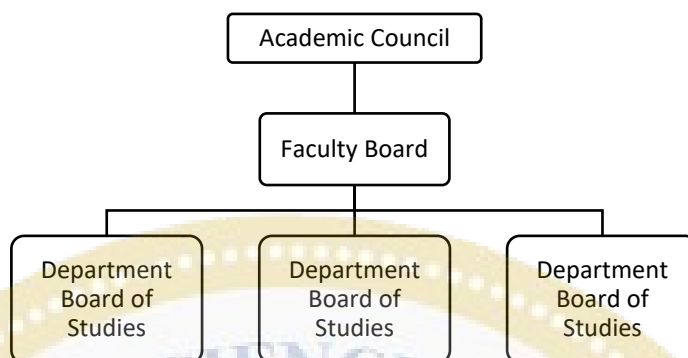
Objectives:

The objectives of offering the B.Tech / M.Tech programme are:

1. To enable students to focus towards conceptual and empirical knowledge in the field of engineering.
2. To encourage multidisciplinary perspective.
3. To encourage depth and breadth in understanding complex issues,
4. To provide broad inter-disciplinary training with well sequenced curriculum over a sufficient length of time so as to give students adequate preparation in their chosen field, either for higher studies or professional careers

The Academic Council:

The academic council is the principal academic body responsible for, the maintenance of standards in teaching, research, training, approval of curriculum / syllabus, conduct of examinations etc. The hierarchical academic structure is illustrated below:

**The Faculty Board:**

The Faculty Board of the College of Engineering and Technology recommends / endorses the proposals approved by the BoS of the departments, Centres of Excellence, units, etc and shall forward the same to the Academic Council for approval.

The Department Board of Studies (BoS):

Each department of the College of Engineering and Technology will have a Board of Studies common for UG, PG and Doctoral programmes offered by the department. The Dean / Chairperson of the School which comprises of one or more departments, will be the Chairman of the Department Board of Studies and the Head of each Department will be the co-chairman of the BoS. The Board of Studies has been constituted as per the guidelines of UGC. The Rules, regulations, curriculum, syllabus and other academic matters shall be approved by the BoS before placing it to the Faculty Board.

Office of the Dean, College of Engineering and Technology:

The office of The Dean, College of Engineering and Technology is responsible for the implementation of the decisions taken on academic matters by the Academic Council.

The office:

- receives, processes and maintains all records relating to the Integrated programmes including curricula, courses offered, academic calendar, registration, leave, assessments, and grades.
- disseminates information pertaining to all academic matters, issues necessary memoranda/orders, and acts as a channel of communication between the students, instructors and Departments.
- Students can get information for various academic programmes, rules and regulations from the office of Dean, College of Engineering and Technology.

ACADEMIC SESSION

The academic session normally begins in the last week of June or the first week of July every year and ends in June of the subsequent year. It generally consists of two semesters:

- Odd Semester: July - November
- Even Semester: December - April

During the summer vacation, i.e., (May - June), there may be one short Summer Semester. Only a few courses may be offered during Summer Semester for the **benefit of students (a) to clear their failed/dropped courses, (b) transferred from other intuitions, (c) pursuing Minor certification (d) under Study Abroad Programme, and (d) who got detained.**

ACADEMIC CALENDAR

The exact dates of all important events, such as orientation, registration, late registration, commencement of classes, submission of documents, examinations, submission of grades, vacation, etc., during the academic session are specified in the Academic Calendar of the College of Engineering and Technology and are approved by the Academic Council. The Academic Calendar shall be displayed on the SRMIST official website / Student Portal

R 1.0 Admission

- R 1.1 Number of Seats:** The number of seats in each B.Tech./M.Tech (Integrated) Programme for which admission is to be made in the College of Engineering and Technology will be decided by the Academic Council / Board of Management of SRMIST. Necessary approval from Government Statutory bodies will be obtained, wherever required.
- R 1.2 Eligibility for Admission:** The minimum eligibility for Admission to B.Tech./M.Tech (Integrated) degree programmes (regular) shall be based on the following criteria:
- (a) Should have completed 12 years of schooling (equivalent to the 10+2 system of Indian Education)
 - (b) The Minimum Percentage of Marks / CGPA prescribed by SRMIST
 - (c) Goes through the laid-down admission procedure
 - (c) Rules and Regulations of the UGC/AICTE / other competent authorities of the Ministry of Education.
- R 1.3 SRM Joint Engineering Entrance Examination - UG (SRMJEEE - UG):** SRMJEEE (UG) is a common entrance examination conducted across India annually by SRMIST for all those seeking admission to Engineering programmes offered by SRMIST. The eligibility for appearing for SRMJEE, the format, and other details shall be mentioned in the application form and would be decided by the Admissions Committee for the respective year of admission.
- R 1.4 Seat Allocation and fulfilment of Admission requirements:** The Admission Committee will prepare a merit list based on the marks scored by the candidates in the SRMJEEE and call / allot the applicants, in the merit order, for counselling. Seats are allotted based on applicant's interest and seat availability. Admission to any undergraduate or Postgraduate programme requires that the applicant.
- be eligible,
 - goes through the laid-down admission procedure, and
 - pays the prescribed fees.
- All admissions to the undergraduate and Postgraduate programmes should be formally approved by the Chairman of the Academic Council.
- R 1.5 Admissions under Lateral Entry Scheme:** Under the Lateral entry scheme of Admissions, the following categories of candidates are eligible for admission directly to the 3rd semester of any B.Tech./M.Tech (Integrated) programme offered by SRMIST.

Minimum Eligibility: A pass in Diploma in Engineering/Technology recognised by the Directorate of Technical Education or equivalent competent agency / body through:

- (i) A minimum of three years of institutional study, after the 10th (SSLC) examination, recognized by SRMIST. (or)
- (ii) A minimum of 2 years of institutional study, after the 10+2 (Higher Secondary) examination, recognized by SRMIST. (or)

- (iii) A Bachelor's degree in Mathematics/Physics/Chemistry, after the 10+2 (Higher Secondary examination, recognized by SRMIST. (or)
- (iv) Any other equivalent degree through a minimum of 3 years of institutional study, after the 10+2 (Higher Secondary) examination, recognized by SRMIST.

The students admitted under lateral entry must register and undergo bridge courses in Mathematics, Physics and Chemistry during the III and IV semester of B.Tech. They can exit only with a B.Tech or M.Tech (Integrated) degree.

R 1.6 Medical Standards for Admission: Candidates must fulfil the medical standards required for admission as set out by the Admission Committee.

R 1.7 Fees for Admission: The selected candidate will be admitted to the B.Tech. / M.Tech (Integrated), programme after he/she fulfils all the admission requirements as indicated in the letter of admission and after making the payment of the prescribed fees within the due date announced.

R 1.8 Authority for Admission: Any matter related to admission to the B.Tech./ M.Tech (Integrated), programme, the decision of the Admission Committee is final.

R 1.9 Revoking / Cancellation of Admission:

All students admitted provisionally or otherwise to any programme shall submit copies of their original mark sheets, provisional certificates, etc., of the qualifying examination and any other documents required by the Directorate of Admission, within the last date specified for the purpose in the Academic Calendar of SRMIST.

The Registrar, on recommendation of the Controller of Examinations or the Dean CET can cancel the admission of any student who fails to submit the prescribed documents within the specified date or to meet other stipulated requirement(s). The Registrar may also cancel the admission, at any later time, if it is found that the student had supplied false information or suppressed / misrepresented / forged relevant information while seeking admission or thereafter and report the matter to the Vice Chancellor.

R 2.0 Structure (Outline) of the Programme

R 2.1 Curriculum: Every department has a prescribed programme structure which, in general terms, is known as the Curriculum. It prescribes all the courses / laboratories / other requirements for the degree and sets out a typical sequence of study semester-wise. The curriculum is structured as an 8-semester (10 semester for M.Tech Integrated) study, in such a manner a student who completes the programme successfully would have a holistic knowledge encompassing Science, Humanities, Technology, Engineering, and Mathematics. It follows the Outcome Based Education (OBE) with well defined:

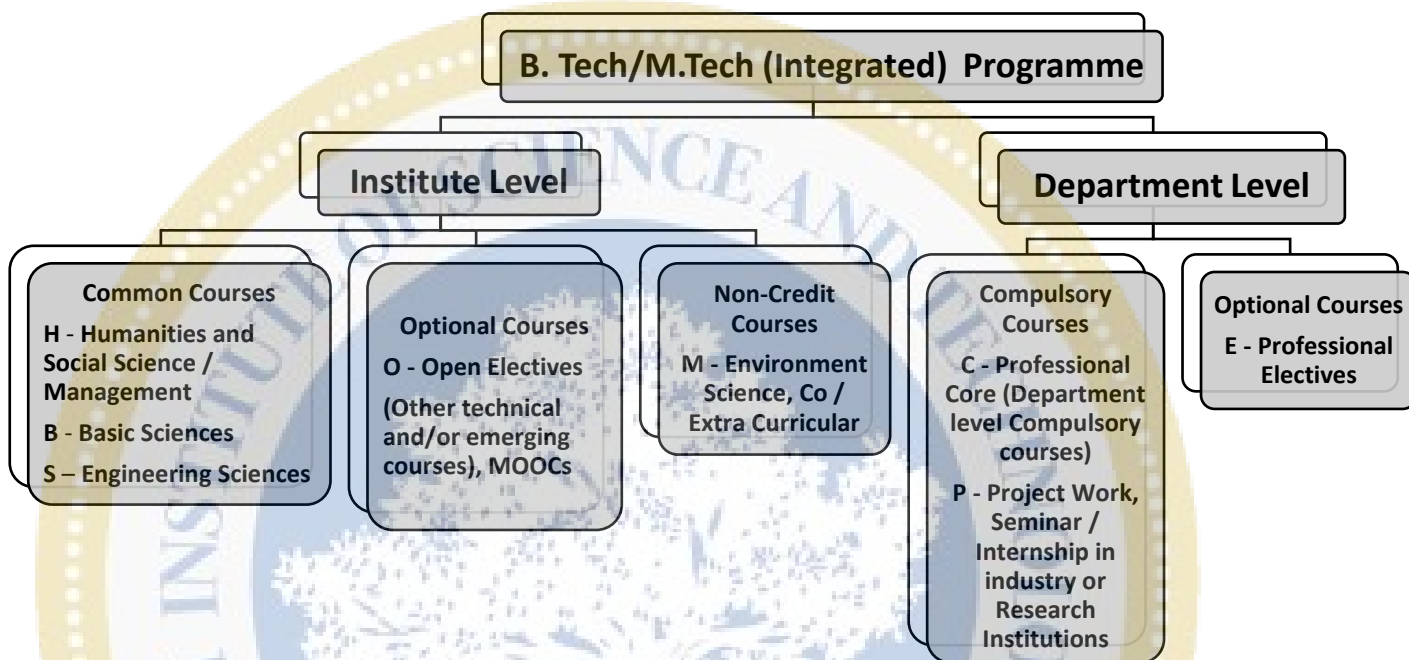
1	Program Educational Objectives (PEO)
2	Program Outcomes (PLO)
3	Mapping Mission of the Department to Program Educational Objectives (PEO)
4	Mapping Program Educational Objectives (PEO) to Program Learning Outcomes (PLO)
5	Structure of the Programme
6	Categorization of Courses
7	Program Articulation Matrix

And, every course has well defined:

1	Course Learning Rationale (CLR)
2	Course Outcomes (CLO)
3	Session Learning Outcomes (SLO)
4	Learning Assessment Scheme (Continuous Learning Assessments and Final Examinations)
5	Course Designer Details (Industry/Research Centres/Higher Institutions/Internal experts)

These details are recommended by the respective Department's Board of Studies (BoS), endorsed by the Faculty Board of the College of Engineering and Technology and approved by the SRMIST Academic Council.

R 2.2 Category of Courses



2.3 Structure of credits and courses:

Each course is worth a certain number of credit points, determined by different criteria in different countries, including student's workload, learning outcome and contact hours. Usually, the more work and effort a student is required to put into a course, the more credits that course is worth. The B. Tech / M.Tech (Integrated), programmes have a learning environment comprising of appropriate combinations of learning from Theory, Tutorials and Practice sessions.

At College of Engineering and Technology, Learning Credits are earned by the learner based on the following pattern:

Learning Environment	Learning Credit (C)
1 Hour of learning from a Lecture Session per week (L)	1
1 Hour of learning from a Tutorial Session per week (T)	1
1 Hour of learning from a Practice Session per week (P)	0.5

(1 Hour of learning is usually a 50-60 minute duration)

R 2.4 Classification and Numbering of Courses: The 9 digit Course Code Structure is provided below: For Example : 21CSC301J

YY DD C L SS A					
YY	DD	C	L	SS	A
2 digits	2 digits	1 digit	1 digit	2 digits	1 digit
Year of Regulation	Course Offering Department	Type of Course	Level of the Course	Serial No. of the Course	Additional Qualifier
2021 Regulations	LE – English PY – Physics CY – Chemistry MA – Mathematics MB – Management Sciences PD – Career Development Centre AS – Aerospace Engineering AU – Automobile Engineering BT – Biotechnology CH – Chemical Engineering CE – Civil Engineering CS – Computer Science & Eng., EE – Electrical & Electronics Eng., EC – Electronics & Commn. Eng., ME – Mechanical Engineering MH – Mechatronics Engineering NT – Nanotechnology	H – Humanities, Social Sciences including Mgt. Courses B – Basic Science Courses S – Engineering Science Courses C – Professional Core Courses E – Professional Elective Courses O – Open Elective Courses P – Project Work, Seminar, Internship etc., M – Mandatory Courses (non-credit) V – Value Added Courses	UG Level – 1 to 4 PG Level - 5 and above	01 02 etc.,	T - Theory L - Laboratory I - Industry B - Bridge J – Joint P- Project based Theory

R 2.5 Professional Electives and Open Electives:

Professional Electives and Open Electives **allow students to design their own course plan that suits their career goals. Professional electives** are courses that further a student's professional development by allowing them to develop a deeper understanding of a specific subject area within the degree discipline. **Open electives** concept allows a student to familiarise himself/herself with basic concepts of a stream of study outside of his / her major field of engineering domain.

The Professional Electives are categorised as **Verticals** that will be Industry Sector specific or Specialisation specific or customised courses for specific company

The Open electives are categorised as

- Horizontal:** Cross-Department Electives (Open Elective) (6 credits)
- Cross-Faculty Electives** (Open Elective) (3 Credits)

Instead of Open Electives / Professional Electives, students will have a choice of choosing maximum of 4 MOOC courses (8 weeks or 12 weeks) from approved platforms like NPTEL / Coursera to acquire those credits starting from 4th semester. The list of MOOC courses that a student can take MUST be approved by the concerned department

R 2.6 Project Work: (FULLY INTERNAL Course)

- Students shall form into **either Intra-Departmental or Inter-Departmental teams** and undertake a project during VI semester in their *Programme Specific Area*. Each team will be mentored by a faculty member and monitored through periodical reviews by the **Project Review Committee / Panel**. A report needs to be submitted upon completion of the project work, which will be assessed by the TWO internal examiners appointed by the head of the department.

- (ii) Alternatively, students can study a MOOC course with duration 8 to 12 weeks, equivalent to 3 credits
- (iii) The MOOC option is not applicable for students who want to exit the programme with diploma. Those students have to do the Project Work compulsorily.

R 2.7 Major Project/ Semester Internship

- (i) Students can undergo Semester Internship either in an Industry or in a Research Centre or Specialised laboratories in a higher educational institution for a duration of 12 to 15 weeks during the Eighth semester, duly approved by the department **Project Review Committee / Panel**. All internships MUST be approved the department. Every student pursuing Semester Internship shall be mentored by a faculty member and monitored through periodical reviews by the **Project Review Committee / Panel**. At the end of the Semester Internship, the student shall submit a report and undergo the due process of assessment by examiners appointed by the head of the department, for successful completion of the internship
- (ii) Alternatively, the students shall form into **either Intra-Departmental or Inter-Departmental teams** and undertake a Major Project in their *Programme Specific Area* during Eighth semester, duly approved by the Department **Project Review Committee / Panel**. The Major Project can be carried out either:
 - a) in any of the Funded Projects / Research Centres / Incubation Centres within SRMIST
 - [or]
 - b) within any laboratories of College of Engineering and Technology
 - [or]
 - c) in an Industry / Research Centre outside SRMIST / Startups duly approved by the Department **Project Review Committee / Panel**.
- (iii) Each team will be mentored by a faculty member and monitored through periodical reviews by the **Project Review Committee / Panel**.
- (iv) After completion of the Major Project Work, the student team shall submit a Report/Dissertation/Thesis, and undergo the due process of assessment by **ONE External and ONE Internal Examiner** recommended by the head of the department and duly approved by the CoE, for successful completion of the Major Project
- (v) Students who wish to continue for M.Tech (Integrated) programme will NOT be permitted to undergo Semester Internships, because they must study few core courses during the Eighth semester, along with the Major Project.
- (vi) In lieu of the Major Project, the students can choose three to four advanced level courses equivalent to the total major project credits done during 8th semester. This is applicable only for students who continue and pursue for M.Tech (Integrated) programme

R 2.8 Specialization Project

- (i) Every student shall initiate his / her Specialization Project related to his / her area of specialization in ninth semester as Project Phase-I and continue his / her work in tenth semester as Project Phase-II. The Specialisation Project can be carried out either:
 - a) in any of the Funded Projects / Research Centres / Incubation Centres within SRMIST
 - [or]
 - b) within any laboratories of College of Engineering and Technology
 - [or]
 - c) in an Industry / Research Centre outside SRMIST duly approved by the Department **Project Review Committee / Panel**.
- (ii) Each student will be mentored by a faculty member and monitored through periodical reviews by the **Project Review Committee / Panel**.
- (iii) After completion of the Specialisation Project, the student shall submit a Report/Dissertation/Thesis, and undergo the due process of assessment by **ONE External and ONE Internal Examiner** recommended by the head of the department and duly approved by the CoE, for successful completion of the Specialisation Project

R 3.0 Registration and Enrollment for Courses

R 3.1 Course Registration for a semester

The process of signing-up for courses is called 'Registration'. All students shall formally register for the courses every semester to undergo their learning course work. The registration process involves filling up of an online Course Registration Form stating the courses that the student proposes to complete during that semester as prescribed in the curriculum.

The Institute generally has an online registration system, and the registration is normally done at least one month before the starting of each semester. The registration for any course will be controlled by the respective Heads of Department. For the first semester, course registration shall be completed within a week prior to the commencement of classes.

R 3.2 Semester Enrollment Requirements: Enrollment for each semester by the students is mandatory which is done on the first day of the semester. Students are enrolled after they pay the prescribed annual tuition fees. Students have to submit their course registration form and fee receipt to their faculty advisor/HoD. For a student, to attend classes he/she has to necessarily complete both course registration and semester enrolment

R 3.3 Late Registration / Enrollment:

Late Registration / enrollment will not be encouraged. If, for any compelling reason like illness, etc., a student is unable to register / enroll on the day of registration /enrollment, he/she can register / enroll after obtaining special permission from the respective Heads of Department and should be done not later than two weeks from the commencement of classes.

R 3.4 Termination of Registration / Enrollment: A student will not be allowed to register for courses / enroll for a semester:

- (i) If a student fails to report and register within the last date of registration without any bonafide reason
- (ii) Has been 'Debarred from study' due to any specified reason in the previous semester.
- (iii) Has any 'Pending Disciplinary Action' against him/her.
- (iv) Has not paid the fees for the current and / or previous year(s).

Under such situation the student must undergo break in studies for a semester or a year, as applicable

R 3.5 Summer Semester:

During the summer vacation, i.e., (May - June), there may be one short Summer Semester. Only a few courses may be offered during Summer Semester for the **benefit of students (a) to clear their failed/dropped courses, (b) transferred from other intuitions, (c) pursuing Minor certification (d) under Study Abroad Programme, and (d) who got detained.**

- (i) Summer semester courses will be offered based on the following:
 - a) Summer semester courses may be announced after the publication of results, by the respective School/Department, with the approval of the Dean(CET)
 - b) Student has to register for the Summer semester course and pay the prescribed fee within the specified time limit.
 - c) Withdrawal from Summer semester courses is not permitted
 - d) These courses will be conducted for 7 to 8 weeks during summer vacation
 - e) A student has to obtain a minimum of 75% attendance in each of these courses.
 - f) All assessments as specified in the syllabus for that course have to be undertaken by the students.

- (ii) Further, the course offering and the number of courses to be offered during summer semester is at the sole discretion of the department or school depending on the enrolment and availability of resources with approval of Dean (CET).

R 3.6 During the Break of Studies, a student:

- (i) Cannot attend any regular classes
- (ii) Will not be permitted to stay in the 'Hostel' facility provided by SRMIST
- (iii) Will not be permitted to participate in any of the SRMIST's activities inside and outside the campus.
- (iv) Can register for Summer Semester courses for such courses in which he / she might have obtained an 'I' grade or 'F' grade or absent for end semester exam with 'Ab'.

R 3.7 Adding and dropping courses: This is applicable only to Professional Elective and Open Elective courses.

- (i) A student may withdraw from an elective course without academic penalty only during the first 2 weeks of the semester.
- (ii) Registering for a new elective course is permitted only during the first two weeks of the semester.
- (iii) If an elective course is dropped within the first two weeks of the commencement of classes, the dropped course does not appear in the academic transcript. In case, the course is dropped any time after 2 weeks unilaterally by the student, for reasons whatsoever, it will be recorded with a mark of "Ab" or "I" as applicable
- (iv) When a Professional Elective / Open Elective course is added within the permissible timeframe, the attendance will be calculated from the date of registering the newly added course. No make-up classes need be conducted for the individual student to compensate for the missed classes.
- (v) If a student has failed in an elective course (Professional / Open), he/she can drop that course and register for a new elective course in the subsequent semester without exceeding the maximum allowed credits in a semester. This is permitted only with the concerned department's approval.

R 3.8 Guided study / Self-Learning: Students who maintain CGPA 9.5 and above will have the flexibility of self-learning an existing **approved elective courses** with prior permission from department starting from Semester-VI. The maximum number of such courses that a student will be permitted by the Department will be TWO for the entire programme. This will be guided and assessed by faculty, **and students will have to undertake all assessments and must appear for end semester examinations.** This will be counted for CGPA.

R 4.0 Teaching and Assessments

R 4.1 Medium of Instruction: English is the medium of instruction, including for examination and project report.

R 4.2 Mode of Instruction: The mode of instruction shall be through physical mode / blended (online / offline) mode, depending on the nature of the course and / or the guidelines of the statutory bodies or the Government. The annual tuition fee for the programme remains the same irrespective of the mode of instruction. The department MUST necessarily take the approval from Dean CET if the mode of instruction for the entire course is online. The CoE must be informed if the mode of instruction is fully online.

R 4.3 Teaching and Assessment in 5th year:

In general, students are recommended to undergo all the theory/lab/project works in the department in on-campus mode. However, students can opt for complete online mode of learning for courses and project during 9th and 10th semesters and use the concept of MOOC and Industry Projects and do all internal assessments as prescribed and take up end semester examinations as decided during the time. Students can choose any one mode of the following two options:

For those who do Internships arranged by SRMIST/ Project in Industry:

- (i) Students can choose industry based MOOC courses instead of Professional/Open Electives in 9th semester as approved, by following the regular course approval process, subject to **R2.5**
- (ii) However, students have to appear for all continuous assessments, end semester examination for those elective courses in online mode.
- (iii) Specialization Project can be taken up in the Industry, R&D organisation, but all reviews of Project need to be attended as prescribed in the academic calendar by the department including the end semester viva-voce examination.
- (iv) There will be one Internal Project guide assigned by the department and a Co-guide from the industry.

R 4.4 Assessment Design:

The learning of a student is assessed and evaluated by the course facilitating faculty member/ department. All assessments are designed based on Revised Bloom's Taxonomy levels of thinking and learning.

Assessments are conducted to check one or more of the following learning capabilities, depending on the nature of a course: (a) Critical Thinking (b) Problem Solving (c) Analytical Reasoning (d) Scientific Reasoning (e) Reflective Thinking (f) Design thinking.

R 4.5 Types of Learning Assessments:

- (i) The student's learning in each course, in general, is assessed and evaluated based on in-semester Continuous Learning Assessment (CLA) (formative) AND / OR end-semester Final Examination (summative). This is identified by the assessment table at the end of course syllabus. Each of these examinations can be of **Closed Book Type (or) Open Book Type**. The type of examination will be explicitly defined in the respective syllabus of the course.
- (ii) In order to verify the different skills acquired in a student, the CLA's are assessed (as appropriately) through:
 - (a) Oral Learning Assessments/Evidences
 - (b) Written Learning Assessments/Evidences
 - (c) Demonstrative Learning Assessments/Evidences
- (iii) The end-semester examination will be conducted at the end of each semester, and shall have learning assessments from the following perspectives with respect to all courses:
 - a. Evaluation with respect to Knowledge and/or Understanding
 - b. Evaluation with respect to Applications and/or Analysis
 - c. Evaluation with respect to Evaluation and/or Creative Abilities

(iv) Learning Assessment Procedure

Various modes of assessment are used for rating students performance in a course:

Formative: Continuous Learning Assessments (CLAs) may be conducted after the completion of every learning unit/module as Oral / Written / Demonstrative / Practice Assessments as decided by the Course Coordinator (CLA-I).

Lifelong Learning: (a) To THINK INDEPENDENTLY (b) To COMMUNICATE EFFECTIVELY (c) To DEVELOP CONTINUOUSLY (d) To ACT RESPONSIBLY

A combination from among one or more of these options (CLA-II)

Higher Order Thinking (HOT) Assignments	Surprise Tests	Viva Voce	Multiple Choice Quizzes
Tech. Talks	Field Visits	Self-Study	Group Discussions
Projects based learning	Case-Study	Group Activities	Seminar
Presentations	Debates	Conference Papers	Coding

Summative: End-Semester Examination

(v) Fully Internal Course

This type of course will be a fully internal course, wherein students are evaluated by only continuous learning assessments. There will not be any end semester examination for this course. The courses like Project come under this category. Depending on the course, whether it is pure theory (or) pure practical (or) joint course the respective components will be used for assessments as specified in the curriculum and syllabus.

(vi) Appropriate guidelines along with rubrics for the following will be provided by the Curriculum Committee, which may be reviewed annually by the Curriculum Committee for enrichment of quality assurance:

- (a) Summer Semester
- (b) Internship
- (c) Community Connect

Accordingly the department will implement the same.

R 4.6 Learning Assessment Weightage: The learning assessment weightage in percentages for every type of course are provided in the respective course syllabus, and follows the respective template as given below:

(i) Theory-cum-Practise Courses (J -Joint Courses) [practise – Perform | Apply | Observe | Train]

The course will be structured in such a manner that the topics learnt in the theory portion (Theory hour) will be practised (Tutorial Hour) to observe, understand, apply and perform the concepts learned.

Student learning from the theory and practice portions in a course shall be assessed by assigning a weightage as shown in the table below:

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life Long Learning CLA-2- Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	%	-	-	%	%	-
Level 2	Understand	%	-	-	%	%	-
Level 3	Apply	%	-	-	%	%	-
Level 4	Analyze	%	-	-	%	%	-
Level 5	Evaluate	%	-	-	%	%	-
Level 6	Create	%	-	-	%	%	-
	Total	100 %		100 %		100 %	

(ii) Theory Courses (T)

This type of course will be a pure theory based course, in which classroom teaching will happen along with all internal assessments assessed by the faculty. At the end of the semester, there will be an end semester examination conducted as per the procedure specified earlier. The CLA-II can be assessed as specified in R4.6.

Student learning shall be assessed with a weightage of 60% for internal assessment and 40% for end semester examination

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	%	-	%	-	%	-
Level 2	Understand	%	-	%	-	%	-
Level 3	Apply	%	-	%	-	%	-
Level 4	Analyze	%	-	%	-	%	-
Level 5	Evaluate	%	-	%	-	%	-
Level 6	Create	%	-	%	-	%	-
	Total	100 %		100 %		100 %	

(iii) Project Based Theory Courses (P) (FULLY INTERNAL)

In this course, a project must be carried out and a report must be submitted at the end of the course. 20% weightage is given for average of unit tests as CLA-I and 60% weightage is given for project demo/presentation as CLA-2. The course faculty will assess the report and conduct the viva-voce.

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		CLA-1 Average of unit test (20%)		CLA-2 Project Based Learning (60%)		Report and Viva Voce (20% Weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	%	-	-	%	-	%	-	-
Level 2	Understand	%	-	-	%	-	%	-	-
Level 3	Apply	%	-	-	%	-	%	-	-
Level 4	Analyze	%	-	-	%	-	%	-	-
Level 5	Evaluate	%	-	-	%	-	%	-	-
Level 6	Create	%	-	-	%	-	%	-	-
	Total	100 %		100 %		100%			

(iv) Laboratory / Practical Courses (L) (FULLY INTERNAL)

The assessment in a laboratory course will be based on manner or effectiveness of carrying out experiments, such as observations, collection of data, analysis, interpretation of results, inferences, performance in viva voce examinations, timely submission of record work done, and an end semester end exam that contains an experiment and / or a written

examination. It is obligatory to maintain a laboratory record as prescribed by the course instructor. In case of absence from Semester end examination, the same rules as those for theory courses are applicable.

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	%	-	%	-	%		
Level 2	Understand	-	%	-	%	-	%		
Level 3	Apply	-	%	-	%	-	%		
Level 4	Analyze	-	%	-	%	-	%		
Level 5	Evaluate	-	%	-	%	-	%		
Level 6	Create	-	%	-	%	-	%		
	Total	100 %		100 %		100%			

(v) **Training/Community Connect**

Students shall undergo Training (either in an Industry or in a Research Centre or in a higher educational institution)/Community Connect (Service in government recognized NGOs/Hospitals/Service organizations) for a duration of 4 to 6 weeks during the IV semester vacation. At the end of the training/community connect, the student shall submit a report to the department and make a presentation during the 5th semester, which will be assessed by a committee constituted by the department or school.

(vi) **Project**

The evaluation for the Project will be based on continuous learning assessment only and there will not be end semester examination.

	Continuous Learning Assessment (100% weightage)				Final Examination (0%)
	Review - 1	Review - 2	Project Report	Viva-Voce	
Project (6 th semester)	30 %	40%	10 %	20 %	

(vi) **Major Project/Specialization Project**

- a) The assessment method for the Project works consists of in-semester CLA and end semester evaluations as detailed below:

	Continuous Learning Assessment (100% weightage)				
	Review - 1	Review - 2	Review - 3	Project Report	Viva-Voce
Major Project (8 th semester)	10 %	20 %	30 %	10 %	30 %
Specialization Project (10 th semester)	10 %	20 %	30 %	10 %	30 %

- b) Both Major project and Specialization Project are advisable to be published in a referred or indexed journal and the evidence of publication or the evidence of submitting to the journal is mandatory for appearing in the final viva voce.

R 5.0 Programme Requirements

R 5.1 Semester Duration: Each semester of study shall normally consist of 90 working days or 450 hours inclusive of end-semester final examinations. A student is ordinarily expected to complete the Programme in the expected number of full-semesters as specified below for a regular programme. However, a student may complete the programme at a slower pace by taking more time but in any case, not more than the semesters specified below for each programme excluding semesters withdrawn on medical grounds etc.

In compliance with the rules and norms of UGC, no student will be allowed to complete the Programme in less than the minimum duration specified for each Programme.

- (i) Diploma – 6 full semesters with maximum of 10 semesters
- (ii) B.Tech Degree – 8 full semesters with maximum of 12 semesters
- (iii) M.Tech (Integrated) Degree – 10 full semesters with maximum of 14 semesters

R 5.2 Temporary withdrawal from the programme: A student may be permitted by the Dean CET to withdraw from the programme for a semester or longer for reasons of ill health or other valid reasons. Normally a student will be permitted to discontinue from the programme only for a maximum continuous period of two semesters or the aggregate of individual discontinuation not exceeding two semesters.

R 5.3 Exit option and award of Diploma: Students who join the 4 year B.Tech degree program/5 year M.Tech (Integrated) program can opt for a diploma at the end of 3 years and after successfully completing the specified number of credits subject to the following:

- (i) This exit option will be allowed only under exceptional circumstance and not as a matter of rule. The institution intends that all students graduate with minimum an undergraduate degree.
- (ii) The students opting for exit option shall inform the HoD in writing before the commencement of 5th semester examinations.
- (iii) HoD shall carefully consider the request and the reasons cited for it.
- (iv) HoD shall try to convince the student to continue with degree program only.
- (v) HoD shall also contact the parents to stress the advantages of completing the degree program just by spending one more year in the institution.
- (vi) In spite of all such efforts if the student wishes to exercise the exit option, the same may be granted by the Dean on the recommendation of the HoD.

R 6.0 Conduct and Discipline

R 6.1 Expected Conduct and Discipline: Every student is required to:

- (i) Demonstrate ethical, professional and exemplary conduct and decorous behaviour both inside and outside SRMIST campus and not to indulge in any activity that will tend to bring down the prestige/image of the individual as well as SRMIST.
- (ii) Be self-motivated and to be self-disciplined
- (iii) Make the most of their ability and to contribute to the happiness and well-being of SRMIST community by supporting others.
- (iv) Treat others in the way that they would wish to be treated themselves
- (v) Abide by the orders of the Honourable Supreme Court of India, and not to get involved in any acts of ragging in any form. Ragging is absolutely and completely prohibited in SRMIST.
- (vi) Avoid Plagiarism, cut and paste jobs, malpractices of any kind in learning assignments including project work and its reports.

R 6.2 Act of Indiscipline: A student who does not conduct in the manner expected of and as stated above is considered to be performing an act of Indiscipline.

- (i) Acts of Indiscipline are dealt with at zero tolerance

- (ii) Any acts of Indiscipline of a student is first to be considered by the Student Discipline Committee of the Department/School for necessary action. If the issue demands more serious consideration, the act of indiscipline will be reported to the Dean CET and he will refer it to the Discipline and Welfare Committee of SRMIST, constituted by the Vice Chancellor. The Committee will enquire into the charges and recommend suitable action if the charges are substantiated. The Dean CET will take appropriate action on the recommendation of the Discipline and Welfare Committee of SRMIST.
- (iii) Anyone found indulging in ragging or any such acts is liable to be dismissed forthwith.

R 6.3 Suspension: Dean CET may suspend a student pending inquiry depending upon the prima facie evidence.

R 6.4 Appeal: The aggrieved student may appeal to the Vice Chancellor whose decision will be final and binding.

R 7.0 Attendance

R7.1 Attendance Definition: It is the physical presence and active learning participation of a student in the class / laboratory / field work etc. It is a well-observed fact that the students who score good grades are those who attend and participate in all the assigned learning activities in the class / laboratory / field work, regularly. Therefore, the students must strive to attend and sincerely participate in all the assigned learning activities without fail.

R 7.2 Attendance Percentage & Code: Every faculty member facilitating a course will take notice of student attendance and their learning participation till the last instruction day in the semester. The percentage of attendance, calculated up to this point, will be indicated by a code number/letter as follows:

Attendance rounded to	Code
95% and above	H
85 to 94%	9
75 to 84%	8
Below 75%	L

R 7.3 Minimum Attendance: A student must strive to attend all the classes without fail. A student must maintain a minimum attendance record of at least 75% in individual courses, exclusive of leave of absence due to: medical reasons, accidents, on-duty, extra-curricular / extramural activities, permitted assignments such as job interviews, inter-university sports meet, inter-university competitions, unforeseen emergencies etc., which can add up to 25%.

- (i) Without the minimum attendance of 75%, in any course, students become ineligible to appear for the end semester examination in that course.
- (ii) His / Her registration for that course will be treated as cancelled, and he/she shall be awarded 'I' grade (I stands for Incomplete or registration cancelled for want of minimum attendance) in that course. This grade shall appear in the grade card until the course is successfully completed.
- (iii) It is the responsibility of each and every student to keep track / monitor his / her percentage of attendance for each course and ensure that he / she satisfies the attendance norms prescribed by SRMIST. If the student finds any discrepancy / error in the attendance status, he /she should immediately bring it to the attention of the concerned faculty member and seek redressal.

R 7.4 Attendance Shortage and Examination: The teacher shall prepare the particulars of all students who have attendance less than 75% in his / her course. Percentage of attendance is calculated for each and every course. Copies of the same should also be sent to the Dean CET, and Heads of Schools/ Departments concerned. The students who have less than 75% attendance in a course will not be permitted to appear in Final end semester examination of that course but awarded 'I' Grade in that course and the same will be informed to the student's parents.

R 7.5 Condonation of Attendance: In rare and genuine cases, a committee consisting of Head of the Department and Senior Faculty members of the concerned department will examine the case, based on the documents submitted by the student, facts and circumstances. Assessment will be done, by the committee, on the merit of the case and spell out their recommendation to the Dean CET. Based on the recommendation of the committee, Dean CET may then give condonation of attendance, only if he deems it fit and deserving but in any case, the condonation cannot exceed 10%.

R 8.0 Examination and Award of Degree

R 8.1 Course Wise Grading of Students: Letter Grades and Grade Points (GP) are earned by the student for each course based on the aggregate of marks obtained through continuous learning assessments and end-semester final examination. The letter grades and the corresponding grade points, as recommended by UGC, are as follows:

Letter Grade	Grade Points	Mark Range
O (Outstanding)	10	91 - 100
A+ (Excellent)	9	81 - 90
A (Very Good)	8	71 - 80
B+ (Good)	7	61 - 70
B (Above average)	6	56 - 60
C (Average)	5	50 - 55
F (Fail)	0	<50
Ab (Absent)	0	Failure due to insufficient marks in the course
I (Incomplete)	0	Failure due to non-appearance in examination
		Failure due to insufficient attendance in the course.

- For mandatory non-credit courses letter grade will be awarded and this will not be counted for the computation of SGPA/CGPA.
- For non-credit audit courses which are not mandatory for the award of degree, if a student has successfully undergone them, then only such courses will be listed in the transcripts.
- A student is considered to have successfully completed a course and earned the credits if he / she secured a letter grade other than 'F' or 'Ab' or 'I' in that course. A letter grade 'F' or 'Ab' or 'I' in any course implies a failure to have completed the course.
- A course successfully completed cannot be repeated.

R 8.2 Method of Awarding Letter Grades: The internal marks awarded to the students are first normalized and combined with the normalized marks of end-semester final examination. Subsequently letter grades are awarded for the normalized marks as indicated in the table under section R8.1. The detailed methodology of normalization of internal marks as well as marks in the end-semester final examinations shall be formulated by the Controller of Examinations. To 'Pass' a course with earnable credits a student has to score a minimum of 50% of the total normalized marks secured in both the continuous learning assessments and the end-semester final examination.

R 8.3 Declaration of Results: Normalized marks are referred to the Result Passing Board for the finalization of results. Controller of Examinations announces the results. The 'Ab' / 'I' / 'F' grade once awarded stays in the record of the student and is deleted when he/she completes and passes the course successfully later. The grade acquired by the student will be indicated in the grade card of the appropriate academic year with an indication of the month and the year of passing of that course. The CGPA will be accordingly revised.

R 8.4 Re-view of Answer scripts: In case any student feels aggrieved on the final outcome of the learning assessment in any THEORY course (Descriptive component only), the student shall apply to the Controller of Examinations, along with the prescribed fee, for the review of only the end-semester final examination answer scripts, within the stipulated time after the announcement of the results of the examinations. The Controller of Examinations shall facilitate the review of the answer script jointly to be carried out by the student and the faculty detailed for this purpose. If any discrepancy is noticed during review the same shall be rectified and the originally awarded grade would be accordingly amended.

R 8.5 Grade Card: The grade card issued by the Controller of Examinations to each student, after the announcement of the results will contain the following:

- The credits for each course registered for that semester
- The letter grade obtained in each course
- The attendance code in each course
- The total number of credits earned by the student up to the end of that semester
- The Semester Grade Point Average (SGPA) and the Cumulative Grade Point Average (CGPA) of all the courses taken from the I semester onwards for regular students.

R 8.6 Computation of CGPA / SGPA: Computation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

- SGPA** will be calculated according to the formula: $SGPA = \frac{\sum_1^n C_i \times (GP)_i}{\sum_1^n C_i}$
 - Where C_i = credit for the i^{th} course, $(GP)_i$ = the grade point obtained for the i^{th} course, n = total number of courses and the sum is over all the courses taken in that semester, including those in which the student has secured F grades.
- CGPA** (Cumulative Grade Point Average) is calculated using: $CGPA = \frac{\sum_1^r S_i \times (SGPA)_i}{\sum_1^r S_i}$
 - where S_i = Sum of credits in i^{th} semester, $(SGPA)_i$ = Semester Grade Point Average earned in i^{th} semester and r = number of semesters and the sum is over all the semesters under consideration.
- The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

R 8.7 Equivalent Percentage Calculation:

Normally CGPA score is reflected in the grade sheet. The equivalent percentage of marks for CGPA shall be calculated as follows

$$\text{Equivalent Percentage of marks} = (\text{CGPA} \times 10)$$

R 8.8 Class / Distinction:

- Integrated M.Tech Degree** with Class / Distinction will be awarded to the students after they successfully complete the Programme as per the norms stipulated in the following table:

Category	CGPA (From I to X semesters)	Class / Distinction
Students who successfully complete the Programme within the time duration of 10 semesters (R5.1)	≥ 5.0 & < 6.0	Second Class
	≥ 6.0 & < 8.0	First Class
	≥ 8.0 (without 'Ab' or 'F' or 'T' or 'temporary withdrawal' in any Semester)	First Class with Distinction
	≥ 8.0 (with 'Ab' or 'F' or 'T' in any Semester but obtained pass grade ('O' to 'P') subsequently)	First Class

Students who cannot complete the Programme in 10 semesters but complete it successfully within the time duration of 11 semesters (R5.1)	≥ 5.0 & < 6.0	Second Class
	≥ 6.0	First Class
Students who cannot complete the Programme in 11 semesters but complete it successfully within the time duration of 14 semesters (R5.1)	≥ 5.0	Second Class

- (ii) **B.Tech Degree** with Class/Distinction will be awarded to those students who opt for early exit from the Integrated Programme after they successfully complete the Programme as per the norms stipulated in the following table:

Category	CGPA (From I to VIII semesters)	Class / Distinction
Students who successfully complete the Programme within the time duration of 8 semesters (R5.1)	≥ 5.0 & < 6.0	Second Class
	≥ 6.0 & < 8.0	First Class
	≥ 8.0 (without 'Ab' or 'F' or 'T' or 'temporary withdrawal' in any Semester)	First Class with Distinction
	≥ 8.0 (with 'Ab' or 'F' or 'T' in any Semester but obtained pass grade ('O' to 'P') subsequently)	First Class
Students who cannot complete the Programme in 8 semesters but complete it successfully within the time duration of 9 semesters (R5.1)	≥ 5.0 & < 6.0	Second Class
	≥ 6.0	First Class
Students who cannot complete the Programme in 9 semesters but complete it successfully within the time duration of 12 semesters (R5.1)	≥ 5.5	Second Class

- (i) **Diploma** with Class/Distinction will be awarded to those students who opt for early exit from the Integrated Programme after they successfully complete the Programme as per the norms stipulated in the following table:

Category	CGPA (From I to VI semesters)	Class / Distinction
Students who successfully complete the Programme within the time duration of 6 semesters (R5.1)	≥ 5.0 & < 6.0	Second Class
	≥ 6.0 & < 8.0	First Class
	≥ 8.0 (without 'Ab' or 'F' or 'T' or 'temporary withdrawal' in any Semester)	First Class with Distinction
	≥ 8.0 (with 'Ab' or 'F' or 'T' in any Semester but obtained pass grade ('O' to 'P') subsequently)	First Class
Students who cannot complete the	≥ 5.0 & < 6.0	Second Class
	≥ 6.0	First Class

Programme in 6 semesters but complete it successfully within the time duration of 7 semesters (R5.1)		
Students who cannot complete the Programme in 7 semesters but complete it successfully within the time duration of 10 semesters (R5.1)	≥ 5.0	Second Class

R 8.9 Academic Dishonesty: When a student is found responsible for a violation of the SRMIST code of conduct pertaining to academic dishonesty (Malpractice in Examinations), the Office of Controller of Examinations will initiate action based on the pre-approved procedures. Appropriate penalty or punishment will be awarded to the student and communication sent to the concerned Head of the Institution. The matter will be informed to the student's parents/guardian duly.

R 8.10 Eligibility for Award of the M.Tech.(Integrated) Degree: A student shall be declared to be eligible for the award of the M.Tech.(Integrated), if he/she has

- Registered and successfully completed the courses and Specialization project as per the curriculum and obtaining an aggregate of learning credits totalling **210 credits**
- Successfully acquired the required learning credits as specified in the curriculum corresponding to the branch of his/her study within the stipulated time duration as given in R 5.1.
- No disciplinary action is pending against him/her.

R 8.11 Eligibility for Award of the B.Tech Degree: A student shall be declared to be eligible for the award of the B.Tech, if he/she has

- Registered and successfully completed the courses and Major Project as per the curriculum and obtaining an aggregate of learning credits totalling **160 credits**
- Successfully acquired the required learning credits as specified in the curriculum corresponding to the branch of his/her study within the stipulated time duration as given in R 5.1.
- No disciplinary action is pending against him/her.

R 8.12 Eligibility for Award of the Diploma: A student shall be declared to be eligible for the award of Diploma, if he/she has

- Registered and successfully completed the courses as per the curriculum and obtaining an aggregate of learning credits totalling **127 credits**
- Successfully acquired the required learning credits as specified in the curriculum corresponding to the branch of his/her study within the stipulated time duration as given in R 5.1.
- No disciplinary action is pending against him/her.

R 8.13 Minor certification:

- Minor is an option rather than a requirement for B. Tech or Integrated MTech students. They may opt for one of the Engineering or Non-engineering discipline as Minor, earning additional credits ranging from 18 to 20. However, students are permitted to choose only one Minor either from engineering or Non-engineering discipline.
- This additional certification is for students who pursue Major in a discipline but would still like to pursue their passion in another discipline or to enrich/equip themselves for a specific profession where greater job opportunities exist. Another advantage of opting for a Major with a Minor is to earn standing credits for pursuing a specialized research in R&D centers in India or abroad
 - In order to successfully complete a Minor, a student must earn a minimum of 18-20 credits over and above the maximum credits required for his / her regular (Major) field of study.

- b) The student who opts for a Minor and satisfies the credit requirements as per the regulations, will be awarded a Certificate in Minor in addition to the Degree in Major or Degree in Major with Specialization, as the case may be.
- c) Further, this Minor certification is not eligible for students who opt for early exit for a Diploma.
- (iii) **Eligibility Criteria**
Only students who satisfy a set of minimum eligibility criteria set forth by the university and meet certain pre-requisites, will be permitted to opt for a Minor. A student will be permitted to pursue a Minor, if and only if, he / she fulfils the following criteria:
 - a) Must have secured a minimum of 7.0 CGPA upto semester-V
 - b) There must NOT be any standing arrears / Backlogs.
 - c) Must be in the active rolls of the department without any break of study or disciplinary action pending against the student
 - d) Must have NO outstanding fee dues

R 8.14 B.Tech Honors Degree : Students who consistently maintain CGPA 8.5 and above along with no history of arrears will get a Honors Degree by earning additional 12 credits from the professional electives and / or research and / or Co-Curricular and / or Extra-Curricular, and / or Extra Mural activities, conforming to the approved guidelines prescribed by the College of Engineering & Technology. It is applicable from Semester-IV onwards. This clause is not applicable for students who opt for early exit for a Diploma.

R 8.15 Deviation in Procedure: Whenever there is a deviation from procedures as warranted by the unique nature of the course, the same will be specified by the concerned Course Coordinator and approved by the Dean CET.

R 8.16 Change of Regulations: Any part of this regulation can be modified by the Academic Council of SRMIST.

ACADEMIC CURRICULA
UNDERGRADUATE/ INTEGRATED
POST GRADUATE DEGREE
PROGRAMME

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203,

Tamil Nadu, India

25. B.Tech. in Computer Science and Engineering with Specialization in Internet of Things

25. (a) Mission of the Department

Mission Stmt - 1	<i>To impart knowledge in cutting edge Computer Science and Engineering technologies in par with industrial standards.</i>
Mission Stmt - 2	<i>To collaborate with renowned academic institutions to uplift innovative research and development in Computer Science and Engineering and its allied fields to serve the needs of society</i>
Mission Stmt - 3	<i>To demonstrate strong communication skills and possess the ability to design computing systems individually as well as part of a multidisciplinary teams.</i>
Mission Stmt - 4	<i>To instil societal, safety, cultural, environmental, and ethical responsibilities in all professional activities</i>
Mission Stmt - 5	<i>To produce successful skilled IoT engineers to emerge as independent entrepreneurs and future leaders.</i>

25. (b) Program Educational Objectives (PEO)

PEO - 1	<i>Graduates will be able to perform in technical/managerial roles ranging from design, development, problem solving to production support in software industries and R&D sectors.</i>
PEO - 2	<i>Graduates will be able to successfully pursue higher education in reputed institutions.</i>
PEO - 3	<i>Graduates will have the ability to adapt, contribute and innovate new technologies and systems in the key domains of Computer Science and Engineering.</i>
PEO - 4	<i>Graduates will be ethically, eco-friendly and socially responsible solution providers in Computer Science and other engineering disciplines.</i>
PEO - 5	<i>Graduates will be able to demonstrate their leadership abilities with IoT skills while addressing various social issues in an industrial, entrepreneurial, and research setting.</i>

25. (c) Mission of the Department to Program Educational Objectives (PEO) Mapping

	Mission Stmt. – 1	Mission Stmt. – 2	Mission Stmt. – 3	Mission Stmt. – 4	Mission Stmt. – 5
PEO – 1	3				1
PEO – 2		3	1		
PEO – 3	3		3		
PEO – 4		2		3	
PEO – 5				3	3

3 – High Correlation, 2 – Medium Correlation, 1 – Low Correlation

25. (d) Mapping Program Educational Objectives (PEO) to Program Outcomes (PO)

	Program Outcomes (PO)											
	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning
PEO – 1	3			1		2		3	2	3		
PEO – 2		2	2		3		3	2				
PEO – 3		3	3	2						2		3
PEO – 4		2	3			3	2		2		2	2
PEO – 5						3			3	3	3	3

3 – High Correlation, 2 – Medium Correlation, 1 – Low Correlation

25. (e) Program Structure: B.Tech. in Computer Science and Engineering with Specialization in Internet of Things

1. Humanities & Social Sciences including Management Courses (H)						
Course Code	Course Title	Hours/ Week				C
		L	T	P		
21LEH101T	Communicative English	2	1	0		3
21LEH102T	Chinese					
21LEH103T	French					
21LEH104T	German					
21LEH105T	Japanese					
21LEH106T	Korean					
21LEH107T	Spanish					
21GNH101J	Philosophy of Engineering	1	0	2		2
21PDH201T	Social Engineering	2	0	0		2
21GNH401T	Behavioral Psychology	2	1	0		3
Total Credits						13
3. Engineering Science Courses (S)						
Course Code	Course Title	Hours/ Week				C
		L	T	P		
21CSS101J	Programming for Problem Solving	3	0	2		4
21MES101L	Basic civil and Mechanical Engineering workshop	0	0	4		2
21MES102L	Engineering Graphics and Design	0	0	4		2
21EES101T	Electrical and Electronics Engineering	3	1	0		4
21CSS201T	Computer Organization and Architecture	3	1	0		4
21DCS201P	Design Thinking and Methodology	1	0	4		3
21CSS303T	Data Science	2	0	0		2
Total Credits						21
5. Professional Elective Courses © (Any 8 Elective Courses)						
Course Code	Course Title	Hours/ Week				C
		L	T	P		
21CSE264T	Introduction to IoT: Sensors, Actuators and Microcontrollers	2	1	0		3
21CSE265T	Introduction to Embedded Programming and Embedded OS	3	0	0		3
21CSE266T	IOT Architecture and Protocols	2	1	0		3
21CSE365T	Machine Learning for IoT	2	1	0		3
21CSE366T	Introduction to Cloud Application Development for IoT	2	1	0		3
21CSE367T	IoT Forensics	2	1	0		3
21CSE368J	Network Programming for IoT	2	0	2		3
21CSE369J	Introduction to Security of Internet of Things and Cyber-Physical Systems	2	0	2		3
21CSE370J	Data Visualization for IoT	2	0	2		3
21CSE371J	IoT Techniques, Tools and its application	2	0	2		3
21CSE467T	Advanced Database Systems	2	1	0		3
21CSE468T	Edge Computing	2	1	0		3
21CSE469T	Energy Management for IOT devices	2	1	0		3
21CSE470T	Applied Software Techniques in IoT Engineering	2	1	0		3
21CSE471T	Fundamentals of Cyber security	2	1	0		3
21CSE472J	Full Stack Development for IoT	2	0	2		3
21CSE473T	Deep Learning for IoT	2	1	0		3
21CSE474T	IoT Privacy	2	1	0		3
Total Credits						24
2. Basic Science Courses (B)						
Course Code	Course Title	Hours/ Week				C
		L	T	P		
21PYB102J	Semiconductor Physics and Computational Methods	3	1	2		5
21CYB101J	Chemistry	3	1	2		5
21MAB101T	Calculus and Linear Algebra	3	1	0		4
21MAB102T	Advanced Calculus and Complex Analysis	3	1	0		4
21MAB206T	Numerical Methods and Analysis	3	1	0		4
21MAB204T	Probability and Queueing Theory	3	1	0		4
21MAB302T	Discrete Mathematics	3	1	0		4
21BTB102T	Introduction to Computational Biology	2	0	0		2
Total Credits						32
4. Professional Core Courses I						
Course Code	Course Title	Hours/ Week				C
		L	T	P		
21CSC101T	Object Oriented Design and Programming	2	1	0		3
21CSC201J	Data Structures and Algorithms	3	0	2		4
21CSC202J	Operating Systems	3	0	2		4
21CSC203P	Advanced Programming Practice	3	1	0		4
21CSC204J	Design and Analysis of Algorithms	3	0	2		4
21CSC205P	Database Management Systems	3	1	0		4
21CSC206T	Artificial Intelligence	2	1	0		3
21CSC301T	Formal Language and Automata	3	0	0		3
21CSC302J	Computer Networks	3	0	2		4
21CSC303J	Software Engineering and Project Management	2	0	2		3
21CSC315J	Fog Computing	2	0	2		3
21CSC313J	Cloud Computing for IOT	2	0	2		3
Total Credits						42
3. Open Elective Courses (O) (Any 3 courses)						
Course Code	Course Title	Hours/ Week				C
		L	T	P		
21CSO351T	Web Programming	2	1	0		3
21CSO352T	Python Programming	2	1	0		3
21CSO353T	Mobile Application Development	2	1	0		3
21CSO354T	Data Analytics	2	1	0		3
Total Credits						9
7. Project Work, Seminar, Internship In Industry / Higher Technical Institutions (P)						
Course Code	Course Title	Hours/ Week				C
		L	T	P		
21GNP301L	Community Connect	0	0	2		1
21CSP302L	Project	0	0	6		3
21CSP303T	MOOC	3	0	0		
21CSP401L	Major Project	0	0	30		15
21CSP402L	Internship					
Total Credits						19
Mandatory Courses (M)						
Code	Course Title	Hours/ Week				C
		L	T	P		
21PDM101L	Professional Skills and Practices	0	0	2		0
21PDM102L	General Aptitude	0	0	2		0
21PDM201L	Verbal Reasoning	0	0	2		0
21PDM202L	Critical and Creative Thinking Skills	0	0	2		0
21PDM301L	Analytical and Logical Thinking Skills	0	0	2		0
21PDM302L	Employability Skills and Practices	0	0	2		0
21CYM101T	Environmental Science	1	0	0		0
21LEM101T	Constitution of India	1	0	0		0
21LEM201T	Professional Ethics	1	0	0		0
21LEM202T	Universal Human Values	1	0	0		0
21LEM301T	Indian Art Form	1	0	0		0
21LEM302T	Indian Traditional Knowledge	1	0	0		0
21GNM101L	Physical and Mental Health using Yoga					
21GNM102L	NSS	0	0	2		0
21GNM103L	NCC					
21GNM104L	NSO					
Total Credits						0

25. (f) Implementation Plan: B.Tech. in Computer Science and Engineering with Specialization in Internet of Things

Semester – I					
Code	Course Title	Hours/ Week			C
		L	T	P	
21LEH101T	Communicative English	2	1	0	3
21MAB101T	Calculus and Linear Algebra	3	1	0	4
21PYB102J	Semiconductor Physics and Computational Methods	3	1	2	5
21MES102L	Engineering Graphics and Design	0	0	4	2
21EES101T	Electrical and Electronics Engineering	3	1	0	4
21CSS101J	Programming for Problem Solving	3	0	2	4
21CYM101T	Environmental Science*	1	0	0	0
21PDM101L	Professional Skills and Practices	0	0	2	0
21LEM101T	Constitution of India	1	0	0	0
Total Credits					22

Semester – II					
Code	Course Title	Hours/ Week			C
		L	T	P	
21LEH102T	Chinese	2	1	0	3
21LEH103T	French				
21LEH104T	German				
21LEH105T	Japanese				
21LEH106T	Korean				
21LEH107T	Spanish				
21GNH101J	Philosophy of Engineering				
21MAB102T	Advanced Calculus and Complex Analysis	3	1	0	4
21CYB101J	Chemistry	3	1	2	5
21BTB102T	Introduction to Computational Biology	2	0	0	2
21CSC101T	Object Oriented Design and Programming	2	1	0	3
21MES101L	Basic Civil and Mechanical Workshop	0	0	4	2
21PDM102L	General Aptitude*	0	0	2	0
21GNM101L	Physical and Mental Health using Yoga	0	0	2	0
21GNM102L	NSS				
21GNM103L	NCC				
21GNM104L	NSO				
Total Credits					21

Semester – III					
Code	Course Title	Hours/ Week			C
		L	T	P	
21MAB206T	Numerical Methods and Analysis	3	1	0	4
21DCS201P	Design Thinking and Methodology	1	0	4	3
21CSS201T	Computer Organization and Architecture	3	1	0	4
21CSC201J	Data Structures and Algorithms	3	0	2	4
21CSC202J	Operating Systems	3	0	2	4
21CSC203P	Advanced Programming Practice	3	1	0	4
21LEM201T	Professional Ethics	1	0	0	0
21PDM201L	Verbal Reasoning	0	0	2	0
Total Credits					23

Semester – IV					
Code	Course Title	Hours/ Week			C
		L	T	P	
21MAB204T	Probability and Queueing Theory	3	1	0	4
21CSC204J	Design and Analysis of Algorithms	3	0	2	4
21CSC205P	Database Management Systems	3	1	0	4
21CSC206T	Artificial Intelligence	2	1	0	3
E	Professional Elective-I				3
21PDH201T	Social Engineering	2	0	0	2
21PDM202L	Critical and Creative Thinking Skills	0	0	2	0
21LEM202T	Universal Human Values	1	0	0	0
Total Credits					20

Semester – V					
Code	Course Title	Hours/ Week			C
		L	T	P	
21MAB302T	Discrete Mathematics	3	1	0	4
21CSC301T	Formal Language and Automata	3	0	0	3
21CSC302J	Computer Networks	3	0	2	4
21CSC313J	Cloud Computing for IOT	2	0	2	3
E	Professional Elective – II				3
O	Open Elective – I				3
21GNP301L	Community Connect	0	0	2	1
21PDM301L	Analytical and Logical Thinking Skills	0	0	2	0
21LEM301T	Indian Art Form	1	0	0	0
Total Credits					21

Semester – VI						
Code	Course Title	Hours/ Week			C	
		L	T	P		
21CSS303T	Data Science	2	0	0	2	
21CSC306J	Software Engineering Perspectives in Computer Game Development	2	0	2	3	
21CSC315J	Fog Computing	2	0	2	3	
E	Professional Elective – III				3	
E	Professional Elective – IV				3	
O	Open Elective – II				3	
21CSP302L	Project	0	0	6	3	
21CSP303T	MOOC	3	0	0		
21PDM302L	Employability Skills and Practices	0	0	2		0
21LEM302T	Indian Traditional Knowledge	1	0	0		0
Total Credits					20	

Semester – VII					
Code	Course Title	Hours/ Week			C
		L	T	P	
21GNH401T	Behavioral Psychology	2	1	0	3
E	Professional Elective – V				3
E	Professional Elective – VI				3
E	Professional Elective – VII				3
E	Professional Elective – VIII				3
O	Open Elective –III				3
Total Credits					18

Semester – VIII					
Code	Course Title	Hours/ Week			C
		L	T	P	
21CSP401L	Major Project	0	0	30	15
21CSP402L	Internship				
Total Credits					15

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 2

**(Syllabi for First Year Courses-All Programmes)
(Revised in July 2023)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

Contents (Volume-2)

<u>No</u>	<u>Syllabi for First Year Courses</u>	<u>Page No</u>
1	Humanities and Social Sciences including Management courses	3
	21LEH101T Communicative English	4
	21LEH102T Chinese	6
	21LEH103T French	8
	21LEH104T German	10
	21LEH105T Japanese	12
	21LEH106T Korean	14
	21LEH107T Spanish	16
	21GNH101J Philosophy of Engineering	18
	21MGH101T Fundamentals of Economics	20
	21MGH102T Fundamentals of Management	22
	21MGH103T Basics of Accounting and Costing	24
2	Basic Science courses	26
	21BTB102T Introduction to Computational Biology	27
	21BTB103T Biology	29
	21BTB104T Biology: Human Physiology And Anatomy	31
	21BTB105T Cell Biology.....	33
	21MAB101T Calculus and Linear Algebra	35
	21MAB102T Advanced Calculus and Complex Analysis.....	37
	21MAB301T Probability and Statistics	39
	21PYB101J Physics: Electromagnetic Theory, Quantum Mechanics, Waves and Optics	41
	21PYB102J Semiconductor Physics And Computational Methods	43
	21PYB104J Physics: Mechanics	45
	21CYB101J Chemistry	47
3	Non Credit Courses	49
	21CYM101T Environmental Science	50
	21LEM101T Constitution of India	52
	21PDM101L Professional Skills and Practices	54
	21PDM102T UHV-I: Universal Human Values – Introduction	56
	21PDM102L General Aptitude	58
	21GNM101L Physical and Mental Health using Yoga	60
	21GNM102L National Service Scheme	62
	21GNM103L National Cadet Corps	64
4	Engineering Science Courses	66
	21CSS101J Programming for Problem Solving	67
	21EES101T Electrical and Electronics Engineering	69
	21MES101L Basic Civil and Mechanical Workshop	71
	21MES102L Engineering Graphics and Design	73

21MES101T	Engineering Mechanics	78
21ASS101T	Applied Engineering Mechanics	80
21AUS101L	Artifact Dissection Laboratory	82
21AIS101J	Foundation of Data Analysis	84
5	Professional Core Courses	86
21BTC101T	Biochemistry	87
21BMC101J	Biomedical Sensors	89
21CEC101T	Building Materials in the Built Environment	91
21CHC101J	Physical and Analytical Chemistry	93
21CSC101T	Object Oriented Design and Programming	95
21EEC101J	Electric Circuits	97
21ECC101J	Electronic System and PCB Design	99
21ECC112J	Systems Programming	101
21EIC101J	Sensors and Actuators	103
21MHC101P	Elements of Mechatronics Systems	105
21NTC101T	Nanoscience and Nanotechnology	107
21NTC111T	Physics of Materials	109
6	Basic Sciences - Bridge Courses (For Lateral Entry Students)	111
21MAB205B	Mathematics	112
21PYB105B	Engineering Physics	114
21CYB102B	Chemistry	116

ACADEMIC CURRICULA

Humanities and Social Sciences
including Management Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21LEH101T	Course Name	COMMUNICATIVE ENGLISH	Course Category	H	HUMANITIES	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	English and Foreign Languages		Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1 :	provide an understanding about the importance of communication focusing on primary language skills (LSRW) in personal and professional contexts and also give practice to the learners in writing brief paragraphs using appropriate techniques												
CLR-2 :	enable the students to efficiently use English for accessing scientific and technical knowledge												
CLR-3 :	introduce the students the methods of using efficiently English in gaining knowledge through the internet and the vice versa. To make them understand the importance of acceptable online behaviors and the factors behind multiplicity in media projections of an event												
CLR-4 :	improve the learners' employability related communication skills and thereby equipping themselves for the increased opportunities for employment.												
CLR-5 :	equip the learners with the appropriate business vocabulary by introducing them to the nuances of business communication												

Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	demonstrate the various types, modes, channels and barriers of communication, focusing on LSRW skills and put this awareness into effective use.	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
CO-2:	incorporate the meanings of technical terms in a scientific text and explain the manufacturing process and interpret data	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
CO-3:	analyze digital platforms not only to acquire information from e-sources for developing research skills, analytical skills and problem-solving skills, but also to create e-content following the etiquettes of social media.	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
CO-4:	develop an understanding of the employability skills and how to develop them, which will gradually help them in their career exploration process.	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-
CO-5:	apply nuances of business communication effectively	-	-	-	-	-	-	-	-	2	3	-	-	-	-	-

Unit-1-Understanding Communication	9 Hour
Introduction to Definition and Process of Communication, Types of communication - verbal and nonverbal - Channels of communication –communication of contexts - types of contexts - barriers to communication- Basic listening models- Competitive or combative listening, passive and attentive listening, Active and reflective listening- Barriers of communication- -barriers to effective listening- Listening to speeches of pioneer engineers and making a critical review on them - Delivering presentations- extempore on language learning experiences – prepared speech on language learning strategies - Presentation techniques -Creating Visual Support-Developing Paragraphs -Strategies to manage the writing process, Précis Writing- Creative Writing- Expository essay- writing for clarity- summarizing – paraphrasing - Story through images, Autobiography of Concrete objects - writing slogans-Types of phrases, clauses and sentences- Sentence patterns - Word order of English	
Unit-2-English: The Language of Science & Technology	9 Hour
Scientific method and Engineering Design Process - Single sentence definition and Extended definition of technical terms-Describing types of technical problem through verbs and adjectives describing technical problems- Assessing and interpreting faults through words describing faults and their severity; phrases describing certainty/uncertainty; adjectives with prefixes describing technical problems- text :Air Transat Flight 235 Discussing dimensions and precision through phrases related to scale ;Describing design phases and procedures through phrases related to tolerance, length, width, thickness, etc., - Task-based activities- describing /explaining /defining /classifying objects, etc. - Scientific and technical texts, Skimming for main ideas, Scanning for specifics, Predicting, inferring and guessing the meaning, etc- note making- Abstracting-Interpretations & Transcoding (Pie Chart, Bar Diagram, Flow chart, Tables) - writing Instructions and Checklists -process description -describing the working of a machine and the manufacturing process- assignment and thesis writing -activity verbs-paper presentation - Specific Grammar Items in Scientific and Technical Communication (Use of modal auxiliaries in technical English, Conditional sentence connectives in technical communication.	

Unit-3- English in Digital World	9 Hour
Framing of search terms / keywords in search engines - tools to support synchronous communication such as webinar platforms, and asynchronous communication such as forums and social media. - What is online communication - types of online communication - advantages and disadvantages of online communication - Acceptable online roles and behaviors - netiquettes- etiquettes of social media – problems and opportunities in handling digital resources - presenting with audio and visual aids - Listening to the voice over of a short film/documentary - ted talks- Observing non-verbal cues- learning IPA, framing question tags, stress and intonation through online sources -Tools to check grammar, to cite references, to design logos, to check plagiarism - importance of academic integrity- analyzing the reasons why different sources take different angles while Mass media gives shape to an event as perceived in multiple countries.	
Unit-4 – English for Employability	9 Hour
Difference between career and job-Listening to interviews (choice of career) - Group discussion, Interview skills (Preparation for Interviews, Stress management), Telephone Interview conversation, Mock Interviews -Email writing, Email etiquettes, Job application and Curriculum Vitae - letter of motivation - it's role in job application - components of letter of motivation- critical reasoning- analyzing the text -Vocabulary building strategies - techniques of correct understanding of a text - Reading comprehension - Types of reading- Skimming, Scanning, Extensive reading and Intensive reading-Analysis, Error analysis, Abbreviations, Acronyms and Initialism - synonyms and antonyms, parallelism.	
Unit-5– Business English	9 Hour
Appropriate interactions in right contexts- role of interactions in team building - role of paralinguistic features in business communication - Role plays on –customer-centric marketing methods,- Telephone conversation- Negotiation-Listening to talks, Business conversations (short and long)-customer relationship management, methods of retaining customers.-Drawing and describing an organizational chart -Conducting meetings- writing notice, agenda and minutes-Writing paragraphs on the case studies, articles related to ethics- employment trends, Business English vocabulary- Report Writing (Feasibility and sales)- Memo- Circular-Public Notice - Enquiry & complaint letter- Proposal writing- writing Advertisement- caption and slogan Poster-Brochure-Voices , Tenses, Direct and Indirect, Connectives- Concord and Comparative forms	

Learning Resources	1. Swan, Michael. <i>Practical English Usage</i> . OUP, 1995. 2. Kumar Sanjay and Pushpa Lata. <i>Communication Skills</i> . OUP, 2011. 3. <i>Scientific English: A Guide for Scientists and Other Professionals</i> , 3rd Edition Paperback – Import, 16 June 2011	4. Graduate Attributes, Learning and Employability (English, Electronic book text, Hager Paul J) 5. Great Business English - Phrases, Verbs and Vocabulary for Speaking Fluent English by Hilary F. Moore Mba · 2013
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	-	10%	-	10%	-
Level 2	Understand	10%	-	10%	-	10%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	20%	-	20%	-	20%	-
Level 6	Create	20%	-	20%	-	20%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Usha Kodandaraman, ABK AOTS, Chennai. drushak@gmail.com	1. Dr. S. P. Dhanavel, IIT, Chennai. dhanavelsp@iitm.ac.in	1. Dr. P. Tamilarasan, SRMIST.
2. Ms. Steffi Pearl Vinodhini, LIC Financial Advisor, Chennai. Steffipearl8@gmail.com	2. Dr. S. Vijayakumar, B.S. Abdur Rahman Crescent Institute of Science and Technology, Chennai. vijayakumar@crescent.education	2. Dr. M.M. Umamaheshwari, SRMIST.

Course Code	21LEH102T	Course Name	CHINESE	Course Category	H	HUMANITIES				L	T	P	C
										2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		English and Foreign Languages	Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
CLR-1 :	Recall Chinese Pinyin, tones, scripts and greetings.															
CLR-2 :	Construct simple affirmative, negative, interrogative sentences with Chinese grammar. Apply numbers translate time and date in Chinese															
CLR-3 :	Apply basic grammar asking about nationality, direction, location.															
CLR-4 :	Translate sentences with more vocabulary knowledge.															
CLR-5 :	Apply construction and few frequently used words framing sentences; acquire knowledge about Chinese festival and city.															
Course Outcomes (CO):																
At the end of this course, learners will be able to:																
CO-1:	Write Chinese Romanization , Outline of China and the Chinese speaking countries, basic characters, Greetings	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-2:	Construct basic conversations with simple sentences, counting numbers, Greet each other, express time and date in Chinese.	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-3:	Create WH words make interrogative sentence, translate sentences into Chinese.	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-4:	Develop the knowledge of various Chinese grammar and vocabulary and introduce own self.	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-5:	Implement knowledge about Chinese festivals and culture, adapt conversational skills	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-

Unit-1 -	9 Hour
Chinese speaking country - Introduction of initials and finals in Mandarin - Tables of combination of initials and finals in Putonghua (Mandarin) - Basic greetings and phrases used in daily life (In Pinyin) - Introduction of Four Tones in Chinese language - Pronounce words using Four Tones. - Introduction of Chinese characters - The eight basic strokes of characters - Chinese characters with proper stroke orders. - Personal Pronouns and relations words - Plural forms of pronouns - Writing characters with proper stroke order - Sentence structure with the adjective 很, negative sentence with adjectives - adverb 也 - Interrogative particle 吗 and 呢, application & Usages - Possessive/ Structural Particle 的, Writing Chinese characters - basic conversation related to greetings - Writing greetings in characters with proper stroke order	
Unit-2-	9 Hour
Counting numbers and numeric system - Chinese monetary system (India, China and Taiwan), Sentences with currency. - Converse to greet others and express your need - Asking your need - Telling phone number in Chinese - Converting numbers - Time & time related greetings - Days, Seasons - The basic sentence patterns in Chinese, S - V - O sentences with detailed examples. Framing simple sentences - Introduce 是 and 不是 - Asking date and time - Introducing each other - Weekdays in Chinese, Month, Year & Writing Date - Introduction of 有 and 没有 - Framing of basic interrogative sentences with modal particle 吗 - Introduction of few basic interrogative words and framing basic interrogative sentences - asking Nationality - Introducing one's nationality	
Unit-3-	9 Hour
Making question with 几, 多少 - Asking price - Politely and formally asking names, Expressing apology. - Make sentences with 在, and few correlated location words like 这儿, 那儿 with example - Important locations used in daily life. - Asking about places - profession related vocabulary application with examples - Basic conversation about persons occupation - Asking about occupation.	

Unit-4 –	9 Hour
conversation how to make suggestion, how to accept of dealing suggestion and to make comments - Subject verb construction as its predicate - Fruit related vocabulary, application - Usage of verbs - Usage of adjectives with different adverbs - Sports & Games related vocabulary, special usages, application with examples.	
Unit-5 –	9 Hour
Conversation how to describe your family members and talk about university and department - Introduction & application of few frequently used words in Chinese (以前, 以后, 还是) -, application with examples. - Famous Chinese festivals - Introduction & Application of the basic optative verbs like 会, 能, 可以. Conversation how to describe likes, dislikes - Colour and vocabulary.	

Learning Resources	1. New Practical Chinese Reader Textbook - 1.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Korogi Yu, DGM, Renault Nissan, Japan	1. Ms. Woanyuh Zoe Tsou. Founder and proprietor, IF Lingua Cultural studio, Hsinchu, Taiwan.	1. Dr. P. Tamilarasan, SRMIST
	2. Dr. J. Mangayakarasi, Head, PG and Research, Dept. of English, Ethiraj College for Woman, Chennai	2. Ms. Poulomi Ghosal, SRMIST.
		3. Ms. Ling Yun Tsai, SRM IST

Course Code	21LEH103T	Course Name	FRENCH	Course Category	H	HUMANITIES				L	T	P	C
										2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		English and Foreign Languages	Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
CLR-1 :	Extend the knowledge in the French Language using basic grammar, Self-introduction and Greetings.															
CLR-2 :	Illustrate lexicon related to adjectives, prepositions, possessives Adjectives, using 1st group verbs.															
CLR-3 :	Construct phrases using 2nd group verbs, pronominal verbs, future tense and time, framing questions with Interrogative words.															
CLR-4 :	Make use of 3rd group verbs, demonstrative adjectives and vocabularies related to clothing.															
CLR-5 :	Utilize the adverbs related to alimentation, partitive articles and negation.															
Course Outcomes (CO):																
CO-1:	develop a dialogue by using French greetings, expressions and self- Introduction.	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-2:	create the map and find directions.	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-3:	write simple routine tasks using reflexive verbs.	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-4:	compile paragraph to describe a person with adjectives, colours and clothing.	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-5:	apply adverbs of quantity related to food in sentences.	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-

Unit-1 - : L'alphabet	9 Hour
Les accents - Les salutations - Les pronoms sujets - Les verbes : être, avoir, s'appeler, habiter - Se présenter / Présenter quelqu'un - S'informer sur qqn - Les articles indéfinis - communiquer en classe - Les nombres de 0 à 69 - Les jours - Les mois - Des portraits de pays francophones - Les articles définis - Les pronoms toniques - Demander poliment - Répondre poliment.	
Unit-2-	9 Hour
Les nombres de 70 à 1000 - Le 1er groupe verbe - Les verbes venir et aller - les professions - les couleurs - Les pays - la nationalité - Le genre des adjectifs - les nombre des adjectifs - Les prépositions de lieu (1) - Décrire son voisin - Décrire votre profession - La description physique - Les adjectifs possessifs (sing. / pl.) - Les orientations - les monuments - la monnaie - La famille	
Unit-3-	9 Hour
Les mots interrogatifs - Les verbes : Vouloir, pouvoir, devoir - les verbes pronominaux - Les 2eme groupes verbes - Faire une enquête - Les goûts des autres - Les temps libres et les loisirs - Parler de ses loisirs - Exprimer ses goûts / préférence - Exprimer une envie - Activité quotidienne - Le futur proche - L'heure - Demander / dire l'heure - Le système éducatif en France.	
Unit-4 -	9 Hour
Les adjectifs démonstratifs - le saisons - Les verbes : sortir, partir - Les 3eme groupes verbes - Proposer une sortie à qqn - Proposer à qqn de faire quelque chose - Apprécier qqn - Ne pas apprécier qqn - Les vêtements - Les adverbess de fréquence - Les adverbess de temps - Décrire une tenue - Décrire les accessoires - la mode en France - Demander le prix - Faire des courses.	
Unit-5-	9 Hour
Les articles partitifs (du..) et les quantités - Les verbes (er, ger, yer, cer) - Les adverbess de quantité - le pronom "en" de quantité - Les expressions de quantité - L'Impératif - Les habitudes alimentaires - la négation - Ecrire une recette - commander au restaurant - Donner son appréciation - S'exprimer à table - Les Fêtes en France.	

Learning Resources	1. SAISONS 1 - Didier – 2017						
	2. BIENVENUE - Course Book in French - Department of EFL, SRMIST - 2017.						
Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	
Course Designers							
Experts from Industry		Experts from Higher Technical Institutions			Internal Experts		
1. Ms. Woanyuh Zoe Tsou, Founder and proprietor, IF Lingua Cultural studio, Hsinchu, Taiwan		1. Mr. Eric Perrotel Attaché de coopération pour le français - Zone Sud Institut français en Inde - Embassy of France in India, Bureau de France - Chennai			1. Dr. P. Tamarasran, SRMIST.		
		2. Dr. J. Mangayakarasi, PG and Research, Dept. of English, Ethiraj College for Woman, Chennai.			2. Mr. J. Sabastian Satish, SRMIST		
					3. Dr. Walter Hugh Parker, .SRMIST,		

Course Code	21LEH104T	Course Name	GERMAN	Course Category	H	HUMANITIES	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	English and Foreign Languages		Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Help students learn about the country, its culture, basic grammar elements such as greetings, self - introduction, alphabet and numbers.		Engineering Knowledge	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2 :	Familiarize the basic sentence structure with corresponding verb conjugations.																
CLR-3 :	Introduce nominative elements and directions.																
CLR-4 :	Introduce accusative and time elements.																
CLR-5 :	Prioritize using modal verbs, separable verbs and possessive pronouns in real - time conversation.																
Course Outcomes (CO):		At the end of this course, learners will be able to:	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-1:	demonstrate the features of culture, geography, greeting and self - introduction.		-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-2:	construct simple sentences with personal pronouns and corresponding verb conjugations.		-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-3:	develop sentences with nominative elements and directions.		-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-4:	create conversational sentences using accusative and time elements.		-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-5:	express thoughts in sentences using modal verbs, separable verbs and possessive pronouns in real - time conversation.		-	-	-	-	-	-	-	-	-	3	-	3	-	-	-

Unit-1 :	9 Hour
Begrüßungen und Verabschiedungswörter, Sich vorstellen - Name, Zahlen (bis 100), Länder und Sprachen, Wohnort, Berufe, Hobbys, Verb Konjugationen - kommen, wohnen, leben, heißen, sein und sprechen, Buchstabieren, Telefonnummer und E - Mail - Adresse nennen, Bundesländer und Hauptstädte, W - Fragen - Wer, Wie, Wie alt, Was, Woher, Wo, Welche Warum, Tage, Monate, Jahreszeiten, Zeitangaben am, im, Grundsätzliche Redewendungen.	
Unit-2 :	9 Hour
Personal Pronomen im Nominativ, Konjugation - Regelmäßige Verben und Unregelmäßige Verben ausführlich lernen, Zahlen bis eine Million, Satzbau formulieren - Aussage Satz, Ja / Nein Frage Satz und W - Frage Satz, Formular ausfüllen, Grundsätzliche Redewendungen.	
Unit-3:	9 Hour
Wortschatz lernen - Plätze und Gebäude, Verkehrsmittel, Schulsachen, Technik und Geräte benennen, Adjektiv - Gegenteile, Nominativ - Bestimmter Artikel der, die, das, Unbestimmter Artikel ein, eine, ein, Negation kein, keine, kein, Nach dem Weg fragen und einen Weg beschreiben - links, rechts, geradeaus und die Himmelsrichtungen, Ordinal Zahlen lernen, einen Text verstehen und antworten.	
Unit-4 :	9 Hour
Lebensmittel - Über Essen und Getränke sprechen, Einkauf planen, Über preise wissen, Akkusative Bestimmter Artikel den, die, das, Unbestimmter Artikel einen, eine, ein, Negation keinen, keine, kein, Verben mit Akkusativ, W Fragen - Wen, Wie viel, Wohin, Wann, Wie oft, Wie viele, Wie lange, Die Uhrzeit verstehen und nennen - Singular und Plural, Texte verstehen und antworten.	

Unit-5: **9 Hour**

Modal Verben - müssen, können, wollen, sollen, möchten, dürfen, mögen, Modal Verb im Satz, Kurze Alltags Gespräch führen und verstehen, Trennbare Verben, Possessive Pronomen im Nominativ - mein, dein, sein . . . , Über die Familie schreiben und sprechen, Andere vorstellen, Präteritum - sein und haben, Texte verstehen und antworten.

Learning Resources	Netzwerk A1.1 Neu, Klett, München	
---------------------------	-----------------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Y. S. Kiran Kumar, Robert Bosch, Bangalore.	1. Dr. Dagmar Hellmann Rajanayagam, Professor, Universität Passau, Bayern, Germany.	1. Dr. P. Tamilarasan, SRMIST.
	2. Dr. J. Mangayakarasi, PG and Research, Dept. of English, Ethiraj College for Woman, Chennai.	2. Mr. G. Sugumar, SRMIST.
		3. Ms. Bhuvana Udhaykumar, SRMIST.

Course Code	21LEH105T	Course Name	JAPANESE	Course Category	H	HUMANITIES				L	T	P	C
										2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		English and Foreign Languages	Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PO-1	PO-2	PO-3
CLR-1 : Explain basics concept and facts of Japanese language.		-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CLR-2 : Compare demonstrative pronouns to ask information.		-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CLR-3 : Select different verbs, demonstrative pronouns for place		-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CLR-4 : Outline Japanese etiquette by using vocabularies related to daily activities and time.		-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CLR-5 : Explain diverse food habits of Japanese.		-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1: Write Japanese alphabet pronunciation, greetings, self - introduction		-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-2: Apply the class activity through conversation with other students		-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-3: Analyze directions using different group of verbs		-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-4: Develop knowledge in about festivals and culture. Summarize everyday conversations.		-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-5: Demonstrate the food habits of Japanese and others		-	-	-	-	-	-	-	-	-	3	-	3	-	-	-

Unit-1 :	9 Hour
Japanese language and culture - Self-Introduction - Greetings, classroom expressions - Introduction to others - Grammar (wa, ka, mo, no) - grammar (no/desu/ja arimasen) - Introduction to Japanese Script - Hiragana, Katakana, and Kanji. - Hiragana Lesson-1 (a, i, u, e, o) vowels and related words - Hiragana Lesson 2 (ka, ki, ku, ke, ko) related words - Hiragana Lesson 2 (ga, gi, gu, ge, go) related words. Are wa nan desu ka. - Grammar - Demonstrative Pronouns (kono, sono, ano, dono) - grammar (ni, ga, particles and Arimasu. Imasu sentence pattern and usage of dare, donata) - grammar like kore, sore, are, dore etc. - Days of the week - Numbers - Months of the year - Hiragana Lesson 3 (vowels and related words) - Hiragana Lesson 4 (vowels and related words) - Japanese Festivals (hinamatsuri, obon, oshougatsu, shichi go san, tanabata etc.) different occupations - Kanji - Days of the week.	
Unit-2 :	9 Hour
Sore o kudasai - grammar (time expressions using hours and minutes) - using gozen and gogo. Location markers line ue, shita, naka etc., and its usage. Using Locations grammar koko, soko, asoko doko etc., asking the price of the commodity. Requesting things using o particle like kore o kudasai, mizu o kudasai etc., Numbers upto one lakh. Japanese seasons and weather - Japanese Culture - origami, Ikebana, bonsai, rakugo, kabuki etc., - Hiragana Lesson 5 (vowels and related words) - Hiragana Lesson 6 (vowels and related words) - Hiragana Lesson 7 (vowels and related words) - Hiragana Lesson 8 (vowels and related words) - asking things and persons using of doko desu ka. Different places in town Toukyo Tawaa wa docchi desu ka - Grammar(kochira, sochira, achira and Dochira) - Grammar (kocchi, socchi, docchi) Hiragana Lesson - 9 Double consonants - Hiragana Lesson - 10 long vowels - Days of the week - Numbers and Months of the year compound consonants - revision of Hiragana Lesson - 12 particles, wa, e, o writing system. - Kanji Numbers 1 - 10, 100,1000,10000 and yen Colours and Directions. Locations - mi, hidari, mae, ushiro etc., Japanese martial arts (sumo, kondo, karate, yakyuu) around the station	

Unit-3:	9 Hour
Keeki o yattsu kudasai. - Grammar (general counter ~tsu and person counter ~nin, animals ~hiki vehicles counter ~dai and floors kai) - family members plain and polite way - usage tachi and tame ni etc., - Japanese house and living style. Katakana rules and writing system. Kanji - otoko, onna, ko, hito etc.	
Unit-4 :	9 Hour
Verbs: Ikimasu, okimasu, nemasu, tabemasu etc. Verbs - Past tense, negative - ~mashita, ~masen deshita. Grammar - usage of particles e, de, to, ni, o, ga(but) and exercises Katakana rules and related vocabulary. Kanji - ikimasu, mimasu, yasumimasu and kaimasu Grammar: ~mo (nanimo, dokoemo, donatamo) - negative i - ending and na - ending adjectives - introduction Common daily expressions and body parts (vocabulary) Religious beliefs, Japanese house and living style.	
Unit-5:	9 Hour
Usage of ~masen ka and mashou, Adjectives (present/past - affirmative and negative) Stationery and transport (vocabulary) Grammar - Usage of ~te form, Grammar - Usage of ~tai form Kanji - ookii, chiisai, eki and chuui Japanese tea ceremony and Japanese political system and economy	

Learning Resources	
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ms. Woanyuh Zoe Tsou Founder and Proprietor, IF Lingua Cultural studio,Hsinchu, Taiwan.	1. Mr. Korogi Yu, DGM, Renault Nissan, Japan.	1. Dr. P. Tamilarasan, SRMIST.
	2. Dr. J. Mangayakarasi, PG and Research, Dept. of English, Ethiraj College for Woman, Chennai.	2. Ms. P.R. REKHAA, SRMIST.
		3. Ms. V. SUNDRAVALLI, SRMIST.

Course Code	21LEH106T	Course Name	KOREAN	Course Category	H	HUMANITIES	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	English and Foreign Languages	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Spell, pronounce, and demonstrate the Korean script, and to define oneself and other people in the language. Get to know about Korea, its culture, and its language.	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2 :	Illustrate sentence ending expressions, Numbers, Shopping and Teaching money	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3 :	Construct phrases using action verbs for present and Past daily life activities															
CLR-4 :	Tell time, to socialize: make appointments, phone calls															
CLR-5 :	Determine expressing abilities, hopes, intentions, requests															
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Write words by using Korean script - Self Introduction, Greetings in Korean	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-2:	Demonstrate Number and money terms, managing daily life activities in Korean	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-3:	Develop simple daily life tasks using Verb conjugation in Present and Past	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-4:	Construct time, to socialize make appointments, phone call etiquettes	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-
CO-5:	Express the expressions related to the daily life activities	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-

Unit-1 :	9 Hour
Introduction to Korea and Korean (한글소개, 한국 소개) - Single vowel (단모음) - Double vowels & basic consonants (이중모음과 자음) - Double consonants & syllables (쌍 자음과 음절) - Batchim & syllables (받침과 음절) - New vocabulary (Nationality & Occupation) - Self-Introduction - Greetings.	
Unit-2 :	9 Hour
Grammar point: Topic marking particles(은/는) - Sentence ending expressions (이/예요/아/어요) - Formal sentence ending expressions (버니다/습니다, 버니까/습니까) - Teaching Number System (Sino Korean Numbers) - New vocabulary (counter noun) - Grammar point - 있다/없다 - Subject marking particle: 이/가 - Interrogative words (뭐, 언제, 누구, 어디), Object marking particle (을, 를) - Location marking particle (여/에서) - Particles Noun (와/과, N(이)랑, Noun 하고, N의).	
Unit-3:	9 Hour
Conjugation of a Verb - Present tense (아/요/어/요), Past tense (았/었, 날씨) weather new vocabulary (season & weather) - Progressive tense - vb. 고있다, Particles (N도, N만, N(으)로, N(이)나, N(은/는)) - Negative expressions - Word negation (안 - adj. / vb. (아/요/어/요)).	

Unit-4 :	9 Hour
Time system - Days of the week - Months of a year - Conjugation of a Verb in Future Tense (으) 겠어요 - Listening and contrast - adj. / vb. 고 - vb. 지만, N보다, N마다 - Confirming Information - adj. / vb. 지요, Irregular verbs =	
Unit-5:	9 Hour
Ability & possibility (vb. (으) 수있다/없다) - obligations/permissions vb. (으) 세요, vb. 지마세요 - Making requests vb. 아/어주세요 - Expressions of hope vb. 고싶다 - Asking opinions and making suggestions vb. (으) 까요? - Discovery and surprise adj. vb. 네요.	

Learning Resources	1. Seo gang Korean 서강 new 한국어 1A - Student book 2. Korean Grammar in Use : Beginning to Early Intermediate 3. Seo gang Korean 서강 new 한국어 1A Workbook	
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ms. Woanyuh Zoe Tsou Founder and Proprietor, IF Lingua Cultural studio, Hsinchu, Taiwan.	1. Mr. Lee Hwarang, Professor, Korean Language, Madras Christian College, Chennai.	1. Dr. P. Tamilarasan, SRMIST.
	2. Dr. J. Mangayakarasi, Head, PG and Research, Dept. of English, Ethiraj College for Women, Chennai.	2. Ms. M. Ratna kumari, SRMIST.

Course Code	21LEH107T	Course Name	SPANISH	Course Category	H	HUMANITIES				L	T	P	C
										2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		English and Foreign Languages	Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PO-1	PO-2	PO-3
CLR-1 :	show the students about the language and to select the usage of Grammar, Self - introduction and greetings.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-2 :	extend the knowledge, how to introduce oneself, to ask and give information about others and express simple conversations.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-3 :	utilise the adjectives, to ask and give directions, and an overview of general conversations.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-4 :	identify and to develop the ability to read, understand and initiate sentence formation.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-5 :	maximise the basic conversational skills.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	demonstrate the culture, geography, greetings and introducing themselves.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	create the dialogue between learners in the use of grammar and vocabulary.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	develop a map to find the directions by using vocabularies	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	incorporate a paragraph related to shopping and daily routine.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	construct the sentence using various grammar tenses to improve the conversational skills.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 :	9 Hour
El Abecedario, a Saludar y a despedirnos - Las nacionalidades, las profesiones y sobre las palabras - Los Números 1 - 100 - La Presentación - El Vocabulario - hablar - Pronombre Personal - Días de la semana y meses - Sobre temporadas en España y otros países - Artículos definidos - Usos de los verbos auxiliares - Los verbos ser, tener y llamarse - Sobre tu familia.	
Unit-2 :	9 Hour
Artículos Indefinidos - Los Números 1000 y Vocabulario - a expresar intenciones - Negación y traducción - Números telefónicos - Direcciones cardinales y medios de transporte - Preguntar por direcciones y describir un camino - El Vocabulario - Escuchar: Escribe los números - El presente de Indicativo (verbos terminados en - ar, - er, - ir - conjugación de - AR verbos regulares - Formando oraciones en tiempo presente - El Ejercicio - conjugación de - ER, - IR verbos regulares - Algunos Usos de a, con, de, por y para - Oraciones de ejemplo para y por - Tipos de colores y el artículo determinado - Describe tu clase o colegio en español.	
Unit-3:	9 Hour
Ser y Estar - Números ordinales y días - a expresar existencia - El Vocabulario - Diferenciación entre ser y estar con oraciones de ejemplo - Ejercicio de escucha - A hablar de Ubicación - El Ejercicio - conjugación de - AR verbos Irregulares - Leyendo la comprensión y respondiendo las preguntas - a hablar de Clima - Ejercicios: conjugaciones de verbos - algunos usos de hay - oraciones de ejemplo para hay - El Ejercicio - Escuchar - El Superlativo - Explicar: un/una/unas/unos y oraciones - Explicar: mucho/mucha/muchos/muchas y oraciones - Preguntas: qué /cuál /cuáles /cuantos /cuántas /dónde y cómo.	
Unit-4 :	9 Hour
El Tiempo - Escuchar y Escribir - a identificar objetos - Ejercicio de escucha - El Vocabulario - A comprar en tiendas: preguntar por productos, pedir, precios etc., - Conjugación de verbos - a hablar de preferencia - Los demostrativos: este/esta/estos/estas/esto - Escribe el tiempo - el/la/los/las + adjetivo - Oraciones de adjetivo - qué + sustantivo / cuál/cuáles - El Ejercicio. - tener qué + Infinitivo - Encuadrar las oraciones - el verbo IR - Las prendas de vestir.	

Unit-5:	9 Hour
<i>Hablar del aspecto y del carácter - A expresar gustos e intereses - El Vocabulario - A preguntar sobre gustos - a contrastar gustos - escuchando y entendiendo - El Ejercicio - Ir a un restaurante, ordenar la comida y pagar, hablar sobre un evento - El restaurante: Juego de rol - el verbo gustar - Encuadrar las oraciones - los posesivos - Oraciones del posesivos - tus actividades diarias.</i>	

Learning Resources	Aula 1	
---------------------------	---------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ms. Woanyuh Zoe Tsou Founder and Proprietor, IF Lingua Cultural studio, Hsinchu, Taiwan.	1. Mr. Xavier, Assistant Professor, Vellore Institute of Technology, Chennai.	1. Dr. P. Tamilarasan, SRMIST.
	2. Dr. J. Mangayakarasi, Head, PG and Research, Dept.of English, Ethiraj College for Woman, Chennai.	2. Mr. J. Sabastian Satish, SRMIST.
		3. Dr. Walter Hugh Parker, SRMIST

Course Code	21GNH101J	Course Name	PHILOSOPHY OF ENGINEERING	Course Category	H	HUMANITIES	L	T	P	C
							1	0	2	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	---	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12			
CLR-1:	Inspire a holistic overview of engineering	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Enlighten the methods and methodologies for building ontologies for systems engineering															
CLR-3:	Acquaint with engineering knowledge, building engineering knowledge and value of engineering															
CLR-4:	Upskill the engineering design process in aspects of conceive, design, implement and operate methodology															
CLR-5:	Instill the role of engineers in society, code of ethics and socio-politics of technology and engineering															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Analyze the relation between Arts, Mathematics, Science, Technology and Engineering and desired attributes of an engineer	1	-	-	3	-	1	-	1	3	3	-	3	-	-	-
CO-2:	Build ontologies for systems engineering using concept/mind mapping techniques	3	-	-	3	3	-	-	-	3	3	-	3	-	-	-
CO-3:	Analyze the knowledge base in engineering, distinctive features of engineering design and RIASEC model	3	-	-	3	-	-	-	-	3	3	-	3	-	-	-
CO-4:	Illustrate the engineering design process for the given application, analyze the requirements of CDIO engineers	3	1	3	3	3	-	-	-	3	3	-	3	-	-	-
CO-5:	Evaluate designs on their environmental and societal aspects and do organizational analysis on profession engineering organizations	3	3	3	3	-	3	3	3	3	3	-	3	-	-	-

Unit-1 : Introduction to Philosophy of Engineering	9 Hour
Define Engineering - History of Engineering Development - Practice 1: Compare Prehistory, Medieval and Present Engineering Development - Relation between Arts, Mathematics, Science, Technology and Engineering - STEAM Pyramid - Practice 2: STEAM Pyramid Analysis: Is Art Context Necessary? - Desired Attributes of an Engineer - Engineering Habits of Mind - Practice 3: Case Study on Attributes of an Engineer.	
Unit-2 : Ontology of Engineering	9 Hour
Ontology - Reference Ontology and Application Ontology - Practice 4: Reference Ontology using Concept/Mind Mapping - Suites of Ontology Modules - Functions and Capabilities - Practice 5: Engineering Application Ontology using Concept/Mind Mapping - Product Life Cycle - Commodities, Services and Infrastructure - Practice 6: Product Life Cycle Ontology using Concept/Mind Mapping	
Unit-3: Epistemology of Engineering	9 Hour
Relations between Science, Technology and Engineering - Questions on Philosophy of Engineering - Practice 7: Analyze the nature, contents and complexity of the knowledge base in engineering Four Dimensions of Engineering - RIASEC Model - Practice 8: Case Study on RIASEC Theory of Career Choice - Epistemology of Engineering Design - Rigour, Creativity and Change in Engineering - Practice 9: Analyze Distinctive Features of Epistemology of Engineering Design	
Unit-4 : Methodology of Engineering	9 Hour
Difference between Scientific Method and Engineering Design (ADDIE)- CDIO Engineers in Industry - Practice 10: Relate ADDIE and CDIO Methodology - Conceive and Design - Engineering Design Process Practice 11: Illustrate the Engineering Design Process for the given Application - Implement and Operate - Operational Factors in System Design - Practice 12: Analyze the Requirements of Operational Engineers	

Unit-5: Axiology of Engineering	9 Hour
Engineering and Society- Engineers Code of Ethics - Practice 13: Evaluate Popular Inventions and apply their new point of view to Re-Design - Sustainability and Diversity - Engineer's role to achieve Sustainable Development - Practice 14: Case Study on Achieving Sustainable Development Goals - Socio-Politics of Technology & Engineering - Professional Engineering Organizations - Practice 15: Case Study on Professional Engineering Organizations	

Learning Resources	1. Louis L. Bucciarelli, <i>Engineering Philosophy, Illustrated</i> , DUP Satellite, 2007 2. Gregory Bassett, <i>Philosophical Perspectives of Engineering and Technology Literacy</i> , I, Original writing Ltd, 2014 3. <i>Philosophy of Engineering, Volume I</i> , Royal Academic of Engineering (UK), 2010	4. Christensen, S.H, <i>Engineering Identities, Epistemologies and Values</i> , Springer, 2015 5. Van De Poel, Ibo, <i>Philosophy and Engineering, An Emerging Agenda</i> , Springer, 2010 6. Diane P. Michelfelder, <i>The Routledge Handbook of The Philosophy of Engineering</i> , Routledge, 2020
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life Long Learning CLA-2 – Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	15%	20%	-
Level 2	Understand	20%	-	-	15%	20%	-
Level 3	Apply	20%	-	-	20%	20%	-
Level 4	Analyze	20%	-	-	20%	20%	-
Level 5	Evaluate	10%	-	-	15%	10%	-
Level 6	Create	10%	-	-	15%	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Sainarayanan Gopalakrishnan, HCL Technologies, sai.jgk@gmail.com	1. Dr. R. Kumar, NIT Nagaland, rajagopal.kumar@nitnagaland.ac.in	1. Dr. Rajeev Sukumaran, SRM-CARE, SRMIST
2. Dr. Sricharan Srinivasan, Wipro Technologies, sricharanms@gmail.com	2. Dr. B. Surendiran, NIT Puducherry, surendiran@nitpy.ac.in	2. Dr. G. Vairavel, SRM-CARE, SRMIST

Course Code	21MGH101T	Course Name	FUNDAMENTALS OF ECONOMICS	Course Category	H	HUMANITIES	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Faculty of Management	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the fundamentals of economic principles	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Gain knowledge of demand and supply analysis in business environment	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Study various theories of production, costs and revenue	-	-	-	3	-	-	3	3	2	2	-	-	-	-	-
CLR-4:	Illustrate key characteristics and consequences of different forms of markets	2	-	3	3	-	-	3	3	-	-	2	-	-	2	-
CLR-5:	Equip the learners with macro-economic tools for business analysis	3	3	2	3	-	-	-	-	2	2	2	-	-	-	2
CO-1:	Apply economic concepts in rational allocation of resources	-	3	-	-	-	-	2	2	2	-	-	-	-	2	-
CO-2:	Assess the demand and supply analysis in business environment	2	-	3	3	-	-	3	3	-	-	2	-	-	2	-
CO-3:	Analyze the relationship between production, cost and price for effective decision making	3	3	2	3	-	-	-	-	2	2	2	-	-	-	2
CO-4:	Assess the different competitive environment in which the firm operates	-	3	-	-	-	-	-	2	2	2	-	-	-	2	-
CO-5:	Identify potential market opportunities based on macro-economic indicators	-	2	-	2	2	-	2	-	-	3	2	-	-	3	-

Unit-1 : Introduction	9 Hour
Meaning-Definitions of Economics - Nature & Scope of Economics – Subject Matter of Economics – Branches of Economics – Relevance of Economics in Engineering. Utility analysis, Marginal Theory of utilities and Equi-Marginal theory of utility	
Unit-2 : Demand and Supply Function	9 Hour
Meaning of demand - Demand theory and objectives- Demand analysis - Demand schedule - Demand Curve - Laws of Demand - Elasticity of Demand -Types and Measurement - Indifference curves analysis - Laws of Supply - Elasticity of Supply - Consumer Equilibrium - Consumer Surplus	
Unit-3: Theory of Production, Cost and Revenue	9 Hour
Production: Firm as an Agent of Production- Factors of production - Concept of Production Function- Law of Variable Proportions - Isoquants- Returns to Scale- Economies & Diseconomies of Scale. Costs & Revenue: Costs in the Short Run- Costs in the Long Run- Profit Maximization and Cost Minimization- Equilibrium of the Firm- Technical/Technological Change- Concept of Revenue: Total, Average and Marginal Revenue.	
Unit-4 : Market Analysis	9 Hour
Perfect competition – Short Run and Long Run- Equilibrium of the Firm and Industry - Price and Output Determination – Supply Curve- Monopoly – Short run and Long run Equilibrium- Price Discrimination – Monopolistic Competition – General and Chamberlin Approaches to Equilibrium- Equilibrium of the Firm and Group with Product Differentiation and Selling Costs- Excess Capacity under Monopolistic and Imperfect Competition- Criticism of Monopolistic Competition- Oligopoly	
Unit-5: Money, Banking and Trade	9 Hour
Money- nature and functions – Inflation and Deflation – Kinds of Banking – commercial banks – Central banking – Credit instrument - Monetary Policy – International trade – Balance of trade and Balance of Payments – taxation – Direct and Indirect taxes – GST- Impact and Incidence of tax- Concept of National Income – Features with reference to developing countries.	

Learning Resources	1. P.L. Mehta, "Managerial Economics- Analysis, Problems & Cases", Sultan Chand & Sons, 21st Edition, 2019	4. Zahid A khan: Engineering Economy, "Engineering Economy", Dorling Kindersley, 2012
	2. J.P. Mishra, "Business Economics", Sahitya Bhavan Publications, Agra, 2022	5. Francis Cherunilam, "Business Environment", Himalaya Publishing House, Mumbai - 04, 25th Edition, 2017.
	3. P.M. Salwan, Priyanka Jindal, "Business Economics – Second Edition", TAXMANN, 2022	6. Panneer Selvam, R, "Engineering Economics", Second Edition, PHI Learning Private Limited, New Delhi, 2013
	4. C.M.Chaudhary, "Business Economics", RBSA Publishers, 13th Edition, 2016.	7. Nick Wilkinson, "Managerial Economics, Problem-Solving in a Digital World – Second edition", Cambridge University Press, 2022

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	10%	-	10%	-	10%	-
Level 6	Create	10%	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Expert member from TCS	1. Dr. N. Siva Sankaran, XLRI, Jamshedpur	1. Dr. Kumar. N, SRMIST
2. Mr. Madhan Raj, General Manager (Audit), Hyundai Motors India Ltd., Chennai	2. Dr. Narasiman, IIM Bangalore	
3. Dr. T.N. Sekhar, CA, CIMA		

Course Code	21MGH102T	Course Name	FUNDAMENTALS OF MANAGEMENT	Course Category	H	HUMANITIES	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Faculty of Management	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Acquire knowledge about the historical evaluation and the fundamental concepts of Management	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2 :	Develop an understanding of planning, Decision making tools and techniques.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3 :	Evolve practical application of organizing and the staffing function.	-	-	-	-	2	-	-	-	-	-	2	2	-	-	3
CLR-4 :	Enable the learners to practice to be an effective leader and motivational concepts in an organization	2	2	3	2	1	-	-	-	-	-	2	-	-	2	2
CLR-5 :	Exercise controlling techniques in an organization for measuring organizational performance and managerial actions.	3	2	-	-	-	2	-	2	2	2	3	-	-	-	
CO-1:	Understand the concepts related to management and current practice of Management	-	-	-	-	2	-	-	-	-	-	2	2	-	-	3
CO-2:	Use the techniques and tools of planning and make prudent decisions	2	2	3	2	1	-	-	-	-	-	2	-	-	2	2
CO-3:	Able to formulate effective organizational structure and Identify how organizations adapt to uncertain environment and learn the recruitment process	3	2	-	-	-	2	-	2	2	2	3	-	-	-	
CO-4:	Practice concepts related to leadership, motivation and communication.	-	-	-	-	3	2	-	2	3	-	-	-	1	-	
CO-5:	Apply controlling techniques in business.	-	3	3	2	2	-	2	-	-	-	3	2	-	1	3

Unit-1:	9 Hour
Management- definition-Different levels of Management -Functions of Management-Kinds of managers (Corporate, Business and Functional Managers)- Managerial roles-Managerial skills-Evolution of management-Pre-scientific Management Period-Principles of Scientific Management - Taylor principles- Henry Fayol contribution for management -14 principles -Trends of Management in global scenario-Challenges of Management in global scenario	
Unit-2 :	9 Hour
Planning- Definition-Nature & purpose of planning-Benefits of Planning-Types of plans-Strategic & tactical Plan-planning process & The Planning Cycle-MBO -Need for Management by Objectives -Process of MBO-Decision making-Rational decision making-Decision Making Process-Decision Making Techniques -Decision support System-Individual decision making-Group decision making-Using groups to improve decision making-Managing Work teams	
Unit-3:	9 Hour
Organization –Definition-Nature and characteristic of organizing-Organizational structure –meaning-Significance of Organization Structure-Types of Organizational structure-Types of organization & Organisational Culture-Span of control-Basis of power and authority-Delegation of authority-Centralization and decentralization-Departmentalization-Strategic business unit-Staffing - Meaning - Importance of staffing-Recruitment-Selection- Training-performance appraisal	
Unit-4:	9 Hour
Leadership –meaning-Scope and Elements of Leadership-Approaches of Leadership-Leadership style-Skill requirements of leader-Qualities of Effective Leadership –Motivation-Nature and characteristics of motivation - Motivation theories -Applications of Motivational theories –Communication-Importance of effective communication -Kinds of communication-barriers in communication-How to improving communication-Avoiding pitfalls of communication	

Unit-5:	9 Hour
Coordination–meaning-Principles of Coordination-importance of Coordination-Techniques of Coordination-Control –meaning-Control process-Requirements for effective control-Techniques of Managing Control-Types of control-Strategic Control-challenges in control-Management By Exception-Process of MBE-Principles of MBE-Management Information System-Management audit-Strategic management-Role of Strategy in Management	

Learning Resources	1. William/ Tripathi, MGMT - A south Asian Perspective, 1st edition, Cengage Learning, 2022 2. Dr.J.Jayasankar, Principles of Management, 1st edition, Margham Publications, 2021. 3. P.C Tripathi & P.N Reddy, Principles of Management, 4th edition, Tata McGraw Hill, 2021.	4. Stephen P. Robbins and Mary Coulter, 'Management', Prentice Hall of India, 8th edition. 5. L.M.Prasad, Principles and Practice of Management, 7ed, S.Chand Publishers, 2020 Richard Daft, Principles of Management, 10th edition, Cengage Learning, 2021. 6. https://lecturenotes.in/subject/62/principles-of-management-pom 7. https://www.slideshare.net/ersmbalu/principles-of-management-lecture-notes
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	10%	-	10%	-	10%	-
Level 6	Create	10%	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Expert member from TCS	1.Dr.Jayasanker,D.G Vaishnav college, Arumbakkam, Chennai	1. Dr.M.Srinivasan, SRMIST
2. Mr.Rajan, CEO, XYZ private Ltd, Chennai. drrajan@gmail.com		2. Dr.L Jayanthi, SRMIST

Course Code	21MGH103T	Course Name	BASICS OF ACCOUNTING AND COSTING	Course Category	H	HUMANITIES	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Faculty of Management	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Understand the fundamentals of Accounting	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2 :	Gain knowledge on the basics and preparation of statutory financial statements	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3 :	Learn to analyse the financial statements using ratios	2	-	-	-	-	-	3	2	-	-	-	3	-	-	-
CLR-4 :	Understand the importance of costing and the method of preparation of cost sheet	-	-	-	3	3	-	3	1	2	3	3	3	-	2	-
CLR-5 :	Study the technique of marginal costing and budgetary control	3	3	2	3	2	-	3	-	3	2	3	-	-	-	1
CO-1:	Acquire the knowledge on foundations of accounting and accounting cycle	2	-	3	-	-	2	-	2	-	1	3	3	-	2	-
CO-2:	Acquire the ability to prepare statutory financial statements	-	3	2	2	3	2	2	-	2	3	2	2	-	3	-
CO-3:	Analyse the financial statements using ratios	3	3	2	3	2	-	3	-	3	2	3	-	-	-	1
CO-4:	Appreciate the concepts of Cost accounting systems	2	-	3	-	-	2	-	2	-	1	3	3	-	2	-
CO-5:	Apply the techniques of marginal costing and budgetary control	-	3	2	2	3	2	2	-	2	3	2	2	-	3	-

Unit-1:	9 Hour
Introduction to Accounting: Concepts and Conventions - Financial Statements: Significance, interpretation – Accounting process: steps in accounting cycle, Bookkeeping, Record Maintenance – Principles of Accounting: Basic Types of Accounts, Golden rules of Accounting – Journal Entry: sample problems – Ledger posting: sample problems – Trail Balance: sample problems – Computerized Books.	
Unit-2 :	9 Hour
Financial statements: Types, Significance, and Contents – Final Accounts: Preparation of Trading Account – problems with simple adjustments, Preparation of P&L account - problems with simple adjustments, Balance Sheet - problems with simple adjustments.	
Unit-3:	9 Hour
Ratio Analyses: Types, Significance and Characteristics – Benefits of Ratios – Calculation of Ratios: Profitability ratios: Gross Profit Ratio, Net Profit Ratio, ROI, ROE, ROA, EPS, PE ratio - Liquidity ratios: Current ratio, Quick ratio, Interval measure (NWC ratio) - Leverage ratios: Total Debt ratio, D/E ratio, Capital Equity ratio, Interest Coverage ratio -Turnover ratios: Inventory turnover ratio, Debtor turnover, Collection period, Assets turnover, WC turnover - Case Discussion.	
Unit-4:	9 Hour
Costing Systems – meaning of cost; Types of costs - Elements of Cost – Material, Labour and Overheads - Cost sheet – simple problem - Cost Behavior and Cost Allocation (theory) ; Overhead Allocation - Unit Costing, Process Costing – meaning, application - Job Costing – meaning, application ; Absorption Costing – meaning, application (only theory).	
Unit-5:	9 Hour
Marginal Costing - Cost Volume Profit (CVP) Analysis – uses, application; CVP chart - Simple problems in CVP analysis; ABC Analysis - Budgets – meaning, uses, types (only theory).	

Learning Resources	1. Robert N Anthony, David Hawkins, Kenneth Merchant, <i>Accounting: Texts and Cases</i> , McGraw-Hill, 13th Edition, 2017	4. S.P. Jain and K.L. Narang, <i>Cost Accounting: Principles and Practice</i> , Paperback, Kalyani Publishers, 2014
	2. Dr. Narayana Swamy, <i>Financial Accounting for Managers</i> , Tata McGraw Hill, 2021 edition	5. Case Study Materials: To be distributed for class discussion
	3. Eugene F. Brigham and Joel F. Houston, <i>Fundamentals of Financial Management</i> , 14th Edition, Cengage Learning India Pvt. Ltd., 2021.	6. Equity research reports published by Citi group, Barkley's and HSBC on fundamental analysis; Also book titled "Balance sheet reading" by Dun and Brad street and YouTube videos on how to read a Balance Sheet

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	10%	-	10%	-	10%	-
Level 6	Create	10%	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Expert member from TCS	Dr. N. Siva Sankaran, XLRI, Jamshedpur	Dr. Maria Evelyn Jucunda. M
2. Mr. Madhan Raj, General Manager (Audit), Hyundai Motors India Ltd., Chennai	Dr. Narasiman, IIM Bangalore	
3. Dr. T.N. Sekhar, CA, CIMA		

ACADEMIC CURRICULA

Basic Science Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21BTB102T	Course Name	INTRODUCTION TO COMPUTATIONAL BIOLOGY	Course Category	B	BASIC SCIENCES	L	T	P	C
							2	0	0	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR): <i>The purpose of learning this course is to:</i>		Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Explain the cell structure and function from its organization	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2 :	Define the molecular and biochemical basis of an organism and the impact of human genome project	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3 :	Discuss protein structure and its prediction	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CLR-4 :	Acquire knowledge of neurons and workings of the brain	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CLR-5 :	Impart the knowledge of immune system and prediction of vaccines	2	3	-	1	3	-	-	-	-	-	-	-	-	-	-
CO-1:	Correlate cell growth, reproduction, and differentiation	3	2	2	1	3	-	-	-	-	-	-	-	-	-	-
CO-2:	Categorize the concepts and principles of biochemistry and relate their application in genomics	3	-	2	2	3	-	-	-	-	-	-	-	-	-	-
CO-3:	Solve protein sequence analysis and biological structure prediction using computing techniques															
CO-4:	Integrate neuronal mechanisms and computer applications that replicate its workings															
CO-5:	Integrate the immune system and its workings to predict vaccine candidates															

Unit-1 : Cell and evolution	6 Hour
<i>Cell theory, Whitaker's kingdom classification, cell organelles, and their functions, homeostasis, Replication and cell Division, tissue differentiation, stem cells and their applications, genetic algorithms.</i>	
Unit-2 : Basics in biochemistry	6 Hour
<i>Structure and functions of carbohydrates, lipids, proteins, enzymes, DNA, RNA, and hormones. The human genome project, genomics, Sequence databases, BLAST tool.</i>	
Unit-3: Structure biology	6 Hour
<i>Protein synthesis, Secondary structure of the protein, Structure and function, Structural databases, protein visualizing tools, Secondary structure prediction algorithms</i>	
Unit-4 : Neurobiology	6 Hour
<i>Basic of Neurons, glial cells, Brain and its parts, Artificial neural networks, concepts, and differences with biological neural networks. – uses of ANN, machine learning, and data mining in biology</i>	
Unit-5: Immunobiology	6 Hour
<i>Elements of the immune system, Types of the immune response, Active and passive immunity, Immunoinformatics, epitope prediction tools</i>	

Learning Resources	1. Thyagarajan S, N.Selvamurugan, R.A.Nazeer et.al., Biology for engineers McGraw Hill Education. 2012	3. Norman Lewis, Gabi Nindl Waite, Lee R. Waite et.al., Applied Cell and Molecular Biology for Engineers. McGraw-Hill Education. 2007
	2. Parish, and Twyman, Instant notes, Bioinformatics, Westhead (1st edition), Bios Scientific Publishers Ltd., 2003	4. Teresa K. Attwood, David Parry-Smith, Introduction to Bioinformatics, Pearson Education, 2001
		5. Zvelebil, Marketa J., and Jeremy O. Baum. Understanding Bioinformatics. Garland Science, 2007

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 – (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences, ramchand@saksinlife.com	1. Dr. K Subramaniam, IITM Chennai, subbu@iitm.ac.in	1. Dr. Priya Swaminathan, SRM IST
2. Dr. S. Sam Gunasekar, Orchid Pharma Ltd., sam@orchidpharma.com	2. Dr. R. B. Narayanan, Anna university, arbeen09@gmail.com	2. Dr. Jagannathan K SRM IST

Course Code	21BTB103T	Course Name	BIOLOGY	Course Category	B	BASIC SCIENCES	L	T	P	C
							2	0	0	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Describe the cell structure and function and its organization	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Explain the molecular and biochemical basis of an organism	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Acquire knowledge of microbial implications in disease and in health															
CLR-4:	Define biosensors and its environmental and clinical applications															
CLR-5:	Acquire knowledge of mechanical motors within the cell and biologically nontoxic biomaterials															
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Explain cell growth, replication, reproduction, and differentiation with the potential of stem cells	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Integrate the concepts and principles of biochemistry in health	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Relate microbes and their usefulness in human health and industrialization	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Apply the knowledge on biosensors and molecular motor in applications of human health and the environment	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Elaborate biomaterials with applications in biomimetics	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 : Cell: Basic Unit of Life	6 Hour
Organelles of cells, cell cycle, Cell division and differentiation, Stem cells - types and applications	
Unit-2 : Macromolecules and Metabolism	6 Hour
Structure of carbohydrates, lipids, proteins, enzymes, DNA, and RNA. Metabolism of glucose, amino acids, and Fatty acid; Photosynthesis	
Unit-3: Microbiology in Human Life	6 Hour
Medical Microbiology: Pathogenic microorganisms: Bacteria and Virus; Antibiotics; Vaccines; Environmental Microbiology; Industrial Microbiology	
Unit-4 : Basics of Biosensors and Molecular Motors	6 Hour
Types of Biosensors, components of biosensors, and medical applications of biosensors. Linear motors: actin and myosin, rotatory motors: flagella motor and ATPase	
Unit-5: Basics of Biomaterial and its Applications	6 Hour
Properties of biomaterials, types of biomaterials, biomimetics in dental and bone applications	

Learning Resources	1. Thyagarajan S, N.Selvamurugan, MP Rajesh, RA.Nazeer Richard W Thilagaraj, S Barathi, MK Jaganathan ., Biology for engineers McGraw Hill Education. 2012 2. Norman Lewis, Gabi Nindl Waite, Lee R. Waite et.al., Applied Cell and Molecular Biology for Engineers. McGraw-Hill Education. 2007	3. Michael J Pelczar, ECS Chan, Noel R Krieg Microbiology, Tata McGraw-Hill, 2019
--------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 – (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences, ramchand@saksinlife.com	1. Dr. K Subramaniam, IITM Chennai, subbu@iitm.ac.in	1. Dr. Lilly M Saleena, SRM IST
2. Dr. S. Sam Gunasekar, Orchid Pharma Ltd., sam@orchidpharma.com	2. Dr. R. B. Narayanan, Anna university, arbeen09@gmail.com	2. Dr. S Barathi, SRM IST

Course Code	21BTB104T	Course Name	BIOLOGY: HUMAN PHYSIOLOGY AND ANATOMY	Course Category	B	BASIC SCIENCES	L	T	P	C
							2	0	0	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand basic human body functions and life processes	1	2	3	4	5	6	7	8	9	10	11	12	PO-1	PO-2	PO-3
CLR-2:	Familiarize the concepts of cardiac and nervous systems	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	Gain knowledge about functions of respiratory and musculoskeletal systems															
CLR-4:	Explain the structure and functions of digestive systems and excretory systems															
CLR-5:	Attain the knowledge about ear, eye and endocrine systems															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Explain the human body functions and life processes	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Analyze the phenomena taking place in the cardiovascular and nervous system	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Explain the process taking place in the respiratory musculoskeletal system	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Elaborate the structure and function of digestive and excretory systems	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Summarize the structure and function of vision, auditory and endocrine glands	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 : Cell and Circulatory System	6 Hour
The function of the cell, Membrane, resting potential of a cell, Action potential of a cell, Phases of action potential, Propagation of action potentials, The Goldman-Hodgkin-Katz equation, Blood cell - composition, origin of WBC, Blood cell - composition, the origin of platelet, Types of blood groups, Estimation of blood components	
Unit-2 : Cardiovascular System and Nervous System	6 Hour
Blood vessels – Artery, capillary and vein, Heart structure, Cardiac cycle, Cardiac cycle - graphs, Cardiac output, Coronary circulation, Nervous system, Organization of the brain, spinal cord, Structure, and function of nerve the, Action potential of the neuron, Reflex action	
Unit-3: Respiratory System and Musculo Skeletal System	6 Hour
Lungs-in detail, Ventilator volumes – Adult human spirogram, Mechanics of breathing, Control of ventilation, Mechanism of gas exchange, Muscles – Skeletal muscle, Physiology of muscle contractions, Sliding bridge theory, Structural function of joints, Types of joints	
Unit-4 : Digestive System and Excretory System	6 Hour
Salivary glands – Saliva, Tongue – Taste, GI tract, Digestion at the stomach, Digestion at the intestines, Accessory organs of Digestion, Function of bile, gall bladder, pancreas, Mechanism of urine formation, Urine reflex, Structure and function of skin, sweat gland, Temperature regulation	
Unit-5: Sensory Organs and Endocrine Glands	6 Hour
The optic nerve, optic chiasm, optic tract, Vision pathway, Structure and function of ear, Auditory pathway, Endocrine Glans-Overall functions, Pituitary glands, Parathyroid glands, Adrenal glands, Homeostasis of Glucose in the body, Homeostasis of calcium in the body	

Learning Resources	1. Sarada Subramanyam, K. Madhavan Kutty and H.D. Singh, "Textbook of human physiology", S.Chand & Company, 5th edition, 2014.	4. J. Gibson, "Modern physiology and anatomy for nurses", Blackwell SC Publishing, 2nd edition, 1981.
--------------------	--	---

2. Ranganathan T.S., "Textbook of human anatomy", S.Chand & Co. Ltd., Delhi, 5th edition, 2014.	5. Arthur. C. Guyton, John E Hall, "Textbook of medical physiology", W.B. Saunders Company, 11th edition, 2000
3. Tobin, C.E., "Basic human anatomy", McGraw-Hill Publishing Co. Ltd., Delhi, 2nd edition, 1997.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 – (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences, ramchand@saksinlife.com	1. Dr. K Subramaniam, IITM Chennai, subbu@iitm.ac.in	1. Dr. Varshini Karthik, SRM IST
2. Dr. S. Sam Gunasekar, Orchid Pharma Ltd., sam@orchidpharma.com	2. Dr. R. B. Narayanan, Anna university, arbeen09@gmail.com	2. Dr. P Muthu, SRM IST

Course Code	21BTB105T	Course Name	CELL BIOLOGY	Course Category	B	BASIC SCIENCES	L	T	P	C
							2	0	0	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Provide the basic concepts and understanding of cell structure and function	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Explain the different strategies of the organization of organelles	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Familiarize the concepts of structural and functional orientation in eukaryotes															
CLR-4:	Serve as a platform to study the molecular mechanism of cellular transport															
CLR-5:	Integrate the applications of different receptors and their role in diseases															
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Explicate the fundamentals of cell biology.	2	-	3	-	-	-	-	-	-	-	-	-	-	3	3
CO-2:	Relate cell structures and functions	-	-	3	3	-	-	-	-	-	-	-	-	-	3	3
CO-3:	Explain the basis of cell structure and its function in cell development and death.	-	-	-	3	2	-	-	-	-	-	-	-	-	3	3
CO-4:	Describe the steps involved in cell-cell signaling in mammalian cell systems.	-	-	3	3	-	-	-	-	-	-	-	-	-	2	3
CO-5:	Critique the fundamentals and relate with the advances in the various areas of diagnostic and therapeutic applications of cells	-	3	-	3	-	-	-	-	-	-	-	-	-	3	3

Unit-1 : An Overview of Cells and Cell Research	6 Hour
Origin and evolution of cells, Origin of Prokaryotes, Eukaryotes and Development of multicellular organisms; Cells as experimental models; Tools of cell biology, Molecular composition of cells, Cell membrane	
Unit-2 : Cell, Structure and Function-I	6 Hour
Nucleus, Endoplasmic reticulum, Golgi apparatus, Lysosomes, Mitochondria, Chloroplasts and Peroxisomes	
Unit-3: Cell, Structure and Function-II	6 Hour
Cytoskeleton: Actin and myosin filaments, Intermediate filaments and Microtubules; Transport of molecule; Cell-cell interactions: Adhesion junctions, tight junctions, gap junctions	
Unit-4 : Cell Signaling	6 Hour
General principles of cell signaling-Modes of cell-cell signaling, Pathways of intracellular signal transduction-function of cell surface receptors; GPCR pathway, MAPK pathway	
Unit-5: Cell Regulation	6 Hour
Cell division, Cell cycle and its regulation; Mitosis, Meiosis; Cell death: Necrosis, Apoptosis; Cancer-Introduction to cancer, types of cancer, Epithelial cell cancer; Stem cells and its therapeutic applications.	

Learning Resources	1. Channarayappa, "Cell biology," Universities Press, 2010. 2. Rastogi, S.C, "Cell biology," New Age International Publishers, 2005.	3. Thyagarajan S, N.Selvamurugan, MP Rajesh, RA.Nazeer Richard W Thilagaraj, S Barathi, MK Jaganathan ., Biology for engineers McGraw Hill Education. 2012 "Biology for Engineers " Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012 4. .Ajoy Paul, "Textbook of cell and molecular biology", Second edition, Books & Allied (P) Ltd., 2009.
--------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences, ramchand@saksinlife.com	1. Dr. K Subramaniam, IITM Chennai, subbu@iitm.ac.in	1. Dr.S. Sujatha SRM IST
2. Dr. S. Sam Gunasekar, Orchid Pharma Ltd., sam@orchidpharma.com	2. Dr. R. B. Narayanan, Anna university, arbeen09@gmail.com	2. Dr. K Venkatesan SRM IST

Course Code	21MAB101T	Course Name	CALCULUS AND LINEAR ALGEBRA	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Apply the concept of Matrices in problems of Science and Engineering	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Utilize Taylor series, Maxima minima, composite function and Jacobian in solving various Engineering problems	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Apply the concept of Differential Equations in problems of Science and Engineering															
CLR-4:	Utilize the concepts of radius of curvature, evolute, envelope in problems of Science and Engineering															
CLR-5:	Apply the Sequences and Series concepts in Science and Engineering															
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Apply the concepts of Matrices to find Eigenvalues and Eigen Vectors problems solving in Science and Engineering	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Apply Maxima and Minima, Jacobian, and Taylor series to solve problems in Science and Engineering	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Solve the different types Differential Equations in Science and Engineering applications	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Identify Radius, Centre, envelope and Circle of curvature and apply them in Science and Engineering	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Identify convergence and divergence of series using different tests in Engineering applications	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 : Matrices	12 Hour
Characteristic equation – Eigen values and eigen vectors of a real matrix – Properties of eigen values – Cayley – Hamilton theorem – Orthogonal reduction of a symmetric matrix to diagonal form – Orthogonal matrices – Reduction of quadratic form to canonical form by orthogonal transformations.	
Unit-2 : Functions of Several variables	12 Hour
Function of two variables-Partial derivatives - Total differential - Taylor's expansion with two variables up to second order terms -Maxima and Minima - Constrained Maxima and Minima by Lagrangian Multiplier - Jacobians of two Variables - Jacobians Problems - Properties of Jacobians and Problems	
Unit-3: Ordinary Differential Equations	12 Hour
Linear equations of second order with constant coefficients when $PI=0$ or exponential - Linear equations of second order with constant coefficients when $PI=\sin ax$ or $\cos ax$ - Linear equations of second order with constant coefficients when $PI=\text{polynomial}$ Linear equations of second order with constant coefficients when $PI=\text{exponential}$ with $\sin ax$ or $\cos ax$ - Linear equations of second order with constant coefficients when $PI= \text{exponential}$ with polynomial - Linear equations of second order with constant coefficients when $PI=\text{polynomial}$ with $\sin ax$ or $\cosh ax$ - Linear equations of second order variable coefficients - Linear equations of second order variable coefficients - Homogeneous equation of Euler type - Homogeneous equation of Legendre's Type - Homogeneous equation of Legendre's Type - Equations reducible to homogeneous form - Equations reducible to homogeneous form - Variation of parameters - Variation of parameters - Simultaneous first order with constant co-efficient. - Simultaneous first order with constant co-efficient. - Simultaneous first order with constant co-efficient.	
Unit-4 : Differential Calculus and Beta Gamma Functions	12 Hour
Radius of Curvature – Cartesian coordinates - Radius of Curvature – Polar coordinates - Circle of curvature - Centre of curvature -Evolute of a parabola - Evolute of an ellipse - Envelope of standard curves - Beta Gamma Functions - Beta Gamma Functions and Their Properties Sequences – Definition and Examples - Series – Types of Convergence - Series of Five terms – Test of Convergence- -Comparison test – Integral test	

Unit-5: Sequence and Series	12 Hour
Series of Five terms – Test of Convergence- Comparison test – Integral test- Comparison test – Integral test- Comparison test – Integral test- D'Alemberts Ratio test ,D'Alemberts Ratio test, Raabe's root test. - Convergent of Exponential Series - Cauchy's Root test - Log test Log test - Alternating Series: Leibnitz test - Series of positive and Negative terms. - Absolute Convergence - Conditional Convergence	

Learning Resources	1. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons,2006. 2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010. 3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi,2008	4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010 5. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson,Reprint, 2002 6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 – (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.V.Maheshwaran, CTS, Chennai, maheshwaranv@yahoo.com	1. Dr.K.C.Sivakumar, IIT Madras, kcskumar@iitm.ac.in	1. Dr.A.Govindarajan, SRMIST
	2. Dr.Y V S S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	2. Dr. N. Balaji, SRMIST

Course Code	21MAB102T	Course Name	ADVANCED CALCULUS AND COMPLEX ANALYSIS	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Determine the Double and triple Integral and apply then in problems in Science and Engineering.	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Gain knowledge in interpretation of vector differentiation and vector integration which relates line integral, Green's, Stoke's and Gauss divergent theorem.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Identify the techniques of Laplace Transforms and inverse transform and extend them in the problems of Science and Engineering															
CLR-4:	Construct the analytic function, discuss conformal mapping and bilinear transformation in Engineering Problems															
CLR-5:	Evaluate complex integrals and power series using various theorems															
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Apply multiple integrals in solving problems in Science and Engineering	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Analyze vector differentiation and vector integration and related theorems	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Apply Laplace transform techniques in solving Engineering problems	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Utilize complex integrals and power series in solving engineering problems	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply multiple integrals in solving problems in Science and Engineering	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 : Integral Calculus	12 Hour
Evaluation of double integration Cartesian and plane polar coordinates - Evaluation of double integration of plane polar coordinates. Evaluation of double integral by changing of order of integration - Evaluation of double integral by changing of order of integration - Area as a double integral (Cartesian) - Area as a double integral (polar) - Triple integration in Cartesian coordinates -Conversion from Cartesian to polar in double integrals - Conversion from Cartesian to polar in double integrals -Triple integration in Cartesian coordinates -Area of triple Integral.	
Unit-2 : Vector Calculus	12 Hour
Review of vectors in Two and Three dimensions - Gradient, divergence, - curl – Solenoidal - Irrotational fields - Vector identities -(without proof) – Directional derivatives - Line integrals - Surface integrals - Surface integrals - Volume Integrals - Green's theorem (without proof), Green's theorem (without proof), - Gauss divergence theorem (without proof), verification -Gauss divergence theorem (without proof) applications to cubes. - Gauss divergence theorem (without proof) applications to parallelepiped. -Stoke's theorems (without proof) – Verification Stoke's theorems (without proof) – Applications to cubes - Stoke's theorems (without proof) – Applications to parallelepiped only.	
Unit-3: Laplace Transform	12 Hour
Laplace Transforms of standard functions -Transforms properties - Transforms of Derivatives and Integrals - Transform of derivatives and integrals - Initial value theorems (without proof) and verification for some problems - Final value theorems (without proof) and verification for some problems - Inverse Laplace transforms using partial fractions - Inverse Laplace transforms using Partial fractions -Inverse Laplace transforms section shifting theorem - LT using Convolution theorem -problems only - LT using Convolution theorem -problems only -ILT using Convolution theorem -problems only -Applications of Laplace transforms for solving linear ordinary differential equations up to second order with constant coefficient only -Solution of Integral equation and integral equation involving convolution type	

Unit-4 : Analytic Functions	12 Hour
Definition of Analytic Function- Cauchy Riemann equations - Cauchy Riemann equations -Properties of analytic function functions -Determination of analytic function using – Milne-Thomson's method - Conformal mappings: magnification -Conformal mappings: rotation Conformal mappings: inversion - Conformal mappings: inversion -Conformal mappings: reflection - Conformal mappings: reflection bilinear transformation - Cauchy's integral theorem (without proof) -Cauchy's integral theorem applications	
Unit-5: Complex Integration	12 Hour
Cauchy's integral formulae- Problems-Taylor's expansions with simple problems -Taylor's expansions with simple problems - Laurent's expansions with simple problems- Singularities -Types of Poles and Residues - Cauchy's residue theorem (without proof)- Contour integration: Unit circle. -Contour integration: Unit circle. -Contour integration: semicircular contour. -Contour integration: semicircular contour.	

Learning Resources	1. Erwin kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons,2006.	4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010
	2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.	5. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9th Edition, Pearson,Reprint, 2002
	3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi,2008	6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 – (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.V.Maheshwaran, CTS, Chennai, maheshwaranv@yahoo.com	1. Dr.K.C.Sivakumar, IIT Madras, kcskumar@iitm.ac.in	1. Dr.A.Govindarajan, SRMIST
	2. Dr.Y V S S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	2. Dr. N. Balaji, SRMIST

Course Code	21MAB301T	Course Name	PROBABILITY AND STATISTICS	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Apply the basic rules and theorems of probability theory and evaluate the expectation and variance using random variables.	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Gain knowledge of theoretical distributions.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Understand how to develop Null and Alternate hypothesis and draw conclusions using hypothesis tests.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-4:	Apply the knowledge of regression lines and analysis of variance.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-5:	Acquire knowledge to solve the problems of process control.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Implement the concepts of probability and random variables.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Identify the random variables and model them using various distributions.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Infer results by using hypothesis testing on large and small samples.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Examine the regression lines and interpret the results in the analysis of variance.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Utilize quality control techniques to solve real-world problems.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 : Probability and One-dimensional Random Variable	12 Hour
Probability concepts, Types of Events, Axioms and theorems - Conditional probability, Baye's theorem – without proof- Applications of Baye's Theorem. Random variables – Discrete case and continuous case- Mathematical expectation, Variance –discrete case and continuous case - Raw Moments - Central Moments - Moment generating function - MGF- discrete and continuous random variable.	
Unit-2 : Theoretical Distributions	12 Hour
Discrete distributions – Introduction- Mean and Variance of Binomial Distribution- Fitting a Binomial distribution- M.G.F of Binomial Distribution- Poisson Distribution- Mean and Variance of Poisson Distribution- Fitting a Poisson distribution- MGF of Poisson distribution- Geometric distribution- mean and variance, Memoryless property- Continuous distributions – Introduction- Uniform distribution – MGF, Mean and Variance- Exponential distribution - MGF, Mean and Variance, Memoryless property- Normal distribution.	
Unit-3: Testing of Hypothesis	12 Hour
Sampling Distributions – Type I and Type II errors- large sample test-Test of significance for single proportion- Test of significance for difference of proportions- Test of significance for single mean- Test of significance for difference of means- Small sample tests- Student's t- test for single mean- t- test for the difference of means- Fisher's F-test- Test of significance for two sample variances- Chi -square test- for the goodness of fit- Chi-square test- for the independence of attributes.	
Unit-4 : Correlation, Regression and ANOVA	12 Hour
Correlation and its Properties- Karl Pearson's coefficient of correlation- Spearman's rank correlation coefficient for repeated and non-repeated ranks- Linear Regression lines and Properties- Relation between correlation and regression coefficient- Introduction to Analysis of Variance (ANOVA) - One-way Classification – two-way classification.	
Unit-5: Statistical Quality Control	12 Hour
Introduction – Process control – control charts for variables - \bar{X} and R, \bar{X} and S charts control charts for attributes: p-chart, np-chart, c- chart and their applications in process control.	

Learning Resources	1. S. Ross, <i>A First Course in Probability</i> , 8th Ed., Pearson Education India, 2010. 2. Johnson. R.A., <i>Miller & Freund's, Probability and Statistics for Engineers</i> , 8th Edition, Prentice Hall India, 2011. 3. Veerarajan T., <i>Probability and Statistics</i> , Tata McGraw-Hill, New Delhi, 2010.	4. Devore (JL), <i>Probability and Statistics for Engineering and the Sciences</i> , 8th Edition, Cengage Learning, 2012. 5. S.C. Gupta, V.K. Kapoor, <i>Fundamentals of Mathematical Statistics</i> , Sultan Chand & Sons, 11th Edition, 2015. 6. Vijay K. Rohatgi., A.K. Md. Ehsanes Saleh, <i>An Introduction to Probability and Statistics</i> , 2nd Edition, Wiley, 2008
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 – (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com	1. Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	1. Dr. B.Vennila, SRMIST
	2. Prof. K.C. Sivakumar, IIT Madras, kcskumar@iitm.ac.in	2. Dr.R.Varadharajan, SRMIST

Course Code	21PYB101J	Course Name	PHYSICS: ELECTROMAGNETIC THEORY, QUANTUM MECHANICS, WAVES AND OPTICS			Course Category	B	BASIC SCIENCES										L	T	P	C		
																		3	1	2	5		
Pre-requisite Courses	Nil			Co-requisite Courses	Nil			Progressive Courses	Nil														
Course Offering Department		Physics and Nanotechnology				Data Book / Codes/Standards			Nil														
Course Learning Rationale (CLR):		The purpose of learning this course is to:						Program Outcomes (PO)												Program Specific outcomes			
CLR-1 :	Identify the applications of electric field on materials						1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2 :	Identify the applications of magnetic field on materials						Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3 :	Identify the significance of quantum theory																						
CLR-4 :	Create insights to the concepts of optical effects																						
CLR-5 :	Analyze the working principle of lasers and optical fibers																						
Course Outcomes (CO):		At the end of this course, learners will be able to:																					
CO-1:	Express the significance of electrostatic fields						3	3	-	-	-	-	-	-	-	-	-	-	-	-	-		
CO-2:	Analyze electromagnetic induction						3	3	-	-	-	-	-	-	-	-	-	-	-	-	-		
CO-3:	Apply quantum mechanics to basic physical problems						3	-	-	3	-	-	-	-	-	-	-	-	-	-	-		
CO-4:	Apply ray propagation and optical effects						3	3	-	-	-	-	-	-	-	-	-	-	-	-	-		
CO-5:	Understand the types of lasers, structure and propagation properties of optical fiber and analyse its applications						3	3	3	-	-	-	-	-	-	-	-	-	-	-	-		
Unit-1: Electromagnetism and Dielectrics																					18 Hour		
Electromagnetism- Introduction- Del, divergence, curl and gradient operations in vector calculus-Gauss divergence and Stoke's theorem-Electric field and electrostatic potential for a charge distribution-Gauss' law and its applications-Laplace's equations for electrostatic potential-Poisson's equations for electrostatic potential- Concepts of electric current-Continuity equation-Laws of magnetism-Faraday's law, Ampere's law-Maxwell's equations-Maxwell's equations in free space- Characteristics impedance - Polarizations, permeability and dielectric constant-Polar and non-polar dielectrics-Types of polarization-Frequency and temperature dependence																							
Practice 1.Determination of Internal Resistance of the given cell - Potentiometer																							
2 Determine dielectric constant of the sample																							
Unit-2: Magnetic Materials																					18 Hour		
Magnetization, permeability and susceptibility-Classification of magnetic materials-Ferromagnetism-Concepts of ferromagnetic domains-Hard and soft magnetic materials-Energy product--Ferrimagnetic materials-Ferrites-regular spinel and inverse spinel-Magnetic bubbles-Magnetic thin films-Spintronics-GMR-TMR-CMR-Garnets-Magnetoplumbites-Multiferroic materials-Applications of multiferroic materials																							
Practice 1.Calibrate Ammeter using Potentiometer																							
1. Calibrate Voltmeter using Potentiometer																							
2. Determine magnetic susceptibility-Quincke's method																							
Unit-3:Quantum Mechanics																					18 Hour		
Introduction to Quantum mechanics- Black body radiation, Concept of Photon-Photoelectric effect, Compton effect- Explanation of wave nature of particles-de Broglie hypothesis for matter waves-Heisenberg's uncertainty principle-Application of uncertainty principle- -Born interpretation of wave function-Verification of matter wave -Physical significance of wavefunction-Time independent Schrödinger's wave equation-Time dependent Schrödinger's wave equation-Particle in a 1 D box-Normalizations-Concept of harmonic oscillator-Quantum harmonic oscillator																							
Practice 1.Determine Planck's Constant																							
2. Study of I-V characteristics of a light dependent resistor (LDR)																							

Unit-4: Wave Optics	18 Hour
Introduction to interference-Introduction to diffraction-Fresnel diffraction-Fraunhofer diffraction-Fraunhofer diffraction at single slit-Fraunhofer diffraction at double slit-Fraunhofer diffraction at multiple slit-Diffraction grating-Characteristics of diffraction grating-Applications of diffraction grating-Polarization by reflection-Brewster's angle-Polarization by refraction-Malu's Law-Polarization by double refraction-Nicol Prism- Ordinary and Extraordinary Rays-Optical activity-Quarter and Half Waveplate- Circular polarization - Elliptical polarization	
Practice	
<ol style="list-style-type: none"> Determine wavelength of monochromatic light Newton's ring Determine particle size using laser Determine Wavelength- diffraction grating 	
Unit-5: Lasers and Fiber Optics	18 Hour
Absorption and emission processes-two level-Einstein's theory of matter radiation A and B coefficients-Characteristics of laser beams-Amplification of light by population inversion-Threshold population inversion-Essential components of laser system and pumping mechanisms-Nd: YAG laser-Semiconductor laser-CO2 laser-Application of laser – Holography-Optical fiber-physical structure-Total internal reflection-Numerical aperture-Acceptance angle-Losses associated with optical fibers-Classification of optical fibers-Optical fiber communications system-Optical sensors	
Practice	
<ol style="list-style-type: none"> Determine laser parameters – divergence and wavelength for a given laser source Study of attenuation and propagation characteristic-optical fiber Mini project 	

Learning Resources	1. David Jeffery Griffiths, Introduction to Electrodynamics, Revised edition, Pearson, 2013 2. AjoyGhatak, Optics, Tata McGraw Hill Education, 5th edition, 2012	3. David Halliday, Fundamentals of Physics, 7th edition, John Wiley & Sons Australia, Ltd, 2004 4. Eisberg and Resnick, Quantum Physics: Of Atoms, Molecules, Solids, Nuclei and Particles, 2nd Edition, 1985
--------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	10%	20%	-
Level 2	Understand	20%	-	-	30%	20%	-
Level 3	Apply	30%	-	-	20%	30%	-
Level 4	Analyze	30%	-	-	40%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Vinay Kumar Gupta, National Physical Laboratory, guptavinay@nplindia.org	1. Prof. C. Vijayan, IITM, Chennai, cvijayan@iitm.ac.in	1. Dr. C. Preferencial Kala, SRMIST
	2. Prof. S. Balakumar, Univ of Madras, balakumar@unom.ac.in	2. Dr. M. Alagiri, SRMIST

Course Code	21PYB102J	Course Name	SEMICONDUCTOR PHYSICS AND COMPUTATIONAL METHODS	Course Category	B	BASIC SCIENCES				L	T	P	C
										3	1	2	5

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nano Technology		Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes					
CLR-1 :	Introduce band gap and Fermi level in semiconductors and how to compute those properties															Engineering Knowledge	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2 :	Explain the concept of carrier transport mechanism in p-n and metal semiconductor junction																Problem Analysis														
CLR-3 :	Provide an insight on semiconductor optical transitions and photovoltaic effect																	Design/development of solutions													
CLR-4 :	Procure knowledge of electrical and optical measurements in semiconductor and to instigate the concepts of TCAD																		Conduct investigations of complex problems												
CLR-5 :	Develop necessary skills for low dimensional semiconductor material processing and characterization and to introduce the basic of machine learning in image processing																			Modern Tool Usage											

Unit-1 : Energy Bands in Solids	18 Hour
Introduction to Classical Free electron theory-Introduction to Quantum Free electron theory-Density of states-Concepts-Energy band in solids-Kronig-Penney model-E-k diagram-Direct and Indirect band gap-Concept of phonons-Concept of Brillouin Zone-Computational determination of Band Structure – Concepts , Eigenvalue equations-Classification of electronic materials-Fermi level-Probability of occupation-Numerical determination of probability of occupation and carrier concentration-Concept of Fermi surface of a metal-Computational determination of Fermi Surface of Cu as example. Practice 1.Determination of Hall coefficient of Semiconductor material 2.Determination of Band Gap of semiconductor-Post Office Box method	
Unit-2 : Carrier Transport Mechanism in Semiconductors	18 Hour
Intrinsic semiconductor-Dependence of Fermi level on carrier-concentration-and temperature in Intrinsic semiconductor-Extrinsic semiconductors-Dependence of Fermi level on carrier-concentration-and temperature in extrinsic semiconductors-Explanation for carrier generation-Explanation for recombination processes -Carrier transport - diffusion and drift current-Continuity equation-p-n junction-Biasing concept in p-n junction-Metal-semiconductor junction -Ohmic contact -Semiconductor materials of interest for optoelectronic devices-Photocurrent in a P-N junction diode- Light emitting diode- Classification of Light emitting diode-Optoelectronic integrated circuits-Organic light emitting diodes Practice 1.Determination of Band Gap of semiconductor-Four probe method 2 Study of I-V characteristics of a light dependent resistor (LDR) 3 Study of V-I and V-R characteristics , Efficiency of a solar cell	
Unit-3: Optoelectronic Properties of Semiconductors	18 Hour
Concept of optical transitions in bulk semiconductor- Optical absorption process-Concept of recombination process-Optical recombination process-Explanation for spontaneous emission-Explanation for stimulated emission-Joint density of states in semiconductor-Density of states for photons-Explanation of transition rates-Numerical computation of optical loss-Finite element method to calculate Photon density of states -Basic concepts of Photovoltaic-Photovoltaic effect-Applications of Photovoltaic effect-Determination of efficiency of a PV cell-Computational approach to calculate optical excitations-Example: optical excitation in BN (Boron nitride) Practice 1.Characterization of pn junction diode (Forward and reverse bias) 2.Verify Inverse square law of light using a photo cell.	

Unit-4 : Electrical And Optical Measurements	18 Hour
Concept of electrical measurements-Two point probe technique-Four point probe technique-linear method-Four point probe technique-Vander Pauw method-Significance of carrier density-Significance of resistivity and Hall mobility-Hot-point probe measurement-Capacitance-voltage measurements-Extraction of parameters in a diode-I-V characteristics of a diode-Introduction of TCAD in basic level- Significance of band gap in semiconductors-Concept of absorption and transmission-Boltzmann Transport Equation-Scattering Mechanisms-Monte Carlo method- Concept only-Example only Monte Carlo Methods for Solution of BTE(Boltzmann equation)	
Practice	
<ol style="list-style-type: none"> 1. Determination of electron and hole mobility versus doping concentration using GNU Octave 2. Determination of Fermi function for different temperature using GNU Octave 3. Study of attenuation and propagation characteristic of optical fiber cable using laser source 	

Unit-5: Low Dimensional Semiconductor Materials	18 Hour
Density of states in 2D-Density of states in 1D and 0D-Introduction to low dimensional systems-Quantum well-Quantum wire and dots-Introduction to novel low dimensional systems -CNT- properties and synthesis-Applications of CNT-Fabrication technique-CVD-Fabrication technique-PVD-Characterizations techniques for low dimensional systems-Principle of electron microscopy-Scanning electron microscopy-Transmission electron microscopy-Atomic force microscope-Computational and machine learning approach for electron microscopy image processing – Concepts, overview-Example of Graphene	
Practice	
<ol style="list-style-type: none"> 1. Plotting and interpretation of I-V characteristics of Diode GNU Octave 2. Determination of lattice parameters using powder XRD 3. Mini Project. 	

Learning Resources	<ol style="list-style-type: none"> 1. J.Singh, "Semiconductor Optoelectronics": Physics and Technology, McGraw-Hill Inc. 1995. 2. B. E. A. Saleh and M. C. Teich, "Fundamentals of Photonics", John Wiley & Sons, Inc., 2007. 3. S. M. Sze, "Semiconductor Devices" Physics and Technology, Wiley 2008. 4. A. Yariv and P. Yeh, "Photonics:" Optical Electronics in Modern Communications", Oxford University Press, New York 2007. 	<ol style="list-style-type: none"> 5. Computational Materials Science: An Introduction by June Gunn Lee, Chapter 7, Page 227- 230 (Quantum Espresso)and Page 300-307 (VASP) 6. Finite Element Method GouriDhatt, Emmanuel Lefrançois, Gilbert Touzot, Wiley Publication, ISBN: 978-1-848-21368-5
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	10%	20%	-
Level 2	Understand	20%	-	-	30%	20%	-
Level 3	Apply	30%	-	-	20%	30%	-
Level 4	Analyze	30%	-	-	40%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Vinay Kumar Gupta, National Physical Laboratory, guptavinay@nplindia.org	1. Prof. C. Vijayan, IITM, Chennai, cvijayan@iitm.ac.in	1. Dr. C. Preferencial Kala, SRMIST
	2. Prof. S. Balakumar, Univ of Madras, balakumar@unom.ac.in	2. Dr.S. Saurab Ghosh S, SRMIST

Course Code	21PYB104J	Course Name	PHYSICS: MECHANICS			Course Category	B	BASIC SCIENCES							L	T	P	C			
															3	1	2	5			
Pre-requisite Courses	Nil		Co-requisite Courses	Nil			Progressive Courses	Nil													
Course Offering Department		Physics and Nanotechnology			Data Book / Codes/Standards			Nil													
Course Learning Rationale (CLR):		The purpose of learning this course is to:						Program Outcomes (PO)												Program Specific outcomes	
CLR-1 :	Utilize the principles pertaining to vector mechanics and basics of vibrations to structural engineering.						1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3		
CLR-2 :	Utilize the knowledge of rigid body mechanics to identify the forces and torques to setup equations governing the complex motions in engineering structures																				
CLR-3 :	Apply knowledge of statics to determine the forces and moments in truss structures																				
CLR-4 :	Comprehend the failure of structures by identifying the principal stresses and strains																				
CLR-5 :	Analyze the bending types and torsion in structural members																				
Course Outcomes (CO):		At the end of this course, learners will be able to:																			
CO-1:	Identify the principle of mechanics and vibrations						3	3	-	-	-	-	-	-	-	-	-	-			
CO-2:	Understand the rigid body mechanics in 2D and 3D						3	3	-	-	-	-	-	-	-	-	-	-			
CO-3:	Apply the knowledge of free body diagram to establish equations of equilibrium to determine the internal forces in simple truss structures						3	-	-	3	-	-	-	-	-	-	-	-			
CO-4:	Analyze the principal stresses and principal planes to understand the failure of materials.						3	3	-	-	-	-	-	-	-	-	-	-			
CO-5:	Apply the concepts of axial and shear forces in torsion of circular shafts and understand the concept of simple bending in beams						3	3	3	-	-	-	-	-	-	-	-	-			
Unit-1: Vector Algebra and Vibrations																		18 Hour			
Introduction to vector analysis- Scalar quantities & vector quantities- Transformation of scalars and vectors- Transformation of scalars and vectors under rotation transformation- Forces in nature- Newton's laws- Form invariance of Newton's second law- Solving Newton's equations of motion in polar coordinates- Fundamentals of simple harmonic motion- Harmonic oscillator- Damped harmonic motion- Different cases-over critically and lightly damped oscillators- Fundamentals of vibrations- Vibration model- Forced oscillations- Magnification factor of forced oscillations- Resonance- Application of resonance-Dampers and its types																					
Practice																					
1. Determine acceleration due to gravity using Bifilar pendulum																					
2. Determine the restoring force per unit extension of a spiral spring by dynamical method																					
Unit-2: Rigid Body Mechanics																		18 Hour			
Definition and motion of a rigid body in the plane- Rotation in the plane- Kinematics in a coordinate system rotating in the plane- Kinematics in a coordinate system translating in the plane- Angular momentum about a point of a rigid body in planar motion- Euler's laws of motion- Euler's law- Describing rigid body motion-(Euler's equation of motion)- Precession of a body- Precession of a spinning top- Introduction to three-dimensional rigid body motion- Distinction from two-dimensional motion- Two- dimensional motion in terms of angular velocity vector, its rate of change- Two- dimensional motion in terms of Moment of inertia tensor- Three-dimensional motion of a rigid body - coplanar manner- Rod executing conical motion with center of mass fixed- Conical pendulum -Time period and tension in a string																					
Practice																					
3. Determine acceleration due to gravity-Compound bar pendulum																					
4. Determine spring constant-Expansion of a helical spring																					
5. Determine the coefficient of Static friction																					
Unit-3: Equilibrium and Stability of Rigid Structures																		18 Hour			
Introduction to rigid body- Free body diagrams with examples- Reactions at supports and connections for a two dimensional structure- Examples on modeling of typical joints- Equilibrium of a rigid body in two dimensions- Condition for equilibrium in two dimensions- Equilibrium of a rigid body in three dimensions- Condition for equilibrium in three dimensions- Friction- limiting cases- Friction- non limiting cases- Force-displacement relationship-																					

Simple illustration of force displacement- Geometric compatibility for small deformations- Illustrations based on axially loaded members- Introduction to trusses, Planar and Space trusses- Types of Bridge and Roof trusses- Truss Analysis -Statically determinate/Indeterminate- Method of Joints

Practice

1. Determine Moment of inertia and angular acceleration with precision pivot bearing
2. Determine moment of inertia and angular acceleration- Gyroscope

Unit-4: Deformation and Failure of Materials

18 Hour

Concept of stress at a point- Plane stress- Transformation of stresses at a point- Principal stresses- Mohr's circle of stress- Concept of strain at a point- Plane strain- transformation of strain at a point- Principal strains- Mohr's circle of strain- Strain gauges and its applications - Strain Rosettes and its types- Concepts of elasticity, plasticity- Failure of materials-Causes and types of failure- Concepts of fracture and yielding- Brittle and Ductile fracture- Mechanism of ductile fracture- Idealization of one dimensional stress-strain curve- Generalized Hooke's law with thermal strains for isotropic materials- Characteristics of elasticity

Practice

1. Measurement of free fall-Dynamics method
2. Determine rigidity modulus-Torsional pendulum
3. Determine rigidity modulus using static torsion

Unit-5: Force in Beams and Shafts

18 Hour

Force analysis -axial force- Force analysis -shear force, bending moment- Twisting moment diagrams of slender members- Twisting moment diagrams of slender members (without singularity function)- Torsion of circular shafts- Definition of torsion, effects of torsion- Generation of shear stresses- General Torsion equation - Theory of Uniform Bending- Theory of non-uniform Bending- Moment-curvature relation in pure bending of beams with symmetric cross-section- Bending stress, Shear stress- Cases of combined stresses- Concept of strain energy- Strain energy due to axial loading- Strain energy due to shear loading- Strain energy due to torsion- Modulus of toughness and resilience- Strain energy and complementary strain energy for simple structural elements

Practice

1. Determine Young's modulus-non-uniform bending
2. Determine Young's Modulus-Uniform Bending
3. Mini Project

Learning Resources	1.Mahendra K Verma, Introduction to Mechanics, Universities Press (India) Pvt. Ltd., 2016	3.J. P. Den Hartog, Mechanics, Dover Publications Inc., 1961
	2.J. L. Meriam, Engineering Mechanics – Dynamics, 7th edition, Vol. 2, Wiley Publishers, 2012	4.E.P. Popov, Engineering Mechanics of Solids, Prentice Hall India Learning Private Limited; 2nd edition, 2002.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	10%	20%	-
Level 2	Understand	20%	-	-	30%	20%	-
Level 3	Apply	30%	-	-	20%	30%	-
Level 4	Analyze	30%	-	-	40%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. D.K. Aswal, National Physical Laboratory, dkaswal@nplindia.org	1. Prof. V. Subramanian, IITM, Chennai, manianvs@iitm.ac.in	1. Dr.K.D.Nisha, SRMIST
		2. Dr.R.Annie Sujatha, SRMIST

Course Code	21CYB101J	Course Name	CHEMISTRY	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	2	5

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemistry	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Exploit the periodic properties of elements for bulk property manipulation towards technological advancement and interpret water quality parameters	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Address concepts related to electrochemistry, such as corrosion, using thermodynamic principles and measure the acidic strength and redox potentials of aqueous solution	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Employ various organic reactions towards the design of fine chemical and drug molecules for industries and measure the acidic strength and conductance of aqueous solution															
CLR-4:	Brief outline, reaction types and applications of polymers and determine average molecular weight of the polymer															
CLR-5:	Properties, surface characterization and applications of advanced engineering materials and measure the acidic strength of aqueous solution															
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Rationalize bulk properties using periodic properties of elements, evaluate water quality parameters like hardness and alkalinity	3	-	3	2	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Utilize the concepts of thermodynamics in understanding thermodynamically driven chemical reactions, determine acidic strength and redox potentials of aqueous solution	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Perceive the importance of stereochemistry in synthesizing organic molecules applied in pharmaceutical industries, determine acidic strength and conductance of aqueous solution	-	3	3	2	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Utilize the concepts of polymer processing for various technological applications, determine average molecular weight of the polymer	3	-	3	3	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Analyze the importance of advanced processing techniques towards engineering applications and measure the acidic strength of aqueous solution	3	-	3	-	3	-	-	-	-	-	-	-	-	-	-

Unit-1 : Periodic properties	18 Hour
Coordination numbers and geometries - Crystal field theory - Octahedral & Tetrahedral complexes - Optical & magnetic properties of transition metal complexes - Isomerism in transitional metal compounds - Effective nuclear charge, penetration of orbitals - variations of orbital energies of atoms in the periodic table - Electronic configurations, atomic and ionic sizes - ionization energies, electron affinity and electronegativity - Hard soft acids and bases	
Practice:	
1. Determination of the amount of sodium carbonate and sodium hydroxide in a mixture by titration	
2. Determination of hardness (Ca ²⁺) of water using EDTA – Complexometry method.	
Unit-2 : Use of free energy in chemical equilibria	18 Hour
Thermodynamic functions: Energy, Entropy and free energy - Estimation of entropy & free energies - Free energy and emf. Cell potentials - The Nernst equation and applications - Acid base, oxidation reduction - Solubility equilibria - Corrosion - Free energy of a corrosion reaction - Pourbaix diagram Salient Features and phase diagram for Iron	
Practice:	
1. Determination of strength of an acid by Conductometry.	
2. Determination of ferrous ion using potassium dichromate by Potentiometric titration	

Unit-3: Stereochemistry and Organic reactions	18 Hour
Representations of 3 dimensional structures - structural isomers and stereoisomers - configurations and symmetry and chirality - enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis - Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings - Synthesis of a commonly used drug molecule. Practice: 1. Estimation of amount of chloride content of a water sample. 2. Determination of the strength of a mixture of acetic acid and hydrochloric acid by Conductometry	
Unit-4 : Polymers	18 Hour
Introduction to concept of macromolecules - Tacticity - Classification of Polymers - Thermoplastics, Thermosets and Elastomers - Types of Polymerization - Important addition and condensation polymers – synthesis and properties – Polypropylene, polystyrene, PVC, Teflon, Nylon, PET, Polyurethane and Synthetic rubber, Conducting polymers – introduction, types – n and p doping, examples (polyacetylene and P3HT), applications Practice: 1. Determination of molecular weight of polymer by viscosity average method.	
Unit-5: Advanced Engineering Materials	18 Hour
Mechanical properties of solid – stress-strain relationship - Tensile strength, Hardness, Fatigue, Impact strength, Creep – Composite materials - introduction - Types of composites - Fibre Reinforced Composites. Particle Reinforced Composites. Metal Matrix Composites. Ceramic Matrix Composites. Examples and applications. Surface Characterisation techniques - XRD and XPS. Practice: 1. Determination of strength of an acid using pH meter.	

Learning Resources	<ol style="list-style-type: none"> B. H. Mahan, R. J. Meyers, University Chemistry, 4th ed., Pearson publishers, 2009. M. J. Sienko, R. A. Plane, Chemistry: Principles and Applications, 3rd ed., McGraw-Hill publishers, 1980 B. L. Tembe, Kamaluddin, M. S. Krishnan, Engineering Chemistry (NPTEL Web-book) http://nptel.ac.in/downloads/122101001/ Peter W. Atkins, Julio de Paula, James Keeler, Physical Chemistry, 11th ed., Oxford publishers, 2021 K. P. C. Vollhardt, N. E. Schore, Organic Chemistry: Structure and Function 7th ed., Freeman, 2014 W. D. Callister, D. G. Rethwisch, Materials Science and Engineering: An Introduction, 8th ed., Wiley, 2009 J. C. Kuriacose, J. Rajaram, Chemistry in Engineering and Technology, Tata McGraw-Hill Education, 1984
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	-	-	20%	10%	-
Level 2	Understand	30%	-	-	20%	30%	-
Level 3	Apply	30%	-	-	20%	30%	-
Level 4	Analyze	30%	-	-	40%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Ravikiran Allada, Head R&D, Analytical, Novugen Pharma, Malaysia, ravianalytical@gmail.com	1. Prof. G. Sekar, IIT Madras, gsekar@iitm.ac.in	1. Prof. M. Arthanareeswari, SRMIST
2. Dr. Sudarshan Mahapatra, General Manager, Encube Ethicals Pvt. Ltd., Mumbai, sudarshan.m@encubeethicals.com	2. Prof. Kanishka Biswas, JNCASR Bengaluru, kanishka@jncasr.ac.in	2. Dr. K. Ananthanarayanan, SRMIST

ACADEMIC CURRICULA

Non Credit Courses (M)

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CYM101T	Course Name	ENVIRONMENTAL SCIENCE	Course Category	M	NON CREDIT	L	T	P	C
							1	0	0	0

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemistry	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Acquire knowledge on various causes, effects and control measures of environmental air and water pollution	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Acquire knowledge on various causes, effects and control measures of soil, thermal and radiation pollution	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Acquire knowledge on various process involved in the treatment of wastewater															
CLR-4:	Identify sources, disposal and treatment methods of solid waste management															
CLR-5:	Identify sources, disposal and treatment methods of biomedical waste management															
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Analyze the sources, effects and control measures of environmental air pollution	3	3	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-2:	Analyze causes, effects and control measures of soil, thermal and radiation pollution	3	3	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-3:	Explain the processes involved in waste water treatment and investigate the cause of a local polluted site	-	3	-	-	-	3	-	3	-	-	-	-	-	-	-
CO-4:	Illustrate the treatment methods involved in solid waste management and investigate the impact in local areas	-	3	-	-	-	3	-	3	-	-	-	-	-	-	-
CO-5:	Illustrate the treatment methods involved in biomedical waste management and investigate the impact in local areas	-	3	-	-	-	3	-	3	-	-	-	-	-	-	-

Unit-1 : Environmental Segments, Air and Water Pollution	3 Hour
Environmental segments Structure of atmosphere - Composition of atmosphere - Air Pollution Sources - Effects – acid rain, ozone layer depletion and greenhouse effect Control measures of air pollution - Sources, effects and control measures of Water pollution	
Unit-2 : Soil, Thermal and Radiation Pollution	3 Hour
Determination of BOD and COD - Determination of TDS and trace metals - Sources, effects and control measures of Soil pollution - Sources, effects and control measures of Thermal pollution - Sources and effects of Radiation pollution - Control measures of Radiation pollution	
Unit-3: Waste Water Treatment	3 Hour
Waste water treatment - Introduction - Primary treatment - Secondary treatment - Tertiary treatment - Activity: Visit to a local polluted Urban/Rural/Industrial/Agricultural site	
Unit-4 : Solid Waste Management	3 Hour
Solid waste management - Types – Effects - Process of waste management - Disposal methods, Open dumping, Engineered land filling, Composting, Incineration - Activity: Monitoring solid waste management in local areas	
Unit-5: Biomedical Waste Management	3 Hour
Biomedical Waste Management- Definition and Effects - Categories of biomedical waste - Process of biomedical waste management - Treatment and disposal methods - Activity: Visit a hospital to understand the biomedical waste management.	

Learning Resources	1. Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, 2nd ed., UGC	3. R.Jeyalakshmi, Principles of Environmental Science, Devi publications, 2nd ed., 2008.
	2. Kamaraj. P, Arthanareeswari. M, Environmental Science—Challenges and Changes, 6th ed., Sudhandhira Publications, 2013	4. Helen P Kavitha, Principles of Environmental Science, Shine Publications and Distributors, 1st Edition, 2013

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 (40%)		Life long learning CLA-2 (40%)		Summative (20%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-	-	-
Level 2	Understand	20%	-	20%	-	20%	-	-	-
Level 3	Apply	30%	-	30%	-	10%	-	-	-
Level 4	Analyze	30%	-	30%	-	30%	-	-	-
Level 5	Evaluate	-	-	-	-	20%	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Ravikiran Allada, Head R&D, Analytical, Novugen Pharma, Malaysia, ravianalytical@gmail.com	1. Prof. G. Sekar, IIT Madras, gsekar@iitm.ac.in	1. Prof. M. Arthanareeswari, SRMIST
2. Dr. Sudarshan Mahapatra, General Manager, Encube Ethicals Pvt. Ltd., Mumbai, sudarshan.m@encubeethicals.com	2. Prof. Kanishka Biswas, JNCASR Bengaluru, kanishka@jncasr.ac.in	2. Dr. K. K. R. Datta, SRMIST

Course Code	21LEM101T	Course Name	CONSTITUTION OF INDIA	Course Category	M	NON CREDIT	L	T	P	C
							1	0	0	0

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	English and Foreign Languages	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the basics of Constitution of India – meaning, nature, fundamental right and duties.	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Explain the parliamentary system of the government and the relationship between the governments	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Detail the powers and functions of Central government	-	-	-	-	-	2	-	-	-	-	-	3	-	-	-
CLR-4:	Detail the powers and functions of State government	-	-	-	-	-	2	-	-	-	-	-	3	-	-	-
CLR-5:	Create an awareness in learners about the kinds of local administrations, Election Commission and Political Dynamics	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-
CO-1:	Define the meaning and nature of constitution of India, its fundamental rights and duties.	-	-	-	-	-	2	-	-	-	-	-	3	-	-	-
CO-2:	Demonstrate the powers of President, Vice President, Prime Minister, the process of Parliamentary System and the relation between the governments	-	-	-	-	-	2	-	-	-	-	-	3	-	-	-
CO-3:	Analyze the powers of State Legislature and Inter-state relation	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-
CO-4:	Incorporate the system of Grassroot Democracy	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-
CO-5:	Compile the power and process of Election Commission and Political Dynamics	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-

Unit-1 : Constitutional Framework	3 Hour
Historical Background, Salient Features of the Constitution, Preamble, Union and its Territory, Citizenship, Fundamental Rights, Fundamental Duties, Amendment of the Constitution, Systems of Government	
Unit-2 : Union Government	3 Hour
President, Vice-President, Prime Minister, Union Council of Ministers, Parliament, Parliamentary Committees, Centre-State Relationships, Union Judiciary - Supreme Court of India	
Unit-3: State Administration	3 Hour
Governor, Chief Minister, State Council of Ministers, State Legislature, Inter-State Relationships, State Judiciary - High court.	
Unit-4 : Urban and Local Administration	3 Hour
District's Administration Head, Mayor, Chairman, Elected Representatives, Panchayat Raj, Municipalities, Municipal Corporation	
Unit-5: Election Provisions and Emergency Provisions	3 Hour
Election Commission of India- Composition, Powers and Functions and Electoral Process, Anti-Defection Law. Types of Emergency-Grounds, Procedure, Duration and Effects	

Learning Resources	1. M Laxmikanth, <i>Indian Polity</i> , Mc Graw Hill Publications, 2019.	2. D D Basu, <i>Introduction to the Constitution of India</i> . Lexis Nexis, 2020.
---------------------------	--	--

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Summative Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Life Long Learning CLA-2 – (60%)		Summative (20%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	-	-	-	-	-	-	-
Level 2	Understand	100%	-	100%	-	100%	-	-	-
Level 3	Apply	-	-	-	-	-	-	-	-
Level 4	Analyze	-	-	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Y. S. Kiran Kumar, Robert Bosch, Bangalore.	1. Dr. S. Soundiraraj, Professor and Head, Dept.of English, College of Engineering, Anna University Guindy Campus, Chennai	1. Dr. P. Tamilarasan, SRMIST
	2. Dr. J. Mangayakarasi, Head, Dept.of English, Ehiraj College for woman, chennai	2. Mr. G. Sugumar, SRMIST

Course Code	21LEM102T	Course Name	UHV-I: UNIVERSAL HUMAN VALUES – INTRODUCTION	Course Category	M	NON CREDIT	L	T	P	C
							1	0	0	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	EFL-Value Education Cell	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	understand what value education and personal values is.	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2 :	Connect the learners to see the need for developing a holistic perspective of life.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3 :	Strengthen self-reflection	-	-	-	-	-	-	-	3	-	-	-	3	-	-	-
CLR-4 :	Develop more confidence and commitment to understand, learn and act accordingly	-	-	-	-	-	2	3	2	-	-	-	3	-	-	-
CLR-5 :	Sensitize the student about the scope of life – individual, family (inter-personal relationship), society and nature/existence	-	-	-	-	-	-	3	2	-	-	-	3	-	-	-
CO-1:	Analyze the significance of value inputs provided in formal education along with skills and develop a broader perspective about life and education	-	-	-	-	-	2	3	3	-	-	-	3	-	-	-
CO-2:	Formulate their aspirations and concerns at different levels of living, and the way to fulfil them in a sustainable manner.	-	-	-	-	-	-	2	3	2	-	-	3	-	-	-
CO-3:	Evaluate their current state of understanding and living, and model a healthy lifestyle	-	-	-	-	-	-	3	2	-	-	-	3	-	-	-
CO-4:	Examine the issues of home sickness, interactions with seniors on the campus, peer pressure with better understanding and feel grateful towards parents, teachers, and others	-	-	-	-	-	-	3	2	-	-	-	3	-	-	-
CO-5:	Develop more confidence and commitment for value-based living in family, society and nature	-	-	-	-	-	2	3	3	-	-	-	3	-	-	-

Unit-1: Introduction to Value Education	3 Hour
Definition and Understanding of Value Education - Objectives of Value Education - Need for inculcation of Values – Self exploration: Aspirations and Concerns, Individual academic, career, Expectations of family, peers, Society, Nation. Fixing one's goals - Basic human aspirations - Role of UHV in education - Need for a holistic perspective	
Unit-2: Harmony in the Human Being - Understanding Oneself	3 Hour
Definition of 'Self' (person) - Understanding Human being as the Co-existence of the Self and the Body. Understanding Harmony in Self : Self Confidence - Self Discipline – Self assessment - peer pressure, time management, anger, stress, personality development, self- improvement, Understanding the characteristics and activities of the Self. Understanding Harmony in Human Being Self with the Body: Self-Regulation health issues, healthy diet, healthy lifestyle, Nurturing the Body.	
Unit-3: Harmony in the Family	3 Hour
Harmony in the Family - Harmony in relationship - Values in Human-to-Human Relationship - Feeling of Relationship - Exploring Feeling of Trust(Foundation value), Respect as a right evaluation, other naturally acceptable feelings in relationship : Affection, Care, guidance, Reverence, Gratitude, Glory, Love	
Unit-4: Harmony in Society	3 Hour
Understanding Harmony in Society: Participation in Society – Understanding Human Goal - Dimensions (Systems) of Human Order: Education-Sanskar, Health-Self regulation, Production-Work, Justice-Preservation, Exchange-Storage - Scope: Harmony from Family Order to World Family Order – Universal Human Order	
Unit-5: Harmony in the Nature/Existence	3 Hour
Understanding Harmony in the Nature – Classification of Units into Four orders - Interconnectedness and mutual fulfilment - Realizing Co-existence at All Levels with Nature - Understanding units, Space, Submergence - The Holistic Perception of Harmony in Existence. Self-Evaluation and sharing	

Learning Resources	1. Gaur R.R., Sangal R., Bagaria G.P., 2019 (2nd Revised Edition), A Foundation Course in Human Values and Professional Ethics, Excel Books, New Delhi. 2. http://uhv.org.in/uhv1notes	
---------------------------	---	--

Learning Assessment :									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Summative Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (0%)		Life Long Learning CLA-2 – (0%)		Summative (0%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	-	-	-	-	-	-	-
Level 2	Understand	-	-	-	-	-	-	-	-
Level 3	Apply	-	-	-	-	-	-	-	-
Level 4	Analyze	-	-	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	-	-	-	-	-	-	-	-

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.	1.	Dr.P.Supraja, SRMIST
	2.	

Course Code	21PDM101L	Course Name	PROFESSIONAL SKILLS AND PRACTICES	Course Category	M	NON CREDIT	L	T	P	C
							0	0	2	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Career Development Center	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Analyze 'self', identify professional behavior and apply creative ideas	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Enhance necessary critical thinking skills that helps in resolving problems	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Adopt success habits and develop people skills																	
CLR-4:	Enhance holistic development of students and improve their employability skills																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Develop professionalism and discover the creative self	-	-	-	-	-	-	-	3	3	-	-	3	-	-	-		
CO-2:	Apply best practices and approaches to resolve problems effectively	-	-	-	-	-	-	-	-	3	2	-	3	-	-	-		
CO-3:	Acquire inter personal skills and be an effective goal-oriented team player	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-		
CO-4:	Apply behavior changing elements to construct professionalism in behavior	-	-	-	-	-	-	-	3	-	2	-	3	-	-	-		

Unit-1 :	10 Hour
Orientation to the course – IKIGAI – SWOT analysis – JOHARI window – DISC profile - Personal branding – Profile building - Video Profile Attitude reengineering – Challenging the self – Etiquette & grooming - Gratitude – Blue ribbon ceremony	
Unit-2 :	10 Hour
Creativity & Innovations – SCAMPER – Design Thinking – Mind Mapping – Creativity Challenge Decision Making – 6 Thinking Hats – Problem Solving skills – Fish bone Theory	
Unit-3:	10 Hour
Interpersonal skills – Think win x win attitude – Expectation Management – Emotional Intelligence Collaborative Skills – Teamwork – Networking - Leadership - Conflict Management – Approaches – Case Study	

Learning Resources	1. Covey Sean, Seven Habits of Highly Effective Teens, New York, Fireside Publishers, 1998 2. Thomas A Harris, I am ok, You are ok, New York-Harper and Row, 1972 3. Carol Dweck, Mindset, The New Psychology of Success, Random House Pub. 2006	4. Héctor García, Francesc Miralles, Ikigai: The Japanese secret to a long and happy life, Penguin Books, 2017 5. Kenneth Blanchard, The One Minute Manager, Harpercollins, 2014 6. Angela Duckworth, Grit, Why passion and resilience are the secrets to success, Vermillion, 2017 7. James Clear, Atomic Habits, Random House, 2021
--------------------	--	--

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 (30%)		Formative CLA-2 – (30%)		Summative (40%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	15%	-	10%	-	10%	-	-
Level 2	Understand	-	15%	-	10%	-	10%	-	-
Level 3	Apply	-	20%	-	20%	-	20%	-	-
Level 4	Analyze	-	20%	-	20%	-	20%	-	-
Level 5	Evaluate	-	15%	-	20%	-	20%	-	-
Level 6	Create	-	15%	-	20%	-	20%	-	-
Total		100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ms. Sudha Mahadevan, Career Launcher, sudha.m@careerlauncher.com	1. Mr. Nishiith Sinha, dueNorth India Academics LLP, nsinha.alexander@gmail.com	1. Mr. P. Priyanand, SRMIST
2. Mr Ajay Zenner, Career Launcher, ajay.z@careerlauncher.com	2. Dr.Dinesh Khattar, Delhi University, dinesh.khattar31@gmail.com	2. Mrs. M. Kavitha,, SRMIST

Course Code	21PDM102L	Course Name	GENERAL APTITUDE	Course Category	M	NON CREDIT	L	T	P	C
							0	0	2	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Career Development Center	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Recapitulate fundamental mathematical concepts and skills, hone grammar skills to write error-free sentences.	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Sharpen logical reasoning through skillful conceptualization, nurture passion for enriching vocabulary.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Identification of relationships between words based on their function, usage and characteristics.	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
CLR-4:	Acquire the right knowledge, skill and aptitude to face any competitive examination.	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
CO-1:	Build a strong base in the fundamental mathematical concepts, vocabulary and grammar knowledge through methodical approaches.	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
CO-2:	Identify the approaches and strategies to solve problems with speed and accuracy.	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
CO-3:	Enhance lexical skills through systematic application of concepts and careful analysis of style, syntax, semantics and logic, Collectively solve problems in teams and groups.	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
CO-4:	Gain appropriate skills to succeed in preliminary selection process for recruitment.	-	-	-	-	-	-	-	-	3	3	-	3	-	-	-

Unit-1 :	10 Hour
Synonyms – Antonyms - Simple Equations – Age Problems – Ration Proportion & Variation - Average	
Unit-2 :	10 Hour
Sentence Completion– Spotting Error - Percentage – Profit and loss - Simple and Compound Interest	
Unit-3:	10 Hour
Reading Comprehension – Word Analogy - Linear Arrangement – Circular Arrangement – Selection and Distribution - Blood Relations - Direction sense	

Learning Resources	1. Nishit K. Sinha, The Pearson Guide to Quantitative Aptitude and Data Interpretation for the CAT 2. Dinesh Khattar-The Pearson Guide to QUANTITATIVE APTITUDE for competitive examinations 3. Charles Harrington Elston, Verbal Advantage: Ten Easy Steps to a Powerful Vocabulary, Random House Reference, 2002 4. Norman Lewis, How to Read Better and Faster, Goyal, 4th Edition 5. Franklin GRE Word List, 3861 GRE Words, Franklin Vocab System, 2014Wiley's GMAT Reading Comprehension Grail, Wiley, 2016 6. Manhattan Prep GRE : Reading Comprehension and Essays, 5th Edition
--------------------	--

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (30%)		Formative CLA-2 – (30%)		Summative (40%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	40%	-	40%	-	40%	-	-
Level 2	Understand	-	40%	-	40%	-	40%	-	-
Level 3	Apply	-	10%	-	10%	-	10%	-	-
Level 4	Analyze	-	10%	-	10%	-	10%	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Pratap Iyer, Study Abroad Mentors, pratap.iyer30@gmail.com	1. Mr Nishith Sinha, dueNorth India Academics LLP, nsinha.alexander@gmail.com	1. Dr. P. Madhusoodhanan, SRMIST
2. Mr Ajay Zenner, Career Launcher, ajay.z@careerlauncher.com	2. Dr.Dinesh Khattar, Delhi University, dinesh.khattar31@gmail.com	2. Dr Jayapragash J, SRMIST
		3. Dr. M. Snehalatha, SRMIST

Course Code	21GNM101L	Course Name	PHYSICAL AND MENTAL HEALTH USING YOGA	Course Category	M	NON CREDIT	L	T	P	C
							0	0	2	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Center For YOGA	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Utilize rich Indian heritage and knowledge for self-healing and self-protection from diseases	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Application of meditation techniques to balance emotions, state of mind and body equip attain happiness.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Intellectually develop oneself by identifying oneness with divine state merging with absolute space.															
CLR-4:	Social transformations towards meaningful and purposeful humanity through the morality of the both the self and the society.															
CLR-5:	Spiritual enlightenment of self by purifying the body, mind and soul to attain the blissful stage.															
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Identify Indian heritage, culture. Identify key anatomical structures in the human body and basic exercises for the same	1	-	-	3	-	2	-	2	3	3	-	3	-	-	-
CO-2:	Apply yoga meditation practices for emotional development and wellbeing	3	-	-	3	3	-	-	-	3	3	-	3	-	-	-
CO-3:	Identify educational and intellectual development methods using five sense realization and transformation	3	-	-	3	-	-	-	-	3	3	-	3	-	-	-
CO-4:	Demonstrate human values and emotions through thorough understanding about life, naturopathy and food habits	3	1	2	3	3	-	-	-	3	3	-	3	-	-	-
CO-5:	Impact self and society by peaceful coexistence with self-introspection and balanced diet charts	3	3	2	3	-	3	3	3	3	3	-	3	-	-	-

Unit-1 : Physical Development	6 Hour
Indian Heritage & Culture, Concept of Yoga, Objectives, Science & Art of Yoga, Classification, Misconceptions, History of Yoga, Women and Yoga Practice- Meditation (Self Realization), Relaxation - Importance of Guru in Yoga, Purusharthas, Yogic Anatomy – Naadi's, Chakra's and Pancha Koshas, Human anatomy Scientific view - Yogic creation of Universe, Nature of Soul and Prakriti, Understanding the Mind, Disease and Causes, Food Habits. Exercises: Hands, Legs, Neuro-Muscular breathing, Eye, Ears, Nostrils, kidney, brain- Digestive tract, stomach, lungs, spine, hip, neck. Pressure points in our body. Practices Practice1: Standing exercise, Surya Namaskar Practice2: Surya Namaskar, Sitting Exercises Practice3: Prone & Supine posture Exercises	
Unit-2 : Emotional Development	6 Hour
Brain Functions, Bio-Magnetism, Cognitive Mind - Emotional The 3 levels of Consciousness and the Importance of Subconscious mind - Meditation (Five Sense Realization), Relaxation - Brain and its Functions, Bio Magnetism and its operation. Bio Magnetic Operation and Food Transformation - The 5 states of Mind and Brain waves- Meditation (mooladhara) & Relaxation - Asanas (Postures) for Body Structure: Full Body Structure Maintenance - Standing, Sitting, Prone & Supine Posture, Benefits of asanas Practices Practice4: Surya Namaskar, Standing asanas Practice5: Surya Namaskar, Sitting asanas Practice6: Surya Namaskar, Prone & Supine posture Asanas	
Unit-3: Concentration Development	6 Hour
Current Challenges and sensory Overload, Need for better attention and awareness - Methods to improve Self Awareness and Concentration- Meditation (Five Sense Realization), Relaxation- Mind Taming Techniques, Nature of Divine states- Transformation of universe, living beings- Meditation (Agha) – Relaxation- Exercises: Intellectual development Brain Crown Centre (Thuriyam) Meditation- Five Senses Breath based Meditation Practices	

Practice7: Yoga for Youthfulness (Kayakalpa Yoga) Practice8: Dynamic poses Yoga, Pranayama Practice9: , Mudhras, Self-introspection Practice (Thought Analysis)		
Unit-4 :Social Development		6 Hour
Introduction: Social Intelligence- Cultural values, Ethics & Morality- Service to Humanity, Self-Introspection- Yogic Ethics [Yama and Niyama]- Six Bad temperaments and Overcoming actions- Yoga Mudhras, Meditation (Santhi) & Relaxation- Therapy for Social Development: Gestures Yoga (Mudhras) – Body locks (Bhandhas)- Indian Medical System: Naturopathy, Food, Nutrition, Diet Chart for Youthfulness Practices Practice10: Kayakalpa, Bhandas, Meditation (Crown) Practice11: Stay poses Yoga, Krisya Yoga Practice12: Balancing Asanas		
Unit-5: Spiritual Development		6 Hour
Spiritual Connect & Yoga: Self-Realization, Self-Awareness, Self-Actualization, Self-Motivation - Methods for Self-Realization: Karma, Bakthi, Janana and Raja Yoga- Meditation (Nine centre) & Relaxation- The Science of Cause and Effect: Karmic Theory. Internal Cleanliness- Self-Actualization and Maslows theory of Self Actualization- Meditation, Introspection, Sublimination- Spirituality for Stress Management(yoga break by ayush)- Yoga Practices for blissful existence, advance asanas. Practices Practice13: Management of Physical problems (Yoga therapy) Practice14: Project Submission		
Learning Resources	1. B.K.S.Iyengar, Light on yoga, 2006.	5. Vivekananda Kenthria Prkasan Trust, Yogam, 2006.
	2. T.K.V.Desikachar, Heart of Yoga, Inner Traditions Bear and Company, 2003.	6. Swami muktibodhananda, Hatha yoga Prathipika, Bihar School of Yoga 1985.
	3. Swami Ramdev Ji Yog Its Philosophy and Practice, 2008.	7. Swami Satyananda Saraswati, Asana Pranayama Mudra Bandha, Bihar School of Yoga, 1993
	4. Yogiraj Vethathiri Maharishi, Yoga for Modern Age, Tenth edition, Vethathiri Publications, 2007	8. Dr. Asana Andiappan, Thirumoolar's Astanga Yoga, International Yoga Academy, 2017

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 (30%)		Formative CLA-2 (30%)		Summative (40%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	20%	-	20%	-	20%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	30%	-	30%	-	30%	-	-
Level 4	Analyze	-	30%	-	30%	-	30%	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Professional Experts	Experts from Higher Technical Institutions	Internal Experts
1.Dr s. Lakshmiganthan ,Assistant professor., MDINY., AYUSH., slk.pt@rediffmail.com	1. Dr. N. Perumal, Director, Vision for Wisdom, Aliyar, visionacademy@vethathiri.edu.in.	1. Dr.V.Parthiban, SRMIST
2 .Dr. Manimekalai Narayanan, Sri Ramachandra Faculty of allied Health Sciences. m.manimekalai@sriramachandra.edu.in	2. Shri.S. Sivakeerthi, Sr. Strategist APSEL Technologies, siva@apseltech.com	2. Dr.V.Nithyananthan, SRMIST

Course Code	21GNM102L	Course Name	NATIONAL SERVICE SCHEME	Course Category	M	NON CREDIT	L	T	P	C
							0	0	2	0

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	NSS Cell	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand themselves in relation to their community	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2:	Develop among themselves a sense of social and civic responsibility	-	-	-	-	-	3	3	-	3	-	-	-	-	-	-
CLR-3:	Utilize their knowledge in finding practical solution to individual and community problems	-	-	-	-	-	3	3	-	3	-	-	-	-	-	-
CLR-4:	Develop competence required for group-living and sharing of responsibilities	-	-	-	-	-	3	3	-	3	-	-	-	-	-	-
CLR-5:	Acquire leadership qualities and democratic attitude	-	-	-	-	-	3	3	-	3	-	-	-	-	-	-

Unit-1 : Introduction to NSS	6 Hour
Basic concepts –Profile –Aims –Objectives –Symbol –Motto –Structure –Regular Activities –Special Camping Programme –National Days and Celebrations.	
Unit-2 : Man Making	6 Hour
Personality Development –Leadership Training	
Unit-3: Community Development	6 Hour
Definition –Structure and Composition –Community based issues –Need for awareness –Developmental Programmes.	
Volunteer Empowerment:	
Women's Emancipation –Formation of Youth Clubs –Self-Help Groups –Youth and Development	
Unit-4 :Social Issues	6 Hour
Media Infiltration – Human Rights Education –Consumer Awareness –HIV/AIDS –Role of NSS in Eradicating Child Labour –Environmental Issues –National Integration- Blood Donation –Flood Relief –First Aid –Earthquake Relief –Anti Atomic Movement –Drought Relief –Refugees Services.	
Unit-5:Sustainable Development	6 Hour
Rain Water Harvesting –Watershed Management –Health and Hygiene –Alternative Medicinal Systems –Yoga –Mental and Physical Health- Adoption of Village.	

Learning Resources	National Service Scheme Manual (Revised), Ministry of Human Resource Development, Government of India.	
---------------------------	--	--

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 (30%)		Formative CLA-2 (30%)		Summative (40%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	20%	-	20%	-	20%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	30%	-	30%	-	30%	-	-
Level 4	Analyze	-	30%	-	30%	-	30%	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Professional Experts	Experts from Higher Technical Institutions	Internal Experts
		1. Dr.T.Rajasekaran, SRMIST

Course Code	21GNM103L	Course Name	NATIONAL CADET CORPS	Course Category	M	NON CREDIT	L	T	P	C
							0	0	2	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	NCC Cell	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Understand the history, aims and objective of NCC	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2 :	Understand about armed forces and various entries	-	-	-	-	-	3	-	3	3	-	-	-	-	-	-
CLR-3 :	Know about Drill and various physical training	-	-	-	-	-	3	-	3	3	-	-	-	-	-	-
CLR-4 :	Understand about weapons using in NCC	-	-	-	-	-	3	-	3	3	-	-	-	-	-	-
CLR-5 :	Know about social awareness program conducting by NCC	-	-	-	-	-	3	-	3	3	-	-	-	-	-	-
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	known the history, aims and objective of NCC	-	-	-	-	-	3	-	3	3	-	-	-	-	-	-
CO-2:	Apply to armed forces through various entries	-	-	-	-	-	3	-	3	3	-	-	-	-	-	-
CO-3:	Perform the Drill and various physical training	-	-	-	-	-	3	-	3	3	-	-	-	-	-	-
CO-4:	Use the weapons using in NCC	-	-	-	-	-	3	-	3	3	-	-	-	-	-	-
CO-5:	Conduct the social awareness programs	-	-	-	-	-	3	-	3	3	-	-	-	-	-	-

Unit-1 :	6 Hour
Introduction to NCC-Aims, Objective, and Structure Of NCC-History and Present of NCC-Duties of NCC Cadet-NCC Camps: Types and Conduct	
Unit-2 :	6 Hour
Armed Forces - Entries into various armed forces, Police, and Paramilitary forces (Procedure of SSB) - National Integration and importance - Role of NCC during peace and wartime - Various Wars fought, War heroes.	
Unit-3:	6 Hour
Physicals (Various Types of Physical Activities), Obstacle Training - History of Drill - Types of Drill and Rules of Drill - Various Drills (Ceremonial Drill, Foot Drill, Rifle Drill) - Commands of Drill	
Unit-4 :	6 Hour
Weapon Training - Introduction to .22 and SLR, Handling of Rifles, Firing - Range Procedure and Theory of Group - Case Studies - Adventure, General Awareness, and Knowledge	
Unit-5:	6 Hour
Personality Development (Communication, Empathy, Critical and creative thinking) - Leadership (Motivation, Moral Values, Honor Code) - Turnout and Traits - Health and Hygiene - Social Work and awareness	

Learning Resources	National Cadet Corps Manual (Revised), Ministry of Defense, Government of India.	
---------------------------	--	--

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 (30%)		Formative CLA-2 (30%)		Summative (40%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	20%	-	20%	-	20%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	30%	-	30%	-	30%	-	-
Level 4	Analyze	-	30%	-	30%	-	30%	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Professional Experts	Experts from Higher Technical Institutions	Internal Experts
		1. Mr.P. Jegan, SRMIST

ACADEMIC CURRICULA

Engineering Science Courses (S)

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSS101J	Course Name	PROGRAMMING FOR PROBLEM SOLVING	Course Category	S	ENGINEERING
--------------------	-----------	--------------------	---------------------------------	------------------------	---	-------------

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
------------------------------	-----	-----------------------------	-----	----------------------------	-----

Course Offering Department	Computer Science and Engineering	Data Book / Codes / Standards	Nil
-----------------------------------	----------------------------------	--------------------------------------	-----

Course Learning Rationale (CLR):		The purpose of learning this course is to:					Program Outcome									
CLR-1 :	Think and evolve with a logic to construct an algorithm and pseudocode that can be converted into a program										Engineering Knowledge	1	2	3	4	5
CLR-2 :	Utilize the appropriate operators and control statements to solve engineering problems											Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	Professionalism and Ethics
CLR-3 :	Store and retrieve data in a single and multidimensional array															
CLR-4 :	Create custom designed functions to perform repetitive tasks in any application															
CLR-5 :	Create basic Abstract Data Types with python															

Course Outcomes (CO):		At the end of this course, learners will be able to:	Engin	Proble	Design	solutio	Condu	of cor	Mode	The e
CO-1:	Solve problems through computer programming. Express the basic data types and variables in C		2	3	-	-	-	-	-	-
CO-2:	Use appropriate data types in simple data processing applications. To create programs using the concept of arrays.		2	3	-	-	-	-	-	-
CO-3:	Create string processing applications with single and multi-dimensional arrays.		2	3	-	-	-	-	-	-
CO-4:	Create user defined functions with required operations. To implement pointers in applications with dynamic memory requirements.		2	3	-	-	-	-	-	-
CO-5:	Create programs using the python data types, loops, control statements for problem solving		2	3	-	-	-	-	-	-

Unit-1 :

Evolution of Programming & Languages - Problem solving through programming - Writing algorithms & Pseudo code - Single line and multiline comments - Introduction to statements. Variables and identifiers, Constants, Keywords - Values, Names, Scope, Binding, Storage Classes - Numeric Data types: integer, floating point Non-Numeric Data types: character, string, Boolean, Enum - Arithmetic, Relational and logical Operators - Conditional Operators - Conditional execution with pre / post increment operator

Unit-2 :

Conditional Control -Statements :Simple if, if...else - Conditional Statements : else if and nested if - Conditional Statements : Switch case - Un-conditional Control Statements - Looping Control Statements: nested for, nested while - Introduction to Arrays -One Dimensional (1D) Array Declaration and initialization - Accessing Array Elements - Array Programs – 1D - Initializing and Accessing 2D Array, Array Programs – 2D - Pointer and address-of operators -Pointer Declaration and dereferencing, Void Pointers, Null Pointers

Unit-3:

String Basics - String Declaration and Initialization - String Functions: gets(), puts(), getchar(), putchar(), printf() - Built-inString Functions: atoi, strlen, strcat, strcmp -String Functions: strcpy, strncpy, strncat, strncmp - String Operations on Strings - Function prototype declaration, function definition - Actual and formal parameters - Function with and without Arguments - Function with and without return values - Passing Array to Function - Passing Array elements to Function - Function Pointers.

Unit-4 :

Python: Introduction to Python - Introduction to Google Colab - Basic Data Types: Integers, Floating Points, Boolean types - Working with String functions - Working with Input, Output - Error Handling - Conditional & Looping Statements : If, for, while statements - Working with List structures - Working with Tuples data structures - Working with Sets - Python Libraries - Introduction to Numpy - High Dimensional Arrays

Unit-5:

Creating NumPy Array -Numpy Indexing - Numpy Array attributes - Slicing using Numpy - Descriptive Statistics in Numpy: Percentile - Variance in Numpy -Introduction to Pandas - Simple Operations with Data frames - Querying from Data Frames -Applying Functions to Data frames - Comparison between Numpy and Pandas - Speed Testing between Numpy and Pandas

Practice

Practice 1: Input, Output Statements, Variables

Practice 2: Data types & Operators-I

Practice 3: Data types & Operators-II

Practice 4: Control Statements (Branching, Looping)

Practice 5: Arrays

Practice 6: Arrays with Pointers

Practice 7: Strings

Practice 8: Functions

Practice 9 : Arrays and Functions

Practice 10: Input, Output in Python

Practice 11: Python data structures

Practice 12: Arrays in Python

Practice 13: Operations with Numpy

Practice 14: Operations with Pandas

Practice 15: case study: Data science with Numpy, Pandas

Learning Resources	1. Programming in C, E.Balagurusamy,Mc Graw Hill, Eighth Edition.2019. [chapters 1 to 6 & 8 To 11]	5. https://www.tutorialspoint.com/cprogramming/index.htm
	2. Head First C: A Brain-Friendly Guide, By David Griffiths, Dawn Griffiths,Oreilly. [Chapters 2 to 4]	6. https://www.geeksforgeeks.org/c-programming-language/
	3. Let Us C, Fifth Edition, Yashavant P. Kanetkar,BPB publications.[Chapters 1 to 6, 8 to 9]	7. Python Datascience Handbook, Oreilly,Jake VanderPlas, 2017.[Chapters 2 &3]
	4. Problem Solving & Programming Concepts, Maureen Sprankle, Jim Hubbard, Prentice Hall, Ninth Edition. [Chapters 1 to 7]	8. Python For Beginners, Timothy C.Needham,2019. [Chapters 1 to 4]
		9. https://www.tutorialspoint.com/python/index.htm
		10. https://www.w3schools.com/python/

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life Long Learning CLA-2 –Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	15%	15%	-
Level 2	Understand	20%	-	-	15%	15%	-
Level 3	Apply	20%	-	-	20%	20%	-
Level 4	Analyze	20%	-	-	20%	20%	-
Level 5	Evaluate	10%	-	-	15%	15%	-
Level 6	Create	10%	-	-	15%	15%	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Sainarayanan Gopalakrishnan, HCL Technologies, sai.jgk@gmail.com	1. Prof. Janakiram D, IIT Madras, djam@iitm.ac.in	1. Dr. E.Poovammal, SRMIST
2. Dr. Sricharan Srinivasan, Wipro Technologies, sricharanms@gmail.com		2. Dr. B. Amutha, SRMIST
		3.Dr. Rajeev Sukumaran, SRMIST

Course Code	21EES101T	Course Name	ELECTRICAL AND ELECTRONICS ENGINEERING	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Outline the concepts and theorem of DC and AC electric circuits	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions
CLR-2 :	Gain knowledge on analog and digital electronics													Conduct investigations of complex problems	Modern Tool Usage	The engineer and society
CLR-3 :	Familiarize the concept of DC / AC machines and drives													Environment & Sustainability	Ethics	Individual & Team Work
CLR-4 :	Illustrate the working of different sensors and transducers													Communication	Project Mgt. & Finance	Life Long Learning
CLR-5 :	Acquire the knowledge on Power Engineering													PSO-1	PSO-2	PSO-3
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Examine the fundamentals of DC and AC electric circuits	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Apply the analog and digital electronics to real time problem	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Describe the working principle of machines and interpret its application to drives	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Summarize the working of various sensors and transducers	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Disseminate the latest trends in power engineering and its application to electric vehicle	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1: Electric Circuits	12 Hour
Introduction to basic terminologies in DC circuit, Kirchhoff's Current law, Kirchhoff's 21EE Voltage law, Mesh Current Analysis, Nodal Voltage Analysis, Thevenin's Theorem, Maximum power transfer Theorem, Superposition Theorem.	
Basic terminologies of AC - RMS and Average value of halfwave and Full wave alternating quantity, Fundamentals of single-phase AC circuits- Analysis of R-L, R-C, R-L-C series circuits- Fundamentals of three phase AC system, Three-Phase Winding Connections, Relationship of Line and Phase Voltages, and Currents in a Delta and Star-connected System.	
Practice on Theorems, Halfwave, Full wave bridge rectifier circuits	
Unit-2 : Electronics	12 Hour
Overview of Semiconductors, Diodes and Transistors, Introduction to JFET and MOSFET, Construction and working of power devices-SCR, BJT, MOSFET, IGBT -Switching Characteristics of SCR- Types of power converters- Natural and forced commutation, Linear voltage Regulator, SMPS.	
Realize the logic expression using basic logic gates, Combinational logic design-Sum of Product form (SOP) and Product of Sum (POS) form, Minterm and Maxterm, Karnaugh Map (K-Map) representation of logical functions, Two variables K-Map, Three variables K-Map, Four variables K-Map. Introduction to FPGA.	
Practice on realization of logical expression, combinational circuits, PCB design, soldering and testing	
Unit-3: Machines and Drives	12 Hour
Construction and working principle of DC machines- Construction and Working principle of a single-phase Transformer- Construction and working of three phase Induction motor, BLDC motor, PMSM, Stepper and Servo motor.	
Introduction to Electrical Drives-Block diagram explanation of chopper fed DC drives, Selection of drives for real time applications (cranes/EV/ Pumping applications)	
Practice on chopper applications, Demo on DC& AC machines	

Unit-4 : Transducers and Sensors	12 Hour
<p>Basic principles and classification of Instruments- Moving Coil instruments, Moving Iron instruments, Digital Multimeter, Digital storage Oscilloscope.</p> <p>Transducer- Classification- Capacitive and Inductive transducers, Linear Variable Differential Transformer (LVDT), Thermistors, Thermocouple, Piezoelectric transducer, Photoelectric transducer, Hall effect transducers.</p> <p>Introduction to Opto-electronics Devices, Light Dependent Resistor (LDR), Photodiodes, Phototransistors, Photovoltaic cells (solar cells), Optocouplers, Liquid crystal display, Proximity sensor, IR sensor, Pressure sensor, Introduction to Bio sensor, Sensors for smart building.</p> <p>Practice on capacitive and inductive transducer, thermistor and LVDT using virtual lab</p>	
Unit-5: Power Engineering	12 Hour
<p>Electrical supply system- simple layout of Generation, transmission and Distribution of power, Typical AC and DC power supply schemes, overview on substation equipment with key diagram of 11kV/400 V indoor substation- Introduction to smart grid.</p> <p>Safety Measures in Electrical systems- Basic Principle and importance of Earthing- precautions for Electric shock- safety devices.</p> <p>Introduction to renewable energy resources: Solar Photovoltaic -Introduction to energy storage systems-overview of battery, Fuel cell technologies- HEVs, PHEVs and EVs – EV Charging station</p> <p>Practice session on different types of wiring circuits and safety measures</p>	

Learning Resources	<ol style="list-style-type: none"> 1. Edward Hughes, John Hiley, Keith Brown, Ian McKenzie Smith, Hughes Electrical and Electronics Technology, Pearson Education, 12th ed., 2016 2. S. K. Bhattacharya, Basic Electrical and Electronics Engineering, Pearson Education, 2011 3. R. Muthusubramanian, S. Salivahanan, Basic Electrical and Electronics Engineering, Tata McGraw-Hill, 2012 4. Charles Alexander, Matthew Sadiku, Fundamentals of electrical circuits, McGraw-Hill Education; 5th ed., 2012 5. Morris M. Mano, Digital Design, 3rd ed., Pearson Education, 2011 6. Ernest Doebelin, Dhanesh Manik, Measurement systems, Fourth Edition, McGraw Hill, July 2017.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	20 %	-	20 %	-	20 %	-
Level 4	Analyze	20 %	-	20 %	-	20 %	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Paramasivam, Danfoss, Industries Pvt Ltd., paramsathya@yahoo.com	1. Dr. K. S. Swarup, IIT Madras, ksswarup@iitm.ac.in	1. Dr. A.Rathinam, SRMIST
2. Dr. Bhaskar Sahu, Schneider Electric Ltd, bhaskar.Sahu@se.com	2. Dr. S.Chandramohan, CEG, c_dramo@annauniv.edu	2. Dr. P.Eswaran, SRMIST

Course Code	21MES101L	Course Name	BASIC CIVIL AND MECHANICAL WORKSHOP	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							0	0	4	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil and Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Practice machining and glass cutting shop floor trade	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Practice arc & gas welding, and fitting and make new assemblies according to various dimensions and tolerances	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Practice basic carpentry joints and sheet metal shop floor practices.															
CLR-4:	Practice casting, moulding, & smithy trades															
CLR-5:	Practice and make G.I & P.V.C. plumbing trade															
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Machine in a lathe. Drill using drilling machines. Cut glass. Create new components according to specifications	3	-	-	-	1	-	3	-	-	-	-	2	-	-	-
CO-2:	Weld joints using arc & gas welding. Fit pipes and fixtures. Make new assembly for given dimensions, and tolerances	3	-	-	-	1	-	3	-	-	-	-	2	-	-	-
CO-3:	Practice basic carpentry joints used in house hold furniture items, and sheet metal items used shop floor practices	3	-	-	-	1	-	3	-	-	-	-	2	-	-	-
CO-4:	Practice casting, moulding, & smithy trades	3	-	-	-	1	-	3	-	-	-	-	2	-	-	-
CO-5:	Make G.I & P.V.C pipe line connections used in the plumbing trade	3	-	-	-	1	-	3	-	-	-	-	2	-	-	-

Unit-1 : Machining Process	12 Hour
Machining, Drilling, Tapping, Glass cutting - Machining: Basics of Machining Processes Equipment's - Tools and demonstration of machining to produce models - Simple turning of cylindrical surface on MS rod using lathe machine tool - Simple turning of cylindrical surface on MS rod using lathe machine tool - Basics of drilling and tapping processes, Equipment's, tools - Demonstration of drilling and tapping to produce models. - Generate hole on a metal piece - Generate internal thread on a metal piece. Basics of Glass cutting processes, - Equipment's.- Tools and demonstration of producing models - Make glass panels for boxes	
Unit-2 : Metal Joining Process	12 Hour
Welding (Arc and Gas) and fitting - Basics of Metal Arc welding operations, Equipment's - Tools and demonstration of producing models - Butt joint of two metal plates using arc welding process - Lap joint of two metal plates overlapping on one another using arc welding process. - Basics of gas welding operations, Equipment's, - Tools and demonstration of producing models - MIG welding of metal plates - TIG welding of metal plates - Basics of fitting practice, tools and method - of producing models - Tools and demonstration of producing models - Step fitting of two metal plates using fitting tools	
Unit-3: Carpentry and Sheet metal	12 Hour
Basics of Carpentry operations, Equipment's - Tools and demonstration of producing models - Cross halving joint of two wooden pieces at perpendicular direction - To make duster from wooden piece using carpentry tools.- Basics of Sheet metal operations, Equipment's - Tools and demonstration of producing sheet metal models - To make Rectangular shaped tray using GI sheet - To make bigger size scoop using GI sheet. - Basics of different geometrical shapes in Sheet metal operations - Equipment's, tools and demonstration of producing models - To make geometrical shape like frustum, Cone and Prism using G.I sheet	
Unit-4 : Foundry and Smithy	12 Hour
Casting, moulding and smithy - Basics of Casting, processes, Equipment's - Tools and demonstration of producing models - To make the mould using stepped flange - To make the mould using stepped flange - Basics of injection moulding and processes, Equipment's, - Tools and demonstration of producing models - To make plastic models using injection moulding of simple part - To make plastic models using injection moulding of simple part - Basics of Smithy processes, Equipment's, - Tools and demonstration of producing models - To forge chisel from MS rod using black smithy	

Unit-5: Plumbing		12 Hour
Plumbing (G.I and P.V.C) - Basics of Plumbing practices for G.I and P.V.C. - Tools and demonstration of producing models - Plumbing of bathroom/ kitchen fittings using G.I. fittings - Plumbing of bathroom/ kitchen fittings using G.I. fittings - PVC Plumbing of bathroom/ kitchen fittings using P.V.C. fittings - Tools and demonstration of producing models - Plumbing of bathroom/ kitchen fittings using P.V.C. fittings - Plumbing of bathroom/ kitchen fittings using P.V.C. fittings - Basics of Plumbing practices for G.I pipe - lines and fittings for pumps and machines - Equipment's, tools and demonstration of producing models. - Plumbing of pipe lines and fitting for Pumps using G.I fittings		
Learning Resources	1. Jeyachandran K., Natarajan S. & Balasubramanian S., A Primer on Engineering Practices Laboratory, Anuradha Publications, 2007	5. Kannaiah P. & Narayana K.L., Manual on Workshop Practice, Scitech Publications, 1999.
	2. Jeyapoovan T., Saravanapandian M. & Pranitha S., Engineering Practices Lab Manual, Vikas Publishing House Pvt.Ltd, 2006.	6. Hajra Choudhury S.K., Hajra Choudhury A.K., Nirjhar Roy S.K., Elements of Workshop Technology, Vol.I & Vol.II 2010, Media promoters and publishers private limited, Mumbai.
	3. Bawa H.S., Workshop Practice, Tata McGraw, 2007.	7. Rao P.N., Manufacturing Technology, Vol. I & Vol. II, Tata McGrawHill,2017.
	4. Rajendra Prasad A. & Sarma P.M.M.S., Workshop Practice, Sree Sai Publication, 2002.	8. Gopal T.V, Kumar. T, Murali. G, A first course on workshop practice – Theory, Practice and Work Book, Suma Publications, Chennai, 2005.

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Summative Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	20%	-	20%	-	20%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	30%	-	30%	-	30%	-	-
Level 4	Analyze	-	30%	-	30%	-	30%	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		0 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Dr. R. Kalimuthu, ISRO, Trivandrum	1. Dr. Ramkumar P, IIT Madras, ramkumar@iitm.ac.in	1. Mr. A. Thirugnanam, SRMIST
2.Dr. A. Velayutham, DRDO, Chennai	2. Dr. Sourav Rakshit, IIT Madras, srakshit@iitm.ac.in	2. Dr. S. Prabhu, SRMIST

Course Code	21MES102L	Course Name	ENGINEERING GRAPHICS AND DESIGN*	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							0	0	4	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Utilize engineering graphic fundamentals. Apply the same to draw engineering curves and projection of objects.	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Draw the projection of solids like prisms, cylinder, pyramids and cone.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Model the projection of combined solids, section of solids.	1	-	-	-	3	-	-	-	-	3	-	2	-	-	-
CLR-4:	Create the development of surfaces and construction of building drawing.	2	-	-	-	3	-	-	-	-	3	-	2	-	-	-
CLR-5:	Develop the assemblies of 3D parts and create 2D drawings from the assembly.	2	-	-	-	3	-	-	-	-	3	-	2	-	-	-
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Construct the geometrical curves, projection of points, lines and planes.	1	-	-	-	3	-	-	-	-	3	-	2	-	-	-
CO-2:	Develop the orthographic projection of solids.	2	-	-	-	3	-	-	-	-	3	-	2	-	-	-
CO-3:	Construct the projection of combination and section of solids.	2	-	-	-	3	-	-	-	-	3	-	2	-	-	-
CO-4:	Construct the development of surfaces and projection of buildings.	2	-	-	-	3	-	-	-	-	3	-	2	-	-	-
CO-5:	Develop solid modelling, assembly of parts and extraction of 2D drawings.	2	-	-	-	3	-	-	-	-	3	-	2	-	-	-

Unit-1 : Projection **12 Hour**
 Principles, Standards, Conventions - Angle Projection, Symbols, Dimensions - 2D Geometric Constructions - 2D Geometric Constructions - Conic Curves ellipse by eccentricity method - Conic Curves ellipse by eccentricity method - Cycloids, Epicycloids – Hypocycloid - Involute of a Square, Circle – Spirals -Introduction to perspective projection with terminologies and concepts - Orthographic multiview and isometric projection - Perspective projection of a point, line - Perspective projection of a planes, solids - Orthographic multiview of point, line - Orthographic multiview of planes, solids -Isometric projection of a point, line - Isometric projection of planes, solids - Isometric to orthographic multiview sketching - Orthographic multiview to isometric sketch - Orthographic multiview projection of lines inclined to both planes - Orthographic multiview projection of planes inclined to planes, auxiliary projection - Projection of lines inclined to both the planes - true length, true inclinations, traces of lines - Projection of lines inclined to both the planes - true length, true inclinations, traces of lines - Finding shortest distance between a point and a plane - Shortest distance between two lines -shortest distance between point and plane - shortest distance between point and plane

Unit-2 : Projection of solids using CAD software **12 Hour**
 Introducing CAD Software, layers, - dimensions, tolerance, annotations - Create, modify, customize, print using CAD - Demo: Menu, Toolbars, Drawing Area, Dialog box, windows, Shortcut menus - Command Line, Status Bar, Different zoom methods, Create, Select, Erase objects - Draw straight lines, rectangle, polar, absolute, relative - Orthographic constraints, Ortho ON, snap to objects manually, automatically - drawing lines, arcs, circles, polygons, create, edit, use layers, extend lines - Dimensioning objects, annotations - Demo: drawing page, print, units/ scale/ limits settings, standards for dimensioning - ISO, ANSI Std. dimensioning, tolerancing - Projection of solid prisms and cylinders - inclined to both the planes - change of position method, reference line - method / auxiliary projections, - Projection of solid prisms and cylinders - inclined to both the planes - Change of position method - Projection of solid prisms and cylinders inclined to both the planes
 Reference line method - Auxiliary projections - Auxiliary projections - Viewing isometric and perspective views, shaded, wire-frame models - Oblique prismatic solids and its projections - Projection of solid pyramids and cones inclined to both the planes - change of position method and reference line method / auxiliary projections, - Projection of solid pyramids and cones inclined to both the planes - Change of position method - Projection of solid pyramids and cones inclined to both the planes - Change of reference line method - Auxiliary projections - Auxiliary projections - Viewing isometric and perspective views, shaded, wire-frame models - Oblique pyramidal solids and projections

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Summative Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	20%	-	20%	-	20%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	30%	-	30%	-	30%	-	-
Level 4	Analyze	-	30%	-	30%	-	30%	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		0 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.Dr. R. Kalimuthu, ISRO,	1. Dr. Ramkumar P, IIT Madras, ramkumar@iitm.ac.in	1. Mr. D. Kumaran, SRMIST
2.Dr. A. Velayutham, DRDO,	2. Dr. Sourav Rakshit, IIT Madras, srakshit@iitm.ac.in	2. Mr. S. Balamurugan, SRMIST

Note: For all B.Tech Programmes other than Civil, Mechanical, Automobile, Aerospace and Mechatronics, the entire course would be conducted using CAD Software only.

* This syllabus for the students admitted in the AY 2021-22 and 2022-23 only

Course Code	21MES102L	Course Name	ENGINEERING GRAPHICS AND DESIGN*	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							0	0	4	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Utilize the engineering graphics fundamentals. Apply the same to draw geometry and curves	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2 :	Draw the projection of points, lines and planes	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3 :	Produce the projection of solids like prism, cylinder, pyramid and cone and sectioned solids	1	-	-	-	3	-	-	-	-	2	-	-	-	-	-
CLR-4 :	Create the isometric and perspective projection and develop the surfaces	2	-	-	-	3	-	-	-	-	3	-	-	-	-	-
CLR-5 :	Develop the combination of solids using primitives and features	2	-	-	-	3	-	-	-	-	3	-	-	-	-	-
Course Outcomes (CO):	At the end of this course, learners will be able to:	2	-	-	-	3	-	-	-	-	3	-	-	-	-	-
CO-1:	Construct the 2D geometrical figures and special curves	2	-	-	-	3	-	-	-	-	3	-	-	-	-	-
CO-2:	Demonstrate the projection of points, lines and planes	2	-	-	-	3	-	-	-	-	3	-	-	-	-	-
CO-3:	Construct the orthographic projection of regular and sectioned solids	2	-	-	-	3	-	-	-	-	3	-	-	-	-	-
CO-4:	Create the development of surfaces and isometric projection	2	-	-	-	3	-	-	-	-	3	-	-	-	-	-
CO-5:	create combination of solids	2	-	-	-	3	-	-	-	-	3	-	-	-	-	-

Unit-1 : Introduction to Engineering graphics and Design	12 Hour
Engineering graphics principles and standards – Significance of design and drawing – Introduction to drafting Software – Draw, modify and dimension toolbars- 2D geometrical construction – Conic sections – Ellipse and parabola - Special curves – Spiral, Cycloid and Involute	
Unit-2 : Orthographic projection of points, lines and plane surface	12 Hour
Principles of projection – Types of projection - First angle and third angle projection – Projection of points in four quadrants – Projection of straight line inclined to one plane and both principal plane by rotating line method – Projection of plane surfaces inclined to one principal plane	
Unit-3: Projection of solids and Section of solids	12 Hour
Significance of projection of solids – Orthographic projection of simple solids - Projection of polyhedrons and solids of revolution – Inclined to one principal plane and parallel to other by change of position method. Section of solids – Section plane perpendicular to one plane and parallel or inclined to other plane	
Unit-4: Development of surfaces, Isometric projection	12 Hour
Development of lateral surfaces of simple solids - polyhedrons and solids of revolution- Principles of isometric projection and isometric view – Isometric view from orthographic views of simple objects - Perspective projection of polyhedrons and solids of revolution by visual ray method (Demonstration)	
Unit-5: Combination of Solids	12 Hour
Principles of constructive solid geometry – Boolean operations – Combination of simple solids using Boolean operations – Extrude, revolve, sweep, loft and shell features – Modeling of simple products using features	

Learning Resources	<p>1. Venugopal, K. and V. Prabhu Raja. Engineering Drawing and Graphics + AutoCAD. New Age International (P) Limited, 2005</p> <p>2. Narayana, K. L. and P. Kannaiah. Textbook on Engineering Drawing. Scitech Publications, 2011.</p> <p>3. Gopalakrishna, K. R. Engineering Drawing. Subas Publications, 2010.</p> <p>4. Bhatt, N. D. and V. M. Panchal. Engineering Drawing. Charotar Publishing house, 2012.</p>	<p>[5Jeyapoovan. T., Engineering Drawing and Graphics using AutoCAD, Vikas Pub. House, 2015.</p> <p>6. Natarajan, K. V. A text book of Engineering Drawing Graphics. Dhanalakshmi Publishers, Chennai, 2008.</p> <p>Dhananjay A Jolhe. Engineering Graphics McGraw-Hill Publishing Company, Ltd, 2009.</p>
---------------------------	---	--

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Summative Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-	30%	-
Level 2	Understand	30%	-	40%	-	40%	-	30%	-
Level 3	Apply	40%	-	40%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		0 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in	1. Dr. Shankar Krishnapillai, IIT Madras, skris@iitm.ac.in	Dr. V. Magesh, SRM IST, KTR
2. Mr. Parameswaran, Nokia, Chennai, parameswaran.s@nokia.com	2. Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in	Mr. S. Arun Prasath, SRM IST, KTR

This syllabus for the students admitted from the AY 2023-24 onwards

Course Code	21MES101T	Course Name	ENGINEERING MECHANICS	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Apply static equilibrium problems in engineering and its applications	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2 :	Apply theory of dry friction in Mechanical Engineering applications	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3 :	Apply the concept of centroid and moment of inertia in engineering problems and its applications															
CLR-4 :	Analyze problems on kinematics and kinetics of particles															
CLR-5 :	Analyze problems on kinematics and kinetics of rigid bodies															
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Solve statically determinate equilibrium problems in Engineering	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Solve problems related to dry friction and analyze trusses	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Determine centroid and moment of inertia for composite objects	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Perform kinematic analysis of particles with rectilinear, curvilinear motions and solve dynamic equilibrium problems in particles	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Perform kinematic analysis of rigid bodies with translation, rotation, general plane motion and solve dynamic equilibrium problems in rigid bodies	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 : Statics of Particles and Rigid Bodies	12 Hour
Introduction to Mechanics, classification of mechanics - Fundamental concepts and principles of engineering mechanics - Concurrent forces in a plane, Coplanar forces - Vector approach on addition, subtraction of forces - Resolution of forces - Resultant of several concurrent forces in plane (vector approach) – Equilibrium of particles, Free body diagram, Forces in planes, Lami's theorem - Forces in space: resultant of concurrent forces in space, Principle of transmissibility - Moment of a force, Varignon's Theorem and its applications - Reduction of system of forces into single force and couple system - Resultant of non-concurrent forces in plane - Types of supports and reactions - Equilibrium of rigid bodies in two dimensions.	
Unit-2 : Analysis of Friction and Trusses	12 Hour
Friction and its types, Laws of Friction, coefficient of friction - Angle of Friction, Angle of repose, limiting friction - Equilibrium of a block resting on a rough inclined plane - Range of force required to maintain equilibrium of block on rough inclined plane – Dry Friction – wedge friction – Ladder friction - Belt friction - flat and V-belts, Ratio of belt tensions - Screw friction - screw jack - Terminology in screws, self-locking of screw - Effort, Mechanical advantage of a screw jack- problems on simple screw jack, Trusses - Simple Trusses - Analysis of Trusses - Method of joints- Method of sections.	
Unit-3: Centroid and Moment of Inertia	12 Hour
Centroids of lines, areas, and volumes –Determination of centroids of line, area and volume by integration - Determination of centroids of composite lines, areas and volume - Theorem of Pappus-Guldinus - Second moment or Moment of inertia of an area- Determination of moment of inertia of area by integration - Radius of gyration - Parallel and perpendicular axis theorems - Mass moment of inertia of plate, prism, cylinder, cone and sphere.	
Unit-4 : Dynamics of Particles	12 Hour
Rectilinear motion –Curvilinear motion –Normal and tangential components of acceleration- Radial and transverse components of acceleration -Newton's second law of motion – D'Alembert's principle- Principle of work and energy –Applications- Conservative forces-Principle of impulse and momentum – Impulsive motion - Impact of elastic bodies – Direct central- Oblique central impact.	

Unit-5: Dynamics of Rigid bodies **12 Hour**

Introduction to Kinematics of rigid bodies - Translation and rotation of rigid bodies - Fixed axis rotation – determination of angular displacement, velocity and acceleration, General plane motion –Absolute and Relative velocity in plane motion - Instantaneous center of rotation in plane motion – Kinetics of rigid bodies, Angular momentum – Kinetics of rigid bodies by Newton's second law - Principle of work and energy.

Learning Resources	<p>1. Ferdinand.P. Beer, E, Russell Johnston Jr., David Mazurek, Philip J Cornwell, Vector Mechanics for Engineers: Statics and Dynamics, McGraw - Hill, 10th ed., 2013</p> <p>2. Meriam J.L and Kraige L.G., Engineering Mechanics, Volume I - statics, Volume II - dynamics, John Wiley & Sons, 7th ed., 2012</p>	<p>3. Russel C Hibler, Engineering Mechanics: Statics, Dynamics, Pearson, 14th ed., 2015</p> <p>4. Shames.I.H, Krishna Mohana Rao.G, Engineering Mechanics (Statics and Dynamics), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 4th ed., 2006</p> <p>5. Timoshenko, Young, Engineering Mechanics, Tata Mc-Graw Hill, 5th ed., 2013</p>
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20 %	-	20 %	-	20 %	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30 %	-	30 %	-	30 %	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Anand Gurupatham, Renault Nissan, Chennai	1. Dr. Arulprakash, Professor, IIT Madras	1. Dr. P. Nandakumar, SRMIST
2. Dr. Saravanan, Mahindra & Mahindra, Chennai	2. Dr. Raju Abraham, NIOT, Chennai	2. Mr. A.Vinoth. SRMIST

Course Code	21ASS101T	Course Name	APPLIED ENGINEERING MECHANICS	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Apply the concept of static equilibrium of particles and rigid bodies.	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Apply the concept of centroid and moment of inertia about different axes on static structures	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Apply the concept of the dynamics of particles															
CLR-4:	Apply the concept of the dynamics of rigid bodies.															
CLR-5:	Solve problems related to space mechanics.															
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Determine the forces under static equilibrium	3	2	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-2:	Calculate the centroids and determine moment of inertia	3	3	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-3:	Determine the forces acting on particle for kinetics and kinematics	3	2	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-4:	Determine the forces acting on rigid body for kinetics and kinematics	3	2	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-5:	Solve the problems of orbital mechanics and projectile motions	3	3	-	-	-	-	-	-	-	-	-	1	-	-	-

Unit-1: Statics of Particles	9 Hour
Fundamentals of mechanics - Forces on particles - Resolution and Resultant of forces - Principle of Transmissibility - Forces in space - Moment of force - Varignon's theorem - Equivalent system of forces -Free body diagram - Types of supports and Equilibrium of rigid bodies in two dimensions – Statically determinate and indeterminate structures.	
Unit-2 : Properties of Surfaces and Volumes	9 Hour
Determination of centroids by integration - centroids of lines, areas and volumes - Determination of moment of inertia by integration, Parallel and Perpendicular axis theorems - Polar moment of inertia - Mass moment of inertia..	
Unit-3: Dynamics of Particles	9 Hour
Rectilinear motion: Uniform motion and Uniformly accelerated motion - Rectangular components of velocity. Curvilinear Motion-Normal and tangential components - Radial and transverse components. Cylindrical coordinates, Newton's second law – D' Alembert's principle - Principle of work and energy, principle of impulse and momentum.	
Unit-4 : Dynamics of Rigid bodies	9 Hour
Kinematics of rigid bodies: Fixed axis rotation - General plane Motion-Absolute and Relative velocity in plane motion - Instantaneous center of rotation in plane motion - Principle of work and energy, Principle of impulse and momentum for the plane motion of a rigid body	
Unit-5: Applications in Space Mechanics	9 Hour
Angular momentum of a particle- Rate Of change of angular momentum - Newton's Law of Gravitation – Kepler's Law of motion - Conservation of angular momentum, conservation of energy, Space Mechanics – Central Force Motion, Trajectory of a particle under a central force: Application to space mechanics	

Learning Resources	1. Ferdinand P. Beer, E. Russell Johnston Jr., David Mazurek, Philip J Cornwell, "Vector Mechanics for Engineers: Statics and Dynamics", McGraw - Hill, New Delhi, Tenth Edition, 2013. 2. Shames, I.H., and Krishna Mohana Rao, G., "Engineering Mechanics (Statics and Dynamics)", Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), 2006.	3.. NPTEL Engineering Mechanics Lectures by IIT Guwahati ' https://nptel.ac.in/courses/112103109/ '
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 – (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20 %	-	20 %	-	20 %	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	60 %	-	60 %	-	60 %	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. R. Krishnamurthy, Group Director, Design Group, DRDL- DRDO, Hyderabad, rkmurthy@drdl.drdo.in	1. Dr. K. M. Parammasivam, Professor, Department of Aerospace Engineering MIT Campus, Anna University, Chennai, Indiamparams@mitindia.edu	1. Mr.K.B.Ravichandrakumar ,SRMIST
2. Dr. A Sakthivel, Scientist 'G', Regional Director RCMA (Helicopters), CEMILAC, DRDO, Bengaluru	2.Dr.S. Nadaraja pillai, Professor, Department of Mechanical Engineering, Sastra university Thanjavur, nadarajapillai@mech.sastra.edu	2. Mr. K.lynthezhuthon, SRMIST

Course Code	21AUS101L	Course Name	ARTIFACT DISSECTION LABORATORY	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							0	0	2	1

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Automobile Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Identify the commonly used tools in a household and its usages.	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2 :	Identify the parts in a given machine.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3 :	Investigate the functions of the component	3	3	-	-	-	-	-	-	-	-	-	3	-	-	-
CLR-4 :	Develop the ability to dismantle study and assemble the given machine.	3	3	-	-	-	-	-	-	-	-	-	3	-	-	-
CLR-5 :	Identify the commonly used tools in a household and its usages.	2	3	-	-	-	-	-	-	-	-	-	3	-	-	-
CO-1:	Describe the functions of the commonly used tools in a household and its usages.	3	3	-	-	-	-	-	-	-	-	-	3	-	-	-
CO-2:	Illustrate the procedure for dismantling the given machine	3	3	-	-	-	-	-	-	-	-	-	3	-	-	-
CO-3:	Examine the components for failure	2	3	-	-	-	-	-	-	-	-	-	3	-	-	-
CO-4:	Demonstrate the procedure for given machine	3	3	-	-	-	-	-	-	-	-	-	3	-	-	-
CO-5:	Describe the functions of the commonly used tools in a household and its usages.	3	3	-	-	-	-	-	-	-	-	-	3	-	-	-

Practice 1: Study of common tools and special tools
Practice 2: Dismantle the bicycle, study of working parts and Assemble the given bicycle
Practice 3: Dismantle Study and Assemble the given Sewing Machine
Practice 4: Dismantle Study and Assemble the given Drilling Machine
Practice 5: Dismantle Study and Assemble the given two stroke engine
Practice 6: Dismantle Study and Assemble the kick starter mechanism of the given two stroke engine
Practice 7: Dismantle Study and Assemble the given wet grinding machine.
Practice 8: Dismantle Study and Assemble the given mixer grinding machine.
Practice 9: Dismantle Study and Assemble the given washing machine
Practice 10: Dismantle Study and Assemble the given Ceiling fan

Learning Resources	1. V. Ganesan, <i>Internal Combustion Engines</i> , Tata McGraw-Hill Education, 2004.	3. B. L. Theraja "Fundamentals of Electrical Engineering and Electronics", S. Chand, 1997
	2. Karen E. Kunkel "The Complete Sewing Machine Handbook " Sterling, 1999	4. Bosch service manual for corded drills

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		CLA-1 Average of first cycle experiments (30%)		CLA-2 Average of second cycle experiments (30%)		Practical Examination (40% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	20%	-	20%	-	20%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	30%	-	30%	-	30%	-	-
Level 4	Analyze	-	30%	-	30%	-	30%	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		0 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Ramakrishnan Ekambaram, Robert Bosch, Coimbatore.	1. Dr. K. Arunachalam, MIT, Chrompet, karunachalam@mitindia.edu	1. Mr. M. Palanivendhan, SRMIST
2. Mr. GovardhanaGiri, ATALON Product Centre PVT LTD giri@atalon.in.	2. Dr. M. Parthasarathy, Vel Tech, nparthasarathy@veltech.edu.in	2. Dr. R. Rajendran. SRMIST

Course Code	21AIS101J	Course Name	FOUNDATION OF DATA ANALYSIS	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Artificial Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1 :	Introduce a range of topics and concepts related to data and data analysis process.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2 :	Understand the basic data structures involved in python to perform exploratory data analysis															
CLR-3 :	Apply EDA for different file formats.															
CLR-4 :	Understands data visualization using python															
CLR-5 :	Provides an exposure to basic machine learning techniques to solve real world problems															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand different types of data and starts working in python environment	3	2	1	-	-	-	-	-	-	-	-	3	-	-	-
CO-2:	Understand various data structures involved in python and perform exploratory data analysis	3	2	1	-	-	-	-	-	-	-	-	3	-	-	-
CO-3:	Apply the concepts of EDA in various datasets.	-	2	-	-	-	3	1	-	-	-	-	3	-	-	-
CO-4:	Formulate and use appropriate visualization techniques for their data	2	2	1	-	-	-	-	-	-	-	-	3	-	-	-
CO-5:	Formulate and use appropriate models of data analysis to solve hidden solutions to business-related challenges	-	-	-	2	-	3	3	-	-	-	-	3	-	-	-

Unit-1 :	12 Hour
An Introduction to Data Analysis - Data Analysis - Knowledge domains of Data Analyst: Computer Science, Mathematics, and statistics - Machine Learning & AI, Professional fields of Application - Introduction to Data - Understanding the nature of Data - Data – Information; Information – Knowledge - Types of Data - Data Analysis Process - Quantitative Data Analysis - Qualitative Data Analysis - Python – The Programming Language - Python 2 and Python 3 - Python Package Index - IDEs for python - Scipy: Numpy- Pandas, Matplotlib	
Unit-2 :	12 Hour
Numpy Library: Numpy Installation - Nddarray, Create an array and Types of data - Basic Operations: Arithmetic Operators, Matrix Product, Increment and Decrement Operators - Universal Functions, Aggregate Functions - Indexing, slicing and iterating - Conditions and Boolean arrays - Shape and array manipulation - Vectorization, structured arrays - Pandas library: Installation - Introduction to Pandas data structures - Other functionalities on indexes - Operations between data structures - Function application and mapping - Sorting and ranking - Correlation and covariance - "Not a number" Data - Hierarchical Indexing and leveling	
Unit-3:	12 Hour
String Pandas: Reading data from csv, xml, text and html files - Writing data in CSV, Html, Excel, files - Json data - HDF5 format - Data preparation – Concatenating - Data transformation- Removing duplicates – Mapping - Discretization and binning: Detecting and filtering outliers - Permutation – random sampling - String manipulation - Regular expressions - Data Aggregation- Group by - Hierarchical grouping - Advanced data aggregation - Case study on data preprocessing	
Unit-4 :	12 Hour
Data visualization with matplotlib library - Matplotlib – Installation and architecture - Pyplot, plotting window - Using Kwarg and adding elements to the chart - Saving charts - Handling data values - Line charts - Bar charts – Histograms - Pie charts - Contour plots - Polar charts - Mplot 3D toolkit: 3D surfaces - Scatter plots and bar charts in 3D - Multi-panel plot	

Unit-5:	12 Hour
Machine Learning with sci-kit learn - sci-kit learn library - Machine Learning - Supervised learning with sci-kit learn - Linear Regression - Logistic Regression - K-Nearest Neighbor classifier - Support Vector Machines - Support Vector Classification - Nonlinear SVC - Support Vector Regression	

Practice

Practice 1: Introduction to Python – Installing Python and Jupyter, Importing Libraries
 2. Writing Python Code – Input and Output statements, Mathematical calculations, and indentation
 3. For loop and If statements
 4. Numpy: Reading and writing array data on files (binary files and tabular data)
 5. Implementation of Pandas data structures
 6. Exploratory Data Analysis with Pandas
 7. Reading and writing data
 8. Data cleaning
 9. Data aggregation using python
 10. Installing matplotlib and implementing line and adding elements to the charts
 11. Implementing bar charts, histogram and pie charts
 12. Implementing multi-panel plots
 13. Binary classification using (Logistic Regression)
 14. Classification using kNN
 15. Implement SVM classifier

Learning Resources	1. Fabio Nelli, Python Data Analytics with Pandas, Numpy and matplotlib (Second edition), Apress 2021. 2. Wes McKinney, Python for Data Analysis, 2nd Edition, O'Reilly Media, Inc. , 2012 (https://learning.oreilly.com/library/view/python-for-data/9781491957653/)
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life Long Learning CLA-2 –Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	15%	15%	-
Level 2	Understand	20%	-	-	15%	15%	-
Level 3	Apply	20%	-	-	20%	20%	-
Level 4	Analyze	20%	-	-	20%	20%	-
Level 5	Evaluate	10%	-	-	15%	15%	-
Level 6	Create	10%	-	-	15%	15%	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Senthilnathan, Co-founder, Tenzai, Bangalore	Dr. E. Sivasankar, Assistant Professor, Department of CSE, NIT, Trichy	Dr. A. Alice Nithya, School of Computing, SRMIST

ACADEMIC CURRICULA

Professional Core Courses (C)

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21BTC101T	Course Name	BIOCHEMISTRY	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Explain the structure and functions of biomolecules	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Define the metabolism, bioenergetics and photosynthesis															
CLR-3:	Explain the carbohydrate metabolism and hormonal regulation															
CLR-4:	Acquire knowledge of the metabolism of proteins and amino acids															
CLR-5:	Explain mechanism of lipid metabolism and associated hormones															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe the structure and functions of biomolecules	3	-	-	3	-	-	-	-	-	-	-	-	-	3	-
CO-2:	Conclude the concepts of metabolism, bioenergetics and photosynthesis	3	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Explain the concepts in metabolism of carbohydrates and hormonal regulation	3	-	-	3	3	-	-	-	-	-	-	-	-	2	-
CO-4:	Describe the metabolism of proteins and removal of nitrogen	3	3	-	3	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Summarize the lipid and nucleic acid metabolism	3	2	-	-	-	-	-	-	-	-	-	-	-	3	-

Unit-1 : Introduction to Biochemistry	9 Hour
History of Biochemistry, Chemical bonds, pH and Buffers. Introduction to Carbohydrates - Classification – Monosaccharides, Oligosaccharides and Polysaccharides - structure and functions. Glycoproteins and lectins. Protein composition and structures – Introduction – structure, classification, functions. Amino acids – classification, structure and functions. Enzymes – Basic concepts and regulations. Lipids and Cell membrane – Introduction – classification, structure and functions. DNA and RNA - structure and functions	
Unit-2 : Introduction To Metabolism, Bioenergetics And Photosynthesis	9 Hour
Metabolism – Basic concepts and design. Bioenergetics – Introduction - High energy compounds, Biological oxidation - Electron transport chain, Oxidative phosphorylation, Chemiosmotic theory - Shuttle pathways – Glycerol phosphate Shuttle, Malate aspartate Shuttle. Photosynthesis - Light and Dark reactions.	
Unit-3: Carbohydrate Metabolism	9 Hour
Carbohydrate metabolism - Glycolysis - Citric acid cycle – Gluconeogenesis - Glycogen metabolism – Glycogenesis – Hormonal regulations - Muscle use of Glycogen - Blood glucose levels regulation by Insulin.	
Unit-4 : Protein Turnover and Amino Acids Metabolism	9 Hour
Protein turnover – Introduction – Degraded to amino acids – Removal of Nitrogen - Regulation - Metabolism of amino acids – Transamination – Deamination - decarboxylation - Metabolism of ammonia - Urea cycle - Biosynthesis of amino acids – Feedback Inhibition Regulations.	
Unit-5: Fatty Acid and Nucleic Acids Metabolisms	9 Hour
Fatty acid metabolism – Introduction - Hormones signal the release of fatty acids from adipose tissue - Fatty acid oxidation - Ketone bodies & Ketogenesis - Biosynthesis of Fatty acids – Eicosanoids - Cholesterol Biosynthesis – Lipoproteins. Nucleic acid metabolism – Introduction – Biosynthesis and Degradation of Purine and Pyrimidine.	

Learning Resources	1. Jeremy M. Berg, John L. Tymoczko, Gregory J. Gatto, Lubert Stryer, "Biochemistry", 9th Edition, 2019 2. Donald Voet, Judith G. Voet, Charlotte W. Pratt, "Fundamentals of Biochemistry: Life at the Molecular Level", 5th Edition, John Wiley & Sons Inc., 2016	3. U. Satyanarayana and, U. Chakrapani, "Biochemistry", 4th Edition, Elsevier India, 2013. 4. David L. Nelson, Michael M. Cox, "Lehninger Principles of Biochemistry", 7th Edition, W.H. Freeman & Co., 2017
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15 %	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30 %	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences, ramchand@saksinlife.com	1. Dr. K Subramaniam, IITM Chennai, subbu@iitm.ac.in	1. Dr. S. Subhashini, SRM IST
2. Dr. S. Sam Gunasekar, Orchid Pharma Ltd., sam@orchidpharma.com	2. Dr. R. B. Narayanan, Anna university, arbeen09@gmail.com	2. Dr. R. Pachiappan, SRM IST

Course Code	21BMC101J	Course Name	BIOMEDICAL SENSORS	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biomedical Engineering			Data Book / Codes / Standards	Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)			Program Specific outcomes
CLR-1 :	Describe the basics of measurement system	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CLR-2 :	Demonstrate the working principles of temperature transducers	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3 :	Exemplify the operating principles of pressure transducers	1	1	-	-	-	-	-	-	-	-	-	3	-	-	-	
CLR-4 :	Elucidate the operation of magnetic sensors	2	-	-	2	-	-	-	-	-	-	-	3	-	-	-	
CLR-5 :	Compile the principles of optical transducers	1	-	2	-	-	-	-	-	-	-	-	3	-	-	-	
CO-1:	Analyze the performance of a measurement system	1	-	-	-	2	-	-	-	-	-	-	3	-	-	-	
CO-2:	Develop a system to determine temperature of a medium	1	-	-	-	2	-	-	-	-	-	-	3	-	-	-	
CO-3:	Implement a system to measure pressure	1	1	-	-	-	-	-	-	-	-	-	3	-	-	-	
CO-4:	Execute a displacement sensor	1	-	-	-	-	-	-	-	-	-	-	3	-	-	-	
CO-5:	Propose an optical transducer system to determine various measurand	1	1	-	-	-	-	-	-	-	-	-	3	-	-	-	

Unit-1 : Measurement System	12 Hour
Measurement system- Functional elements of an Instrument - Measurement terminologies- - Classification of Instruments- types of Instruments, Instruments used to display electrical parameters, Advantages of Electronic Instrument, Functional elements of a Medical Instrument, salient features of Medical Instruments.	
Practice:	
<ol style="list-style-type: none">1. Study about the functional block of Measurement system.2. Measurement of voltage using analog and digital Voltmeters.3. Measurement of current using analog and digital Ammeters.	
Unit-2 : Temperature Transducers	12 Hour
Transducers- Block diagram- Types- RTD- Construction and operating principles, Applications - Thermistor- Construction and operating principles- Characteristics- Applications- - Thermocouple- Construction and operating principles- Characteristics- Applications.	
Practice:	
<ol style="list-style-type: none">1. Characteristics of RTD,2. Characteristics of thermistor3. Characteristics of thermocouple	

Unit-3: Pressure and Magnetic Transducers	12 Hour
Strain Gauge: Principles, Construction and Working, Load cell: Construction and Working, Capacitive transducer- Construction and Working, Piezoelectric transducer: Construction and Working, LVDT- Construction and Working. Practice: 1. Characteristics of – LVDT. 2. Characteristics of Strain gauge. 3. Characteristics of Piezoelectric transducer.	
Unit-4 : Optical Transducers	12 Hour
Photodiodes- Working principles- phototransistor- Working principles- LDR- Working principles, Photovoltaic cell- Working principles, Characteristics of Photodiode. Practice: 1. Characteristics of LDR 2. Characteristics of Phototransistor.	
Unit-5: Medical Applications Of Sensors	12 Hour
Pulse oximetry- Working principle, Applications, Heart rate sensor- Construction and Working principle, Blood pressure sensor- Working principle, IR sensors- Working principle and Applications, Practice: 1. Study of Pulse oximeter. 2. Measurement of Heart rate. 3. Measurement of Blood pressure	

Learning Resources	1. Sawhney A.K, "A Course in electrical and electronic measurements and instrumentation", Dhanpat Rai & Co (P) Ltd, Educational and Technical Publishers, 19th Revised edition 2011, Reprint 2014. 2. Patranabis D, "Sensors and transducers", PHI, 2nd edition, 2004 3. Murty DVS, "Transducer and instrumentation", PHI, 2nd edition, 2010.	4. U.A. Bakshi, A.V. Bakshi, "Measurements and instrumentation", Technical Publications, 3rd revised edition, 2010 5. Paras N, Prasad, "Introduction to biophotonics", John Wiley & Sons, 1st edition, 2003
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life Long Learning CLA-2 –Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	20%	20%	-
Level 2	Understand	20%	-	-	-	20%	-
Level 3	Apply	30%	-	-	40%	20%	-
Level 4	Analyze	30%	-	-	-	20%	-
Level 5	Evaluate	-	-	-	40%	10%	-
Level 6	Create	-	-	-	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Sri Lanka & Maldives	Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University	Dr.D.Kathirvelu, SRMIST

Course Code	21CEC101T	Course Name	BUILDING MATERIALS IN THE BUILT ENVIRONMENT	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)			Program Specific outcomes
CLR-1:	Study different materials used in civil engineering structures.	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	
CLR-2:	Understand the building finishing materials, application of ferro cement and insulating materials.													Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	
CLR-3:	Learn the masonry building, transport and termite treatment.													Environment & Sustainability	Ethics	Individual & Team Work	
CLR-4:	Know the various ecofriendly building materials.													Communication	Project Mgt. & Finance	Life Long Learning	
CLR-5:	Explore energy efficient buildings and cost-effective construction techniques.																
Course Outcomes (CO):		At the end of this course, learners will be able to:												PSO-1	PSO-2	PSO-3	
CO-1:	Apply the acquired knowledge on building materials and products for construction.	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-2:	Identify various building finishing materials and ferro cement applications for the building construction.	3	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-3:	Apply the knowledge on the masonry, building transport and the termite treatment.	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Disseminate the knowledge on various eco friendly building materials	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-5:	Recognize the energy efficient buildings and cost-effective construction techniques	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-

Unit-1 : Building Materials	9 Hour
Introduction to Civil Engineering and Civil Engineering materials - Composition, classifications, properties and uses of stones - Classification of rocks, quarrying, dressing, properties and uses - Properties and uses of timber and plywood - Types, properties and uses of cement and lime, Types of steel, mild, medium and hard, properties of floor and wall tiles and thermal insulating materials.	
Unit-2 : Finishing and Protective Materials	9 Hour
Finishing Materials: Glass, Aluminium, Plastics, Paints, Varnishes, Distemper - Waterproofing - Damp Proofing Materials - Ferrocement and its application - Sound insulation - materials and methods – Fire proof materials – Fire alarms.	
Unit-3: Components of Building and Treatment	9 Hour
Partition wall and Cavity wall - Composite masonry – Doors – Windows – Ventilators – Stairs – Lift – Ramps – Escalators - Anti termite treatment	
Unit-4 : Eco-Friendly Materials	9 Hour
Construction materials: Locally available building materials - Soil, Fly ash, Ferrocement, Lime, Fibres, Stone dust, Red mud, Gypsum, Alternate Wood, Polymer-ADOBE, Cob and Rammed earth, Light clay, Straw-Bale, Bamboo, Agro-Industrial waste, Structural properties of alternate building materials, Composite materials, Artificial aggregates substitutes for natural conservation.	
Unit-5: Modern Techniques	9 Hour
Introduction to Green Buildings- Definition, Importance - Building envelope - Problems in existing buildings - Energy use in buildings - Principle of energy efficient building - Greenhouse gas emissions and indoor air pollution - Green construction materials - Ventilation and air conditioning - Green building assessment system – Cost-effective construction techniques.	

Learning Resources	1. Punmia. B.C., Ashok Kumar Jain, Arun Kumar Jain, Building Construction, Laxmi Publishing (P).Ltd., New Delhi-2, 2012.	4. K.S.Jagadish, B. U. Venkataramareddy and K. S. Nanjundarao. Alternative Building Materials and Technologies. New Age International, 2007.
	2. Bhavikatti.S.S., Building Materials, Vikas Publishing House.Pvt. Ltd., New Delhi, 2012.	5. Energy Conservation Building Code, 2017, Bureau of Energy Efficiency, Ministry of Power, Government of India.
	3. Rangwala .S.C., "Engineering Material"s, Charotar Publishing House, Anand, 2012.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20 %	-	20 %	-	20 %	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30 %	-	30 %	-	30 %	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Er. K. Jayasankar, Senior Vice President, Ultra Tech Cement Limited, Mumbai	1. Dr. R. Senthil, Professor, Anna University, Chennai	1. Dr. P.T. Ravichandran, SRMIST
2. Dr. P. Manoharan, Regional Executive Engineer, Madurai, Municipal Administration.	2. Dr. R. Baskar, Professor, Annamalai University, Chidambaram	2. Dr. N. Pannirselvam, SRMIST

Course Code	21CHC101J	Course Name	PHYSICAL AND ANALYTICAL CHEMISTRY			Course Category	C	PROFESSIONAL CORE												L	T	P	C
																		2	0	2	3		
Pre-requisite Courses	Nil		Co-requisite Courses	Nil			Progressive Courses	Nil															
Course Offering Department	Chemical Engineering			Data Book / Codes / Standards			Nil																
Course Learning Rationale (CLR):		The purpose of learning this course is to:						Program Outcomes (PO)												Program Specific outcomes			
CLR-1 :	Describe the ideal and non-ideal behavior of liquids; learn colligative properties and their applications						1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2 :	Explain the concepts of chemical equilibrium and the effect of various factors on equilibrium constant						Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3			
CLR-3 :	Compare the difference in behavior of different states of matter essential for separation operations																						
CLR-4 :	Describe the properties and applications of colloids; Understand the kinetics of photochemical reactions																						
CLR-5 :	Explain the principles of analytical instruments along with their limitations																						
Course Outcomes (CO):		At the end of this course, learners will be able to:																					
CO-1:	Analyze ideal and non-ideal behavior of fluids and define the colligative properties						3	-	-	1	-	-	-	-	-	-	-	-	-	-	-		
CO-2:	Evaluate the significance of Gibbs' free energy and equilibrium constants						3	2	-	-	-	-	-	-	-	-	-	-	-	-			
CO-3:	Apply Gibbs' phase rule and draw the phase diagram of one- and three-component systems						3	-	1	-	-	-	-	-	-	-	-	-	-	-			
CO-4:	Analyze the properties of colloids and photochemical reactions						2	-	-	3	-	-	-	-	-	-	-	-	-	-			
CO-5:	Implement the appropriate analytical technique for various types of chemical compounds						2	-	-	3	-	-	-	-	-	-	-	-	-	-			
Unit-1 : Properties of Solutions																		12 Hour					
Introduction to solutions, Raoult's law-Vapour pressures of ideal and non-ideal solutions - Deviations from ideality of Type I, Type II and Type III solutions - Completely miscible binary solutions: Vapor pressure-Composition and Boiling point-Composition curves of Type I, Type II, and Type III solutions - Fractional distillation of binary liquid systems, The Lever rule - Distillation of immiscible liquids, Steam distillation - Partially miscible liquids, Critical solution temperature, Phenol-water system, Solutions of gases in liquids: Factors influencing solubility of a gas, Henry's law - Colligative Properties - Relative lowering of vapour pressure, Osmosis and osmotic pressure, Elevation in boiling point, Depression in freezing point, Determination of molecular weight from colligative properties, Effect of association/dissociation on colligative properties																							
Practice 1: Determine the critical solution temperature (CST) of phenol-water system																							
Practice 2: Determine the molecular weight of an unknown compound by Rast method																							
Unit-2 : Chemical Equilibrium																		12 Hour					
Introduction to Chemical equilibria - Gibbs' free energy and Chemical potential - Free energy of a spontaneous reaction - Law of mass action - Law of chemical equilibrium - Thermodynamic derivation of the law of chemical equilibrium - Problems on Gibbs' free energy - Significance of equilibrium constant - Equilibrium constants :Kp, Kc, and, Kx - Relationship between Kp, Kc, and, Kx - Temperature dependence of Equilibrium constant - Van't Hoff Equation - Pressure dependence of equilibrium constants - Problems on equilibrium constants - Le Chatelier's Principle - Effect of change in concentration, temperature, and pressure - Le Chatelier's principle and physical equilibria Practice 1: Determine the strength of the given acid mixture by conductometric titration																							
Practice 2: Determine the rate constant of acid catalyzed hydrolysis of an ester																							
Unit-3: Phase Equilibrium																		12 Hour					
Introduction to Phase equilibria - Component, phase and degrees of freedom - Conditions for equilibrium between phases - Derivation of Gibbs' phase rule - Representation of one component systems using phase diagrams - One component systems - water system, CO ₂ system, sulphur system - Three component systems - Triangular phase diagram - Three component system: acetic acid-chloroform-water system, Two salts and water system, The Nemst distribution law and distribution co-efficient, Conditions for the validity of the distribution law - Association of the solute in one of the solvents - Dissociation of the solute in one of the solvents - Applications of Nernst distribution law - Problems on Nernst distribution law																							

Practice1: Phase diagram of three component system
Practice 2: Determine the partition co-efficient of benzoic acid between benzene and water

Unit-4 : Colloids and Photochemistry

12 Hour

Introduction to Colloids - General properties of colloids: Tyndall effect and Brownian movement - Electrical properties of colloids: electrical double layer, Zeta potential - Electrokinetic properties of colloids: electrophoresis and electro-osmosis - Gels and emulsions - Applications of colloids - Introduction to Photochemistry - Laws of photochemistry - Quantum yield - Photochemical reactions - Photochemical rate law - Determination of quantum yields - Problems on Beer Lambert's law - Problems on quantum yield - Kinetics of hydrogen-chlorine reaction: Mechanism and Derivation - Kinetics of hydrogen-bromine reaction: Mechanism and Derivation

Practice 1: Estimation of sulphate by nephelometry

Practice 2: Determine the amount of reducing sugar by DNS method

Unit-5: Instrumental Methods of Analysis

12 Hour

Instrumental Methods of Analysis - Accuracy, precision, common errors (system/manual) - Calibration curves - Classification of instrumental methods - spectroscopy, electrochemical and chromatography - Electro-magnetic (EM) spectrum, Interaction of EM radiation with matter - Generalities of optical methods (light source/ monochromator / sample introduction / detector / signal generator) - Principle, Instrumentation, Working, Applications, and Limitations of analytical techniques - UV-Vis spectroscopy - Infra-red spectroscopy - Atomic absorption spectroscopy - Chromatographic techniques: General principle - Column chromatography - Paper chromatography - Thin layer chromatography - Gas chromatography - High Performance Liquid Chromatography - Open-ended problems on choice and usage of analytical instruments - Open-ended problems on choice and usage of analytical instruments

Practice 1: Estimate amount of iron present in a sample using UV-Vis spectrophotometer

Practice 2: Determine the amount of fatty acid methyl ester using gas chromatography

Learning Resources	1. B. R. Puri, L. R. Sharma and Madan S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., 47th Ed, 2015	3. Douglas A. Skoog, F. James Holler, and Timothy A. Nieman. "Principles of Instrumental Analysis, Thomson Learning Inc., Toronto, 1998
	2. Arun Bahl, B. S. Bahl, and G. D. Tuli, Essentials of Physical Chemistry, S. Chand & Company Ltd., 2009.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life Long Learning CLA-2 –Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	20%	20%	-
Level 2	Understand	20%	-	-	20%	20%	-
Level 3	Apply	30%	-	-	30%	30%	-
Level 4	Analyze	30%	-	-	30%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd	1. Dr. Lima Rose Miranda, Anna University	1. Dr. K. Deepa, SRMIST
		2. Dr. S. Prabhakar, SRMIST

Course Code	21CSC101T	Course Name	OBJECT ORIENTED DESIGN AND PROGRAMMING	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computer Science and Engineering			Data Book / Codes / Standards	Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)			Program Specific outcomes
CLR-1:	Programs using object-oriented approach and design methodologies for real-time application development	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Method overloading and operator overloading for real-time application development programs	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Inline, friend and virtual functions and create application development programs	-	2	2	-	2	-	-	-	-	-	-	3	-	-	-	
CLR-4:	Exceptional handling and collections for real-time object-oriented programming applications	-	2	2	-	2	-	-	-	-	-	-	3	-	-	-	
CLR-5:	Model the System using Unified Modelling approach using different diagrams	-	2	2	-	2	-	-	-	-	-	-	3	-	-	-	
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	Create programs using object-oriented approach and design methodologies	-	2	2	-	2	-	-	-	-	-	-	3	-	-	-	
CO-2:	Construct programs using method overloading and operator overloading	-	2	2	-	2	-	-	-	-	-	-	3	-	-	-	
CO-3:	Create programs using inline, friend and virtual functions, construct programs using standard templates	-	2	2	-	2	-	-	-	-	-	-	3	-	-	-	
CO-4:	Construct programs using exceptional handling and collections	-	2	2	-	2	-	-	-	-	-	-	3	-	-	-	
CO-5:	Create Models of the system using UML Diagrams	-	2	2	-	2	-	-	-	-	-	-	3	-	-	-	

Unit-1 : Introduction to OOPS	9 Hour
Object-Oriented Programming - Features of C++ - I/O Operations, Data Types, Variables-Static, Constants-Pointers-Type Conversions – Conditional and looping statements – Arrays - C++ 11 features - Class and Objects, Abstraction and Encapsulation, Access Specifiers, Methods- UML Diagrams Introduction – Use Case Diagram - Class Diagram.	
Unit-2 : Methods and Polymorphism	9 Hour
Constructors- Types of constructors - Static constructor and Copy constructor -Destructor - Polymorphism: Constructor overloading - Method Overloading Operator Overloading - UML Interaction Diagrams -Sequence Diagram - Collaboration Diagram - Example Diagram	
Unit-3: Inheritance	9 Hour
Inheritance – Types -Single and Multiple Inheritance - Multilevel Inheritance - Hierarchical Inheritance - Hybrid Inheritance - Advanced Functions - Inline, Friend- Virtual - Pure Virtual function - Abstract class - UML State Chart Diagram - UML Activity Diagram	
Unit-4 : Generic Programming	9 Hour
Generic - Templates - Function templates - Class Templates - Exceptional Handling: try and catch - Multilevel exceptional - throw and throws - finally - User defined exceptional - Dynamic Modeling: Package Diagram - UML Component Diagram - UML Deployment Diagram	
Unit-5: Standard Template Library	9 Hour
STL: Containers: Sequence and Associative Container - Sequence Container: Vector, List, Deque, Array, Stack - Associative Containers: Map, Multimap - Iterator and Specialized iterator - Functions of iterator - Algorithms: find(), count(), sort() - Algorithms: search(), merge(), for_each(), transform()	

Learning Resources	1. Grady Booch, Robert A. Maksimchuk, Michael W. Engle, <i>Object-Oriented Analysis and Design with Applications</i> , 3rd ed., Addison-Wesley, May 2007 2. Reema Thareja, <i>Object Oriented Programming with C++</i> , 1st ed., Oxford University Press, 2015 3. Sourav Sahay, <i>Object Oriented Programming with C++</i> , 2nd ed., Oxford University Press, 2017	4. Robert Lafore, <i>Object-Oriented Programming in C++</i> , 4th ed., SAMS Publishing, 2008 5. Ali Bahrami, <i>Object Oriented Systems Development</i> , McGraw Hill, 2004 6. Craig Larmen, <i>Applying UML and Patterns</i> , 3rd ed., Prentice Hall, 2004
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 – (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Sagar Sahani, Amadeus Software Labs, Bangalore, hello.sagarsahni@gmail.com	1. Prof. R. Golda Brunet, GCE, Salem, goldabrunet@gcessalem.edu.in	1. Mr. C. Arun, SRMIST
2. Mr. Janmajay Singh, Fuji Xerox R&D, Japan, janmajaysingh14@gmail.com		2. Mrs. C. G. Anupama, SRMIST

Course Code	21EEEC101J	Course Name	ELECTRIC CIRCUITS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Solve real-time DC circuits using mesh, nodal analysis and network reduction	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Explain the solution to AC circuits including series and parallel resonance															
CLR-3:	Understand network theorems and apply them to DC and AC circuits															
CLR-4:	Study the circuits at transient condition and analyze the coupled circuits															
CLR-5:	Examine three phase circuits and two port networks															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Analyze problems on DC circuits using mesh and nodal analysis	3	3	-	-	-	-	-	-	2	-	-	-	2	-	-
CO-2:	Solve AC circuits including series and parallel resonance	3	3	-	-	-	-	-	-	2	-	-	-	1	-	-
CO-3:	Apply network theorems to analyze DC and AC circuits	3	3	-	-	-	-	-	-	2	-	-	-	1	-	-
CO-4:	Examine DC and AC circuits under transient conditions	3	3	-	-	-	-	-	-	2	-	-	-	2	-	-
CO-5:	Analyze three phase circuits and two port networks	3	3	-	-	-	-	-	-	2	-	-	-	2	-	-

Unit-1 : DC Circuits	12 Hour
Active and passive elements, Two terminal circuit - Types of sources, Combination of Sources, Source transformation - Network reduction techniques- Star-Delta transformation -Mesh and Nodal analysis of DC circuits with dependent sources. Laboratory Practice: Mesh analysis and Nodal analysis-Simulation and hardware	
Unit-2 : AC Circuits	12 Hour
Introduction to AC circuits - Steady state analysis of RL, RC, RLC series, parallel and compound circuits- Series resonance and parallel resonance circuits- Mesh analysis and Nodal analysis for AC circuits with independent sources. Laboratory Practice: RL, RC, RLC series and parallel circuits -Simulation and hardware	
Unit-3: Network Theorems	12 Hour
Superposition theorem, Thevenin's theorem, Norton's theorem and Maximum power transfer theorem for AC circuits-Reciprocity theorem, Millman's theorem, Compensation theorem and Tellegen's theorem for DC circuits. Laboratory Practice: Practice on theorems-Simulation and hardware	
Unit-4: Transient Analysis and Coupled Circuits	12 Hour
Transients in RL circuit with DC and AC excitation, Transients in RC circuit with DC and AC excitation-Analysis of coupled circuits -Analysis of single tuned circuits. Laboratory Practice: Time domain of RL and RC transient circuit - Simulation	
Unit-5: Three-Phase Circuits and Two Port Networks	12 Hour
Analysis of balanced and unbalanced three phase circuits-Measurement of three phase power and power factor using two wattmeter method- Analysis of two port networks: Z, Y, h, g, ABCD and inverse ABCD parameters. Laboratory Practice: Three phase power and power factor measurement for R and RL loads, Determination of hybrid parameters- Simulation and hardware	

Learning Resources	1. Sudhakar A, Shyammohan S. Palli, <i>Circuits and Networks: Analysis and Synthesis</i> , 5th ed., McGraw Hill Education I, 2017	4. John Bird, <i>Electric circuit theory and technology</i> , 6th ed., Routledge, 2017
	2. William H. Hayt, Jack E. Kemmerly, Jamie D. Phillips, Steven M. Durbin, <i>Engineering circuit analysis</i> , 9th ed., McGraw Hill, 2020	5. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-071j-introduction-to-electronics-signals-and-measurement-spring-2006/lecture-notes/
	3. Jegatheesan R, <i>Analysis of Electric Circuits</i> , McGraw Hill, 2014	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life Long Learning CLA-2 –Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	20%	20%	-
Level 2	Understand	20 %	-	-	20 %	20 %	-
Level 3	Apply	30 %	-	-	30 %	30 %	-
Level 4	Analyze	30%	-	-	30%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. S. Paramasivam, Danfoss, Industries Pvt Ltd., paramsathya@yahoo.com	1. Dr. K. S. Swarup, IIT Madras, ksswarup@iitm.ac.in	1. Dr. K.Vijayakumar, SRMIST
2. Dr.BhaskarSahu, Schneider Electric Ltd, bhaskar.sahu@se.com	2. Dr. S.Chandramohan, CEG, c_dramo@annauniv.edu	2. Dr. C.S.Boopathi, SRMIST

Course Code	21ECC101J	Course Name	ELECTRONIC SYSTEM AND PCB DESIGN	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering		Data Book / Codes / Standards		Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
CLR-1 :	Explore the basics of semiconductors and semiconductor devices															1	2	3	4	5	6	7	8	9	10	11	12																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
CLR-2 :	Study of special semiconductor devices and fabrication techniques															Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
CLR-3 :	Identify the applications of devices in circuit and measuring instruments																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
CLR-4 :	Create insights to the concepts of PCB design and rules																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
CLR-5 :	Analyze the design concept of PCB design for different applications																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
Course Outcomes (CO):		At the end of this course, learners will be able to:																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	</

Unit-1 :	12 Hour
Classifications of Semiconductor, Doping in Semiconductors, Conductivity of semiconductors, Energy Distribution and fermi level, Carrier Concentration in intrinsic semiconductor and Mass-Action Law, Problem Solving techniques, Drift and Diffusion Current , Einstein Relationship for semiconductors, Basic PN junction and applications, Bipolar junction transistor and MOSFETs, Challenges for Nano MOSFETs (Scaling Issues), SOI MOSFET and Double gate MOSFET (Working Principle), FinFET and IGFET (Basic Concept) Practice: Study of electron devices and electronic components- Passive electronic components, Study of electronic components- active devices, analog and digital integrated circuits (IC), Study of testing and measuring Instruments: Logic analyzer, spectrum analyzer, IC tester (Analog and Digital), LCR meters	
Unit-2 :	12 Hour
Introduction to power electronics, applications and role of power electronics, Introduction to power semiconductor devices, Operating characteristics of Power Diodes, Gunn Diode, Schottky Diode, IMPATT Diode, Introduction to Thyristor, PNP Diode, Silicon Control Rectifier (SCR), Thyristor Rating, Physics of Power BJT and Switching Characteristics , Physics of Power MOSFET and Characteristics , Monolithic Fabrication Process, Fabrication of Monolithic Diode, Fabrication of monolithic capacitors and resistors Practice: Study on diodes using CAD tools, Design and analysis of RL and RC time constants using schematic in CAD tool, Design and analysis of RLC circuits using schematic in CAD tool	
Unit-3:	12 Hour
Basic Building block of power supply and its requirements, Rectifiers (Half Wave and Full Wave), Rectifier circuits using SCR, Voltage Regulators (Line regulation and Load regulation) and problem solving , Switched Mode Power Supply (SMPS), Classifications of SMPS, Advantages and comparison, Wave Shaping Circuits, Multivibrators (Astable, Monostable and Bistable), Ammeter, Digital voltmeter, Digital multimeter, Cathode Ray Oscilloscope (CRO) , Spectrum Analyzer, Energy Meter, Power meter and distortion meter (block diagram and working principle) Practice: Schematic and PCB Layout in CAD tool. Regulated power supply design.- Full wave rectifier circuit design with fixed voltage regulator, wave shaping circuits.	

Unit-4 :	12 Hour
Concept of PCB Design, Components of a PCB, Classifications and manufacturing of PCB, Layout planning and Design block diagram, Importance of PCB Design, Mechanical Design of PCB, Types of Boards, Mounting Techniques, Stress analysis , Electrical Design Consideration of PCB , Rules for Component Placement in PCB , Rules for Power supply and Ground, Connections layout, Component Assembly in PCB Practice: PCB Layout Design of single digit pulse counter using PCB design tool, PCB Layout Design - of RL, RC and RLC circuits	

Unit-5:	12 Hour
Environmental Factors on PCB Design, Cooling and Packaging of PCB, Layout Design of PCB and Checklist, Design rules for analog PCB, Design rules for digital PCB, Problems in Digital PCB (reflections, cross-talk, signal noise and interference), PCB Design for high frequency circuits , PCB Design for fast pulse circuits, PCB Design for microwave circuits Practice: Mini Project – Circuit Schematic, PCB Layout Design, manufacturing, Assembly of components and testing (Open choice on any application circuit).	

Learning Resources	1. Simon Sze, Ming-Kwei Lee, " Semiconductor Devices, Physics and Technology" 3rd edition, John Wiley & Sons, Inc, 2015. 2. S. Salivahanan, N Suresh Kumar, "Electronic Device and Circuits" 3rd edition, McGraw-Hill Education, 2012	3. Raghbir Singh Khandpur, Printed Circuit Boards: Design, Fabrication, and Assembly, McGraw Hill Education; 1st edition (1 July 2017) 4. Ned Mohan, T. M. Undeland, W. P. Robbin, "Power Electronics: Converters, Applications, and Design" Wiley; Third edition (1 January 2007)
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		CLA-2 –Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	-	20%	30%	-
Level 2	Understand	30%	-	-	30%	30%	-
Level 3	Apply	40%	-	-	40%	40%	-
Level 4	Analyze	-	-	-	10%	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Mohan, Embedded 360, Chennai	1. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai	1. Dr. Soumyaranjan Routray, SRMIST
2. Mr. Sai Vineeth, ML Silicon Architect, Google Cloud TPU, USA	2. Dr. S. A. Akbar, Chief Scientist, CEERI Pilani	2. Dr. P. Eswaran, SRMIST

Course Code	21ECC112J	Course Name	SYSTEMS PROGRAMMING	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Communication Engineering		Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
CLR-1 :	Explore system software implementation and language processors			1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
CLR-2 :	Acquire a fundamental understanding of the input/output data management, arrays in C++, functions, classes and threads																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
CLR-3 :	Provide the knowledge of basic data structures and their implementations																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
CLR-4 :	Know the design and implementation of linker and loaders.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
CLR-5 :	Make proper use of system software implementation tools																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
Course Outcomes (CO):		At the end of this course, learners will be able to:		2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 : Multi-Paradigm Programming	15 Hour
C++ namespaces, references, exceptions, new/delete, C++ classes & inheritance, C++ templates, polymorphism, C++ functions and lambdas, C++ threads Practice: Develop and practice C++ application programs using classes, inheritance, functions and threads.	
Unit-2 : Basic Data Structures	15 Hour
Trees: Binary search trees, binary heaps, Tables: lookup tables, hash tables, Graphs: DFS, BFS, shortest path, minimum spanning trees, Queues, Stacks, Standard C++ Libraries: stl, boost Practice: Develop and practice application programs using basic data structures like trees, tables, stacks and graphs	
Unit-3: Overview of System Software and Language Processor	15 Hour
Software Hierarchy, Systems Programming, Machine Structure, Interfaces, Address Space, Computer Languages, Tools, Life Cycle of a Source Program, Levels of System Software, Programming Languages and Language Processors, Language Processing Activities, Program Execution, Symbol Tables, Programming language Grammars, Scanning and Parsing Practice: Develop simple programs in C++ for implementing symbol table using basic data structures	
Unit-4 : Linkers and Loaders	15 Hour
Introduction to linkers, Relocation and Linking Concept, Design of a Linker, Introduction to Loaders, Different Loading Schemes, Sequential and Direct Loaders, Compile-and-Go Loaders, Linkers v/s Loaders Practice: Design of linker and loader	
Unit-5: Software Programming Tools	15 Hour
Introduction to compilers, Working of compilers, Types of Compilers, Data structures used in compilers. Interpreters: Benefits of Interpretation, Overview of Interpretation, The Java Language Environment, Java Virtual Machine. Debuggers: Types of Errors, Debugging Procedures, Classification of Debuggers, Dynamic / Interactive Debugger Practice: Develop a program for lexical analyser	

Learning Resources	1. System Programming by D M Dhamdhare McGraw Hill Education, 2011	3. "Systems Programming", Srimanta Pal, Oxford University Press, 2011
	2. "C++ Primer", Stanley Lippman, 5th Edition, Addison-Wesley Professional Publishers, 2012	4. "Computer Systems – A Programmer's Perspective", Bryant and O'Hallaron. Third edition, Pearson India Education Services Pvt. Ltd., 2015

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		CLA-2 –Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	10%	20%	-
Level 2	Understand	20%	-	-	10%	20%	-
Level 3	Apply	30%	-	-	30%	30%	-
Level 4	Analyze	20%	-	-	30%	30%	-
Level 5	Evaluate	10%	-	-	20%	-	-
Level 6	Create	-	-	-	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Mohan, Embedded 360, Chennai	1. Dr. R. Venkatesan, Sr. Scientist, NIOT, Chennai	1. Dr. S. Malarvizhi, SRMIST
2. Mr. Sai Vineeth, ML Silicon Architect, Google Cloud TPU, USA	2. Dr. S. A. Akbar, Chief Scientist, CEERI Pilani	2. Dr. M. S. Vasanthi, SRMIST

Course Code	21EIC101J	Course Name	SENSORS AND ACTUATORS	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering		Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
CLR-1 :	Familiarize with different types of the Sensing physical quantity and their basic principle and sensing properties															1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
CLR-2 :	Introduce the construction and principle of Mechanical, resistive, capacitive and Inductive sensors																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
CLR-3 :	Impart the basic principles and mechanism of Thermal, Magnetic, radiation, smart sensors																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
CLR-4 :	Understand the basic actuator principles and phenomenon on which it works																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
CLR-5 :	Provide the micro sensor and actuators working and construction mechanism																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
Course Outcomes (CO):		At the end of this course, learners will be able to:															2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 :Fundamentals and Sensor Characteristics	15 Hour
Introduction on Sensor, transmitter and transducer - Primary measuring elements- Selection and characteristics: Range, Sensitivity, Error, Linearity, resolutions, repeatability, accuracy, backlash, response time. Classification of sensors: Mechanical and Electromechanical sensor, Resistive sensor, Inductive sensors, Capacitive sensor, Thermal sensors, Magnetic sensors and smart sensors.	
Unit-2 : Classification of Sensor-I	15 Hour
Mechanical and Electromechanical sensor: Definition, principle of Sensing & transduction, Classification, Resistive Sensor : Potentiometric type, Strain gauge , Inductive sensor : Reluctance change type , Mutual inductance change type , transforms action type, LVDT , Proximity sensor , Capacitive sensor :variable -area , variable -distance type , Piezoelectric element , Ultrasonic sensor.	
Unit-3: Classification of Sensor-II	15 Hour
Thermal sensors: Material expansion type : Solid ,liquid, Gas and vapor : Resistance change type : RTD materials , tip sensitive & stem sensitive type , Thermistor: material , shape , range, Thermo emf sensor : types , thermoelectric power : Radiation sensor - Types and characteristics and comparison LDR , Photovoltaic cells, photo diodes, Magnetic Sensors: torque, Thomson effect , hall effect. Smart sensors : Components of smart sensors , Architecture and industrial application	
Unit-4: Actuators	15 Hour
Definitions, types and selection of actuators; linear, rotary, Logical and continuous actuators, Electrical Actuators: electrical actuating systems: solid state switches, Solenoids, electric motors: AC- DC, stepper motors, synchro Pneumatics and Hydraulic Actuators, Shape memory alloys Actuator performance criteria and selection	
Unit-5: Micro Sensor and Micro actuators	15 Hour
Micro-sensor: Principles and example and micro-actuator devices: electrostatic, piezo-resistive, piezoelectric, thermal, magnetic transduction. Electronic position-sensing circuits and electrical and mechanical noise	

Practice:

1. The strain gauge characteristics.
2. The characteristics and weight measurement by load cell
3. The construction of LVDT and its use in displacement and thickness measurement.
4. The characteristics of LDR,
5. The Measurement and testing of different types of thermocouples.
6. The voltage – intensity characteristics of a photo – transistor
7. The ramp response characteristics of a filled in system thermometer.
8. The step response characteristics of RTD.
9. The step response characteristics of thermocouple.
10. The Hall Effect Transducer
11. To design LabVIEW Program for measurement of current, Voltage, PQ (power quality) factor
12. To design LabVIEW Program for measurement of voltage to current conversion
13. Characteristics of capacitive measurement systems
14. Measurement using proximity sensors,
15. Characteristics of a capacitive transducer

Learning Resources	1. Patranabis D, "Sensors and Transducers," Prentice Hall of India, 2nd Edition, PHI Publications, 2021	4. A.K Sawhney. Puneet Sawhney A course in electrical and electronic measurements and instrumentation, Dhanpat Rai and Sons, 2012
	2. Ernest O.Doebelin , Dhanesh N. Manik,Doebelin's Measurement Systems:, Tata McGraw Hill, 7th Edition (SIE), 2019	5. Murthy DVS, "Transducers & Instrumentation", 2nd , edition, Prentice Hall of India, 2008
	3. Robert H. Bishop, "Mechatronic Systems, Sensors, and Actuators: Fundamentals and Modeling"; The Mechatronics Handbook, Second Edition, 2017	6. Clarence W. De Silva, Sensors and Actuators: Control System Instrumentation, University of British Columbia, Vancouver, Canada, CRC Press 2017
		7. Neubert HKP, "Instrument Transducers" Oxford University Press 2nd edition. 1999

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life Long Learning CLA-2 –Practice (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	30%	20%	-
Level 2	Understand	20 %	-	-	20%	20 %	-
Level 3	Apply	30 %	-	-	30%	30 %	-
Level 4	Analyze	30%	-	-	20%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr.Vijesweran, MD, Vi MicroSystem Pvt., Ltd	Dr.K.Srinivasan, Associate Professor, NIT Trichy	Dr.A.Vimala Juliet, SRMIST

Course Code	21MHC101P	Course Name	ELEMENTS OF MECHATRONICS SYSTEMS	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering			Data Book / Codes / Standards	Nil

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Understand the basics of mechanical elements through relative motions	1	2	3	4	5	6	7	8	9	10	11	12	PO-1	PO-2	PO-3
CLR-2 :	Comprehend the type of sensors and signal conditioning circuits	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3 :	Acquire the knowledge of electrical actuators and drives.															
CLR-4 :	Apply simple control strategies for open loop and closed systems															
CLR-5 :	Apprehend the basics of data acquisition systems															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Build simple mechanisms with few degrees of freedom	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Identify appropriate sensors and the suitable conditioning circuits	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Select actuators and the compatible driving circuits	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Construct simple control systems	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Demonstrate a system integration	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 : Mechanical System	9 Hour
Degrees of Freedom – Joints and constraints – Types of mechanism- Transmission Elements – Aspects of mechanical engineering design – Aspects of Manufacturing process	
Unit-2 : Sensors and Signal Conditioning	9 Hour
Basic specification and measurement – types of Physical parameters – Types of sensory signals – Signal conditioning circuits – Signal decoding - sensor calibration	
Unit-3: Actuators and Drives	9 Hour
Electrical Actuators (AC and DC) – Fluid power actuators – Basic specifications of linear and rotary actuators – Special purpose actuators – Electrical drives – Fluid power drives	
Unit-4 : Embedded Control	9 Hour
Introduction to Control Systems – Open loop and closed loop systems – ON OFF control – proportional control – Basics of computing hardware – Types of computing hardware – Real time behavior – Time Performance – Accuracy – parallelization – Concept of programming , Algorithm and coding	
Unit-5:Software Stack and Integration	9 Hour
User Interface – Data acquisition and methods – Sampling and quantization – Data processing – Basic algorithm implementation – Motion control implementation – Development pipeline	
Note: The tutorial and free hours will be utilized to develop small mechatronics project prototypes (in groups/batches of students) which will provide real hands on experience to the students.	

Learning Resources	1. Devdas Shetty, Richard Kolk. "Mechatronics System Design", Cengage Learning, Inc; 2nd ed. Edition, 2010	3. W. Bolton, "Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering", Pearson, 6th edition, 2015.
	2. Kalljob, Patrick O. J. "Control of mechatronic systems: model-driven design and implementation guidelines", John Wiley & Sons, Inc., 1st edition, 2020.	4. Singh, Satya Bir, Ranjan, Prabhat, Vakhrushev, Alexander V., and Haghi, A. K. "Mechatronic systems design and solid materials: methods and practices", CRC Press, 1st edition, 2021
	3. De Silva, Clarence W., Khoshnoud, Farbod, Li, Maoqing, and Halgamuge, Saman K. "Mechatronics: fundamentals and applications", CRC Press, 1st edition, 2016	5. Schmidt, Robert Munnig, "The design of high performance mechatronics : high-tech functionality by multidisciplinary system integration", Delft University Press, 3rd edition, 2020.
	4. Robert H. Bishop, "The Mechatronics Handbook-Mechatronic systems, sensors and actuators", CRC Press, 2nd edition, 2007	

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	-	-	-	-	-	-
Level 2	Understand	40%	-	-	-	-	-	-	-
Level 3	Apply	20%	-	-	20%	-	20%	-	-
Level 4	Analyze	-	-	-	30%	-	30%	-	-
Level 5	Evaluate	-	-	-	30%	-	30%	-	-
Level 6	Create	-	-	-	20%	-	20%	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Ganesh Ram, CTO, Tunga Systems, Chennai		1. Dr. R Senthilnathan, SRMIST
2. Mr. Mohammed Sagheer, Specialist, ZF Wabco, Chennai		2. Mr. Ranjith Pillai, SRMIST

Course Code	21NTC101T	Course Name	NANOSCIENCE AND NANOTECHNOLOGY	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology		Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes									
CLR-1 :	Acquire knowledge on basics of nanoscience, classes of nanomaterials and their size and dimensionality dependence															1	2	3	4	5	6	7	8	9	10	11	12								
CLR-2 :	Obtain knowledge on physical properties of nanostructured materials and their size and dimensionality dependence															Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3					
CLR-3 :	Understand the physics and chemistry-based experimental approaches to synthesize various types of nanomaterials																																		
CLR-4 :	Gain knowledge on the basic principles of characterization techniques at nanoscale																																		
CLR-5 :	Appreciate the potential applications of the nanotechnology																																		
Course Outcomes (CO):		At the end of this course, learners will be able to:															3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-1:	Analyze fundamentals of nanotechnology, different classes of nanomaterials and their sizes and dimensions															2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-3:	Apply chemical and physical methods to synthesize and fabricate nanomaterials															-	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-4:	Distinguish various characterization techniques involved in nanotechnology															-	-	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-5:	Identify the potentialities of nanotechnology															2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Unit-1 : Basics of Nanoscience and Classification of Nanomaterials	9 Hour
Introduction to nanoscience - Moore's Law. Matter at different length scales: Nanosystems-classification based on length scale – Bulk, Quantum dots, quantum wells and quantum wires - Density of states in bulk, two, one and zero dimensions. Quantum confinement: exciton confinement in quantum dots. Surface to volume ratio - Fraction of surface atoms and surface energy. Carbon-based nano materials: Fullerenes, Carbon nanotubes and Graphene. Metal nanoparticles: Nanogold and nanosilver. Metal-oxide based nano materials. Nanocomposites	
Unit-2 : Size-Dependent Physical Properties of Nanomaterials	9 Hour
Size dependent Mechanical properties of nanomaterials. Thermal properties of nanomaterials: melting point - size dependent thermal transport - Electronic properties of nanomaterials: size dependent electrical transport - Luttinger liquid behavior of electrons in 1D metals: Magnetic properties of nanomaterials: Single domain region – super paramagnetism - Langevin function. Optical properties: Size dependent light absorption and emission of quantum dots Red- and blue shift	
Unit-3: Nanomaterials Synthesis Methods	9 Hour
Top-down and bottom-up approach for nanomaterials synthesis. Bottom-up approach: Chemical methods - metal nanoparticle synthesis by chemical reduction - Hydrothermal and solvothermal synthesis of nanoparticles- Photochemical synthesis – spray pyrolysis synthesis of nanoparticles. Fabrication of nanotubes, nanowires and nanorods: Vapor-liquid-solid (VLS) process. Physical Vapor Deposition: Thermal evaporation - DC/RF magnetron sputtering -Molecular beam epitaxy (MBE). Chemical vapor deposition (CVD) - Metal organic chemical vapor deposition (MOCVD). Top-down approach: Ball milling &Grinding – Nanofabrication: Concept of lithography- Photo and electron beam lithography.	
Unit-4 : Characterization of Nanomaterials	9 Hour
X-ray diffractometer (XRD) – Debye Scherrer method. Introduction to electron microscopy – Scanning electron microscope working principle - Field emission scanning electron microscope (FESEM) - Environmental scanning electron microscope (E- SEM) - High resolution transmission electron microscope (HRTEM). Scanning probe microscope (SPM): Atomic force microscope (AFM) – Scanning tunnelling microscopy (STM). Absorption spectroscopy - Photoluminescence spectroscopy. Magnetic measurements - Vibrating sample magnetometer (VSM).	

Unit-5: Applications of Nanomaterials		9 Hour
Magnetic nanoparticles – Hyperthermia – Ferro fluids– Nanotechnology in memory. Nanotechnology in Printed electronics – Nanoinks. Role of nanotechnology in solar energy conversion. Nanotechnology in food storage. Environment: Nanotechnology in improving environment - Catalytic application of nanoparticles. Sensors: Chemical sensors – Biosensors. Nanomedicine - Nanobiotechnology - Nanotoxicology - Nanotechnology in cosmetics		
Learning Resources	1. T. Pradeep, A Textbook of Nanoscience and Nanotechnology, Tata McGraw Hill Education Pvt. Ltd., 2012 2. M. S. Ramachandra Rao and Shubra Singh, Nanoscience and Nanotechnology: Fundamentals to Frontiers, Wiley, 1st ed. 2013 3. Hari Singh Nalwa, Nanostructured Materials and Nanotechnology, Academic Press, 2008	4. Edward L. Wolf, Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience. 2nd ed., Wiley-VCH, 2004 5. Hans-Eckhardt Schaefer, Nanoscience: The Science of the Small in Physics, Engineering, Chemistry, Biology, and Medicine, Springer-Verlag Berlin Heidelberg, 1st Edition, 2010.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20 %	-	20 %	-	20 %	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30 %	-	30 %	-	30 %	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Sunil Varughese, CSIR-NIIST, s.varughese@niist.res.in	1. Prof. S. Balakumar, University of Madras, balakumar@unom.ac.in	1. Dr. E. Senthil Kumar, SRMIST
2. Dr. M. Krishna Surendra, Saint-Gobain Research, Chennai, krishna.muvvala@saint-gobain.com	2. Prof. M. S. Ramachandra Rao, IIT Madras, msrrao@iitm.ac.in	2. Dr. M. Navaneethan, SRMIST

Course Code	21NTC111T	Course Name	PHYSICS OF MATERIALS	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology		Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)			Program Specific outcomes
CLR-1 :	Develop theoretical knowledge in classical mechanics (CM), quantum mechanics(QM) and solid state physics (SSP)												1	2	3	4	
CLR-2 :	Develop skills on solving analytical problems in CM, QM and SSP												Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3
CLR-3 :	Acquire advanced knowledge in current understanding of CM, QM and SSP												3	4	5	6	
CLR-4 :	Understand Schrodinger equation and its applications in Materials Science												7	8	9	10	
CLR-5 :	Understand the crystal structure as basic building block of material and its properties												11	12			
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	Be familiar with some elementary phenomena and concepts in physics												-	3	-	3	-
CO-2:	Apply mathematical tools to explain general properties like stress/strain/elasticity etc.												-	3	-	3	-
CO-3:	Solve problems in CM, QM and SSP												-	3	-	3	-
CO-4:	Apply the knowledge of quantum mechanics for materials science problems												-	3	-	3	-
CO-5:	Calculate Density of states of crystals												-	3	-	3	-

Unit-1 :Classical Mechanics	9 Hour
Mechanics of a single particle, Mechanics of system of particles, Conservation of linear momentum, Conservation of Angular momentum, Mechanical energy for a particle and a system of particles, Centre of mass and equation of motion, Degree's of freedom and constraints, Calculus of Variations; Lagrange's Equations; Hamilton's, principle, Hamilton's equations of motion, SHM, Equation of motion, Applications of Hamilton's equations of motion like SHM, Atwood machine etc.	
Unit-2 : General Properties of Matter	9 Hour
Combination of two mutually perpendicular simple harmonic vibrations of same frequency and different frequencies, Lissajous figures, Gravitation, Acceleration due to gravity, Determination of acceleration due to gravity, Fundamentals of vibration, forced oscillation, Resonance, sharpness of resonance, General Properties of Matter, Elasticity, stress, strain, Young's modulus, bulk modulus, shear modulus, Poisson's ratio, Relation between them, Viscosity, Poiseulli's formula, Stoke's formula, Surface tension, surface energy, contact angle and its determination.	
Unit-3: Basics of Quantum Mechanics	9 Hour
Basics of Quantum Mechanics, Planck's formula of black-body radiation, Photoelectric effect, Bohr atom and quantization of energy levels, de Broglie hypothesis, Electron double-slit experiment, Compton effect, Davisson-Germer experiment, Heisenberg Uncertainty Principle, Wave Function, It,s Interpretation and Normalization, Superposition of Amplitudes.	
Unit-4 :Schrodinger's Equation	9 Hour
Dynamical Variables as Operators, Expectation Values, Schrodinger, Equation, Particle in a Box, Quantum Well, Potential Barrier, Hydrogen atom, Harmonic Oscillator, Electron in periodic potential	
Unit-5:Lattice Structure	9 Hour
Crystal, Lattice, Basis, Lattice translational vectors and unit cell, Primitive lattice cell, Fundamental types of lattices, Miller indices, Simple crystal structures, Hexagonal close pack structure, Diamond structure, Crystal symmetry, Point groups, Space group, Reciprocal lattice, X-Ray diffraction, Bragg's Law, Laue Equation	

Learning Resources	1. <i>Classical Mechanics</i> , H. Goldstein, C. Poole and J. Fafko (Pearson Education Inc., 2002)	4. <i>Introduction to Quantum Mechanics</i> , D J Griffiths, D F Schroeter (Cambridge University Press, 3rd edition, 2021)
	2. <i>Classical Mechanics</i> , Rana & Joag McGraw Hill Education, 2017)	5. <i>C Kittel, Introduction to Solid State Physics</i> , 8th Ed., J. Wiley and Sons, 2005.
	3. <i>Elements of Properties of Matter</i> , D.S. Mathur (S. Chand, 2010)	6. <i>C. Hu, Modern Semiconductor Devices for Integrated Circuits</i> , Pearson, 2009

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20 %	-	20 %	-	20 %	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	40 %	-	40 %	-	40 %	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry		Experts from Higher Technical Institutions
1. Dr. M. M. Krishna Surendra, Senior Research Engineer, Saint Gobain India Pvt. Ltd, Chennai		1. Prof Balakumar, Center for Nanoscience, University of Madras
2. Dr. N Vijayan, National Physical Laboratory, nvijayan@nplindia.org		2.Prof. V. Subramanian, IITM, Chennai, manianvs@iitm.ac.in
		Internal Experts
		1. Dr. Rudra Banerjee, SRMIST
		2. Dr. Payel Bandyopadhyay, SRMIST

ACADEMIC CURRICULA

Basic Science- Bridge Courses
(For Lateral Entry Students)

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21MAB205B	Course Name	MATHEMATICS	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Application of Matrices in problems of science and engineering.	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2 :	Utilize the concepts of radius of curvature, evolute, envelope in problems of Science and Engineering.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3 :	apply the concept of Taylor series, maxima minima, composite function, and Jacobian in problems of science and engineering.																											
CLR-4 :	Construct the analytic function, discuss conformal mapping and bilinear transformation in engineering problems.																											
CLR-5 :	gain knowledge in evaluation of double and triple integral and apply then in problems in engineering.																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	apply the knowledge of matrices, eigenvalues and eigen vectors reduce to quadratic form in problems involving science and engineering.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-												
CO-2:	gain the knowledge of Radius, Centre, envelope and Circle of curvature and apply them in the problems involving Science and Engineering.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-												
CO-3:	Gain familiarity in the knowledge of Maxima and Minima, Jacobian, and Taylor series and apply them in the problems involving Science and Engineering.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-												
CO-4:	Utilize the analytic function and bilinear transformation Engineering problems.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-												
CO-5:	Gain familiarity in evaluation of multiple integrals.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-												

Unit-5 - Analytic Functions	12 Hour
Definition of Analytic Function – Cauchy-Riemann equations in Cartesian coordinates – Cauchy-Riemann equations in polar coordinates - Properties of analytic function – Determination of analytic function using Milne Thomson's method – Mappings (Magnification, Rotation and Inversion) - Bilinear transformation - Conformal mapping.	

Learning Resources	1. Erwin Kreyszig, <i>Advanced Engineering Mathematics</i> , 9th Edition, John Wiley & Sons, 2006.	4. Ramana B.V., <i>Higher Engineering Mathematics</i> , Tata McGraw Hill New Delhi, 11th Reprint, 2010
	2. B.S. Grewal, <i>Higher Engineering Mathematics</i> , Khanna Publishers, 36th Edition, 2010.	5. G.B. Thomas and R.L. Finney, <i>Calculus and Analytic geometry</i> , 9th Edition, Pearson, Reprint, 2002
	3. Veerarajan T., <i>Engineering Mathematics for first year</i> , Tata McGraw-Hill, New Delhi, 2008	6. N.P. Bali and Manish Goyal, <i>A textbook of Engineering Mathematics</i> , Laxmi Publications, Reprint, 2008.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com	1. Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	1. Dr. V. Subburayan, SRMIST
	2. Prof. K.C. Sivakumar, IIT Madras, kcskumar@iitm.ac.in	2. Dr. P. Godhandaraman, SRMIST

Course Code	21PYB105B	Course Name	ENGINEERING PHYSICS	Course Category	B	BASIC SCIENCES	L	T	P	C
							2	0	0	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Introduce to electron theory and Fermi level in semiconductors	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2 :	Explain the concept of carrier transport mechanism	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3 :	Identify the applications of electric field in materials															
CLR-4 :	Understand the working principle of lasers and optical fibers															
CLR-5 :	Utilize the principles pertaining to vector mechanics															
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Identify the energy band in solids and electron occupation probability	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Learning and analyze the working of optoelectronic devices	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Identify the effect of electromagnetic charge dynamics	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Identify the applications of lasers and optical fiber	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply the concepts of vectors and scalars to derive physical laws	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Electron Theory and Quantum Physics	6 Hour
Electron theory of materials- Classical free electron theory-postulates-Success and drawbacks of classical free electron theory-Quantum concepts - de-Broglie wave equation-Physical significance of wave function- Schrodinger wave equation - time dependent-Schrodinger wave equation - Time independent-Density of states-Fermi level-Probability of occupation-Computational determination of Band Structure – Concepts- E-k diagram-Direct and Indirect band gap semiconductors	
Unit-2 - Semiconductors and Optoelectronic Devices	6 Hour
Intrinsic semiconductor-Fermi level on carrier-concentration and temperature in Intrinsic Semiconductor-Extrinsic semiconductors-Fermi level on carrier-concentration and temperature in extrinsic semiconductors- p-n junction-Biasing concept in p-n junction-Semiconductor materials of interest for optoelectronic devices-Photocurrent in a P-N junction diode-Light emitting diode-Classification of Light emitting diode-Optoelectronics integrated circuits-Organic light emitting diodes	
Unit-3 - Electromagnetism and Dielectrics	6 Hour
Electromagnetism- Introduction-Del, divergence, curl and gradient operations in vector calculus-Gauss-divergence and Stoke's theorem-Electric field and electrostatic potential for a charge distribution-Gauss' law and its applications-Concepts of electric current-Laws of magnetism ,Faraday's law-Ampere's law, Biot –Savart law-Maxwell's equations-Maxwell's equations in free space- Polar and Non Polar dielectrics -Types of polarization-Frequency and temperature dependence on polarization mechanism	
Unit-4 - Lasers and Fiber Optics	6 Hour
Absorption and emission processes-Einstein's theory of matter radiation - A and-B coefficients-Characteristics of laser beams-Amplification of light by population inversion-Threshold population inversion-Essential components of laser system and pumping mechanisms-Nd: YAG laser-CO2 laser:-Application of laser – Holography-Optical fiber-physical structure-Total internal reflection-Classification of optical fibers - Materials, modes-Classification of optical fibers -Refractive index profile	

Unit-5 - Principles of Vector Mechanics	6 Hour
Introduction to vector analysis-Scalar quantities & vector quantities-Transformation of scalars and vectors-Transformation of scalars and vectors under rotation transformation-Forces in nature-Newton's laws-Resonance-Applications of Resonance-Introduction to rigid body-Failure of materials-Concepts of fracture and yielding	

Learning Resources	1. J. Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Inc. 2019. 2. S. M. Sze, Semiconductor Devices: Physics and Technology, Wiley 2015. 3. David Jeffery Griffiths, Introduction to Electrodynamics, Revised Edition, Pearson, 2013 4. David Halliday, Fundamentals of Physics, 12th Edition, John Wiley Ltd, 2021 5. Introduction to Mechanics, Mahendra K. Verma, University Press (India) Pvt. Ltd., 2016. 6. Computational Materials Science: An Introduction by June Gunn Lee, Chapter 7, Page 227-230 (Quantum Espresso) and Page 300-307 (VASP) 7. Finite Element Method Gouri Dhatt, Emmanuel Lefrançois, Gilbert Touzot, Wiley Publication, ISBN: 978-1-848-21368-5
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. Vijayan, National Physical Laboratory, guptavinay@nplindia.org	1. Prof. V. Subramanian, IITM, Chennai, vsubramanian@iitm.ac.in 2. Prof. C. Venkateswaran, University of Madras, Chennai, cvenkateswaran@unom.ac.in	1. Dr. V. Ganesh, SRMIST 2. Dr. B. Gunasekaran, SRMIST

Course Code	21CYB102B	Course Name	CHEMISTRY	Course Category	B	BASIC SCIENCES	L	T	P	C
							2	0	0	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemistry	Data Book / Codes / Standards	Periodic Table		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes						
CLR-1 :	Exploit the periodic properties of elements for bulk property manipulation towards technological advancement	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3				
CLR-2 :	Employ various organic reactions towards the design of fine chemical and drug molecules for industries																															
CLR-3 :	Get knowledge on water quality parameters, methods to analyze quality of water and treatment methods for domestic and industrial applications																															
CLR-4 :	Address concepts related to electrochemistry, such as corrosion, using thermodynamic principles																															
CLR-5 :	Employ various spectroscopic techniques in identifying the structure and correlate it with their properties																															
Course Outcomes (CO):		At the end of this course, learners will be able to:												3	-	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-1:	Rationalize bulk properties using periodic properties of elements	-	2	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
CO-2:	Perceive the importance of synthesizing organic molecules applied in pharmaceutical industries	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
CO-3:	Utilize the knowledge about water technology for industrial purpose	2	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
CO-4:	Gaining the knowledge in corrosion chemistry	-	2	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-					
CO-5:	Utilize the principles of spectroscopic technique in analysing the structure and properties of molecules																															

Learning Resources	1. Jain.P.C and Monika Jain, "Engineering Chemistry", Danpat Rai publishing company (P) Ltd, New Delhi, 2010. 2. P. Kamaraj and M. Arthanareeswari, "Applied Chemistry", 9th Edition, Sudhandhira publications, 2012 3. Helen P .Kavitha, "Engineering Chemistry – I", Shine Publications and Distributors, 1st Edition, 2013. 4. R. Jeyalakshmi, Engineering Chemistry Devi Publication, 2nd Edition, 2015.	5. B. L. Tembe, Kamaluddin, M. S. Krishnan, Engineering Chemistry (NPTEL Web-book) 6. Peter W. Atkins, Julio de Paula, James Keeler, Physical Chemistry, 11th ed., Oxford publishers, 2018
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	-	20%	-	10%	-
Level 2	Understand	30%	-	20%	-	30%	-
Level 3	Apply	30%	-	20%	-	30%	-
Level 4	Analyze	30%	-	40%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Ravikiran Allada, Head R&D, Analytical, Novugen Pharma, Malaysia, ravianalytical@gmail.com	1. Prof. G. Sekar, IIT Madras, gsekar@iitm.ac.in	1. Prof. M. Arthanareeswari, SRMIST
2. Dr. Sudarshan Mahapatra, Dr. Reddy's Laboratories, smahapatra@drreddys.com	2. Prof. Kanishka Biswas, JNCASR Bengaluru, kanishka@jncasr.ac.in	2. Dr. R. V. K. Mangalam, SRMIST



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 3

**(Syllabi for Higher Semester Mathematics Courses-All
Programmes)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

Contents (Volume-3)

<u>No</u>	<u>Syllabi for Higher Semester Mathematics Courses</u>	<u>Page No</u>
1	21MAB201T Transforms and Boundary Value Problems	2
2	21MAB202T Numerical Methods	4
3	21MAB203T Probability and Stochastic Processes	6
4	21MAB204T Probability and Queueing Theory	8
5	21MAB206T Numerical Methods and Analysis	10
6	21MAB209T Transforms and Computational Techniques	12
7	21MAB210T Statistical Modelling	14
8	21MAB301T Probability and Statistics	16
9	21MAB302T Discrete Mathematics	18
10	21MAB303T Biostatistics for Biotechnologists	20
11	21MAB304T Probability and Applied Statistics	22

Course Code	21MAB201T	Course Name	TRANSFORMS AND BOUNDARY VALUE PROBLEMS	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific Outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1 :	analyze partial differential equations, and interpret the solutions related to PDE in engineering problems	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2 :	compute the Fourier series expansion and express the sine and cosine series															
CLR-3 :	analyze one-dimensional wave and heat equations using PDE and Fourier series concepts															
CLR-4 :	analyze Fourier transforms and their properties															
CLR-5 :	analyze Z transform for solving discrete-time Signal problems															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	construct and solve partial differential equations using various techniques	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	explain the Fourier series expansion of a function in terms of sine and cosine series	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	identify partial differential equations and utilize Fourier series techniques to solve one dimensional wave and heat equations	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	apply Fourier transforms techniques in signal analysis	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	solve discrete-time signal problems using Z transforms	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Partial Differential Equations	12 Hour
Formation of partial differential equations by eliminating arbitrary constants & arbitrary functions- Solutions of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients of homogeneous types.	
Unit-2 - Fourier Series	12 Hour
Dirichlet's conditions – General Fourier series – Odd and even functions - Half range sine and cosine series - Parseval's identity – Harmonic Analysis	
Unit-3 - Applications of Partial Differential Equations	12 Hour
Classification of second order partial differential equations - Method of separation of variables – Solutions of one dimensional wave equation - One dimensional equation of heat conduction (Insulated edges excluded) - Steady state condition with zero boundary - Steady state condition with non-zero boundary conditions	
Unit-4 - Fourier Transforms	12 Hour
Fourier transform pair – Properties -Fourier sine and cosine transforms – Properties– Transforms of simple functions - Convolution theorem (without proof) – Parseval's identity.	
Unit-5 - Transforms	12 Hour
Z - transforms – Properties of Z transforms – Inverse Z transforms – Convolution theorem (without Proof) – Solution of linear difference equations with constant coefficients using Z-transform	

Learning Resources	1. Erwin kreyszig, <i>Advanced Engineering Mathematics</i> , 10th Edition, John Wiley & Sons, 2015.	5. .N.P. Bali and Manish Goyal, <i>A text book of Engineering Mathematics</i> , Laxmi Publications, New Delhi, 10th edition, 2016.
	2. B.S. Grewal, <i>Higher Engineering Mathematics</i> , Khanna Publishers, 43rd Edition, 2015.	6. Kandasamy P., etal. <i>Engineering Mathematics</i> , Vol.II & Vol.III (4 th revised edition), S. Chand & Co., New Delhi, 2000
	3. Veerarajan T., <i>Transforms and Partial Differential Equations</i> , Tata McGraw-Hill, New Delhi, 3rd edition, 2012.	
	4. Ramana B.V., <i>Higher Engineering Mathematics</i> , Tata McGraw Hill New Delhi, 2010 3rd Edition	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers			
Experts from Industry		Experts from Higher Technical Institutions	Internal Experts
1. Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com		1. Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	1. Dr. B. Vennila, SRMIST
		2. Prof. K.C. Sivakumar, IIT Madras, kcskumar@iitm.ac.in	

Course Code	21MAB202T	Course Name	NUMERICAL METHODS	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes							
CLR-1 :	apply the numerical techniques for solutions of algebraic, transcendental and simultaneous equations															Engineering Knowledge	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3			
CLR-2 :	understand the concept of interpolation for finding intermediate values of well-known data																																
CLR-3 :	interpret the concept of numerical differentiation and integration in physical problems																																
CLR-4 :	apply the numerical techniques for solutions of ordinary differential equations																																
CLR-5 :	apply the numerical techniques for solutions of partial differential equations																																
Course Outcomes (CO):		At the end of this course, learners will be able to:															3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-1:	solve the numerical solutions of algebraic, transcendental and simultaneous equations															3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-2:	apply finite differences concepts and various interpolation methods															3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	utilize various numerical methods in numerical differentiation and integration-related problems in engineering															3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-4:	identify and solve the numerical solutions of ordinary differential equations															3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-5:	analyze the numerical solutions of partial differential equations															3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Unit-1 - Numerical Solution of Algebraic Equations	12 Hour
Solution of nonlinear equations - False position method - Fixed point iteration method - Newton Raphson method - Solution of linear system of equations: Gauss elimination method - Gauss Jacobi method - Gauss Seidel method - Eigenvalues of a matrix by power method.	
Unit-2 - Curve Fitting and Interpolation	12 Hour
Curve fitting – Method of least squares – Interpolation: Newton's forward and backward difference - Divided differences – Newton's divided difference - Lagrange's interpolation – Inverse interpolation.	
Unit-3 - Numerical Differentiation and Integration	12 Hour
Numerical differentiation by using Newton's forward, backward and divided differences - Numerical integration by trapezoidal and Simpson's 1/3rd and 3/8th rules.	
Unit-4 - Numerical Solution of Ordinary Differential Equation	12 Hour
Single step methods: Taylor's series method, Euler and Improved Euler methods, fourth order Runge – Kutta method – Multistep methods: Milne's predictor - corrector method.	
Unit-5 - Numerical Solution of Partial Differential Equations	12 Hour
Finite difference techniques: Solution of two dimensional Laplace's equations by Liebmann's iterative process and Poisson's equations – Solution of one dimensional heat equation using Bender Schmidt and Crank Nicholson difference schemes -Solution of one dimensional wave equation by explicit scheme.	

Learning Resources	1. S.S. Sastry, <i>Introductory Methods of Numerical Analysis</i> , Prentice - Hall of India Pvt Ltd, New Delhi, 2003.	4. Steven C.Chapra and Raymond P. Canale, "Numerical Methods for Engineers with Programming and Software Applications", McGraw-Hill, 2004.
	2. M.K.Jain, SRK Iyengar and R.L.Jain, <i>Numerical Methods for Scientific and Engineering Computation</i> , Wiley Eastern Ltd., 4th edition, 2003.	5. B.S. Grewal, <i>Numerical Methods in Engineering and Science</i> , Khanna Publishers, 42nd edition, 2012.
	3. F. B. Hildebrand, <i>Introduction to Numerical Analysis</i> (2nd edition), Dover Publications, 2013.	6. D. R. Kincaid, E.W. Cheney, <i>Numerical Analysis Mathematics of Scientific Computing</i> , The University of Texas at Austin. Brooks/Cole Publishing Company, 1991.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com	1. Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	1. Dr. V. Subburayan, SRMIST
	2. Prof. K.C. Sivakumar, IIT Madras, kcskumar@iitm.ac.in	2. Dr. R. Perumal, SRMIST

Course Code	21MAB203T	Course Name	PROBABILITY AND STOCHASTIC PROCESSES	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1 :	Describe the applications on discrete and continuous random variables.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2 :	Assess the applications of two-dimensional random variables.															
CLR-3 :	Infer the various modes of convergence of random variables and their limit theorems.															
CLR-4 :	Relate the specialized knowledge in random processes in signals and systems.															
CLR-5 :	Determine the applications of spectral density functions and linear time-invariant systems															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Evaluate the characteristics of discrete and continuous random variables.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Explain the model and analyze systems using two-dimensional random variables.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Classify limit theorems and evaluate upper bounds using various inequalities.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Analyze the characteristics of random processes.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Examine problems in spectral density functions and linear time-invariant systems.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - One-Dimensional random variable and probability distributions	12 Hour
One-dimensional random variable: Discrete Case-Probability function, Cumulative Distribution Function, continuous random variable-Probability density function, Cumulative distribution function-properties, Problems on one-dimensional random variable, Expectation, variance, Moments - raw and central moments, Binomial distribution –moments, Binomial distribution-Applications, Poisson distribution-moments, Poisson distribution –Applications, Exponential distribution-moments, Exponential distribution-Applications, Normal Distribution-moments, Normal Distribution-Applications, Uniform Distribution-moments, Uniform Distribution-Applications, Function of a random variable, Applications of random variables in engineering.	
Unit-2 - Two-dimensional random variable and Correlation functions	12 Hour
Two-dimensional random variables-Discrete cases, Probability function of (X, Y) - Marginal probability distribution, Conditional probability distribution of (X, Y), Problems on discrete random variables, Continuous random variables – Joint PDF, Marginal Probability distributions, Conditional probability distribution of (X, Y), Problems on continuous two-dimensional random variables, Independent random variables, Cumulative distribution function-properties of F(x, y), Expected values of two-dimensional random variables, Covariance and correlation, Conditional expected values, Problems on uncorrelated random variables, Functions of two-dimensional random variables, Probability density functions of the type Z=XY, Probability density functions of the type Z=X-Y, Probability density functions of the type Z=X/Y. Application of two-dimensional random variables in engineering.	
Unit-3 - Probability bounds and Central limit theorems	12 Hour
Limit theorems--Markov's inequality, Chebyshev's inequality without proof, Chebyshev's inequality - Applications, Chebyshev's inequality – Applications using Binomial distribution, Chebyshev's inequality–Applications using Exponential distribution, The weak law of large numbers, Central limit theorem without proof, Central limit theorem - Applications, Central limit theorem- Applications using Poisson random variables, Central limit theorem- Applications using Exponential random variables, The strong law of large numbers, The strong law of large numbers, One-sided Chebyshev's inequality, Cauchy Schwartz inequality, Chernoff bounds, Chernoff bounds for the standard normal variate, Chernoff bounds for the Poisson random variate, Jensen's inequality, Applications of Central Limit Theorem in engineering.	

Unit-4 - Random processes and stationary processes	12 Hour
Random Processes-Introduction, Classification of random processes, Distribution of the process, Averages of the process, Stationary, SSS, WSS processes, Problems on stationary and SSS processes, Problem, Problems on WSS process, Problems on WSS process, Autocorrelation function -properties, Proof of properties, Problems on autocorrelation function, Application of autocorrelation function, Cross-correlation-properties, Proof of properties, Problems on Cross-correlation function, Ergodicity, Mean ergodic process, Mean ergodic theorem, Applications of random process in engineering.	
Unit-5 - Spectral density of random process and linear system with random inputs	12 Hour
Power spectral density function- properties, Proof of properties, Problems on power spectral density function, Problems on power spectral density function, Power density spectrum, Problems based on power density spectrum, Linear systems with random inputs, Representation of system in the form of convolution, Unit impulse response of the system, Properties, Applications of unit impulse function, Einstein Weiner-Khinchine Relationship, Cross-power density spectrum-problems, Cross-power density spectrum Cross-power density spectrum, Applications of power spectral density functions in engineering, Applications of power spectral density functions in engineering.	

Learning Resources	1. A. Papoulis, S. Unnikrishna Pillai, Probability, Random Variables and Stochastic Processes 4th Edition, McGraw Hill, 2002.	4. S.C. Gupta, V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 11th Edition, 2015.
	2. Henry Stark, Probability and Random Processes with Applications to Signal Processing, Third Edition, Pearson 2004	5. Jay L DeVore, Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage Learning India Pvt. Ltd, 2012.
	3. Sheldon Ross, A first course in Probability, Sixth Edition, 2011.	6. T. Veerarajan, Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks, 4th Edition, McGraw-Hill Education, New Delhi, 2015.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com	1. Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	1. Dr. V. Subburayan, SRMIST
	2. Prof. K.C. Sivakumar, IIT Madras, kcskumar@iitm.ac.in	2. Dr. G. Vijayalakshmi, SRMIST

Course Code	21MAB204T	Course Name	PROBABILITY AND QUEUEING THEORY	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Statistical Tables		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Describe the properties of a random variable.	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2 :	Gain knowledge of discrete and continuous distributions.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3 :	Understand the basic concepts of two-dimensional random variables, correlation, and regression lines																											
CLR-4 :	Interpret the system characteristics of queueing models.																											
CLR-5 :	Create Markov chains and investigate stationary state distributions.																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Evaluate the characteristics of discrete and continuous random variables and apply them in science and engineering.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-												
CO-2:	Identify the random variables and model them using various distributions.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-												
CO-3:	Infer results from two dimensional random variables which describe real life phenomenon.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-												
CO-4:	Examine the significant results of various queueing models.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-												
CO-5:	Determine the transition probabilities and classify the states of the Markov chain.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-												

Unit-1 - Random Variables	12 Hour
Probability concepts - Discrete and continuous random variables - Probability distribution function, Cumulative distribution function - Moments - Central and raw moments, Expectation and variance - Moment generating function (MGF) –Tchebycheff's inequality – Function of a random variable.	
Unit-2 - Theoretical Distributions	12 Hour
Discrete distribution - Binomial distribution, Poisson distribution - MGF, Mean, Variance, Theoretical frequencies and applications – Continuous distribution - Exponential and normal distributions – MGF, Mean, Variance and applications.	
Unit-3 - Two-Dimensional Random Variables	12 Hour
Joint distributions - Marginal and conditional distributions – Covariance – Correlation and linear regression – Central limit theorem (for independent and identically distributed random variables)	
Unit-4 - Queueing Theory	12 Hour
Queueing theory – Characteristics of a queueing Model – Kendal's notation – Poisson queues - (M/M/1): (∞/FIFO) Model – System characteristics – Applications - (M/M/s): (∞/FIFO) Model - System characteristics – Applications - (M/M/1): (k/FIFO) Model - System characteristics – Applications.	
Unit-5 - Markov Chain	12 Hour
Markov process – Markov chain – One step transition probability matrix – Chapman Kolmogorov theorem – Limiting probabilities – Classification of states of a Markov chain.	

Learning Resources	1. Sheldon Ross, <i>A first course in probability</i> , Pearson, 9th Edition, 2019.	4. Arnold O. Allen, <i>Probability, Statistics and Queueing Theory with Computer Science Applications</i> , Academic Press, 2nd Edition, 1990.
	2. S.C. Gupta, V.K. Kapoor, <i>Fundamentals of Mathematical Statistics</i> , Sultan Chand & Sons, 12th Edition, 2018.	5. D. Gross, John F. Shortle, James M. Thompson, Carl M. Harris- <i>Fundamentals of Queueing Theory</i> , Wiley India Pvt. Ltd. 4th Edition, 2013.
	3. K. S Trivedi, <i>Probability and Statistics with Reliability, Queueing and Computer Science Applications</i> , Prentice Hall of India, New Delhi, 2nd Edition, 2016.	6. T. Veerarajan, <i>Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks</i> , Tata McGraw-Hill, New Delhi, 4th Edition 2015

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com	1. Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	1. Dr. V. Subburayan, SRMIST
	2. Prof. K.C. Sivakumar, IIT Madras, kcskumar@iitm.ac.in	2. Dr. H. Merlyn Margaret, SRMIST

Course Code	21MAB206T	Course Name	NUMERICAL METHODS AND ANALYSIS	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1 :	Understand the methodologies to solve algebraic and transcendental equations.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2 :	Gain knowledge on interpolating and extrapolating methods in various intervals in real life.															
CLR-3 :	Understand the concept of numerical differentiation and integration.															
CLR-4 :	Solve initial and boundary value problems in differential equations using numerical methods.															
CLR-5 :	Solve initial and boundary value problems in partial differential equations using numerical methods.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Obtain numerical solutions to algebraic and transcendental equations.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Learn about various interpolating and extrapolating methods.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Compute numerical differentiation and Integration.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Interpret initial and final value problems in differential equations.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Interpret initial and boundary value problems in partial differential equations.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Numerical solutions of Algebraic and Transcendental Equations	12 Hour
Numerical Solution of Algebraic and Transcendental equation—Iteration Method, Bisection Method, Method of False Position, Newton-Raphson method and it's rate of convergence; Solving System of Simultaneous Linear Algebraic Equations — Gauss Elimination Method, Gauss Jordon Method, Jacobi Method, Gauss-Seidel Method.	
Unit-2 - Finite Differences and Interpolation	12 Hour
Introduction to Finite Differences—Forward and Backward Differences, Relation Between Operators, Differences of a polynomial—Factorial Polynomial, Newton's interpolation—Newton's forward and Backward Interpolation for Equal Intervals; Divided Differences and Properties, Interpolation with Unequal Intervals— Newton's Divided Difference Interpolation, Lagrange's Interpolation, Inverse Lagrange's Interpolation.	
Unit-3 - Numerical Differentiation and Integration	12 Hour
Numerical Differentiation—Newton's Forward and Backward Difference Formulae to Compute First and Higher Order Derivatives, Numerical Integration- Trapezoidal Rule, Simpson's One-Third Rule, Simpson's Three Eight Rule. Applications of Trapezoidal Rule, Applications of Simpson's One-Third Rule, Simpson's Three Eight Rule	
Unit-4 - Numerical Solution of Ordinary Differential Equations	12 Hour
Taylor Series Method, Euler's Method and it's rate of convergence, Improved Euler's Method, Modified Euler's method, Runge-Kutta Second-Order Method, Runge-Kutta Fourth Order Method and their order of convergence.	
Unit-5 - Numerical solutions of Partial Differential Equations	12 Hour
Classification of Second-Order Partial Differential Equations, Elliptic Equations-Finite Difference Scheme, Standard Five Point Finite Difference Formula, Diagonal Five Point Finite Difference Formula, Liebman's Iterative Process, Solution of Laplace Equations by Liebman's Iterative process, Solution of Poisson Equation, One Dimensional Parabolic Equation— Bender-Schmidt Scheme, Crank-Nicholson scheme	

Learning Resources	1. Brian Bradie, <i>A Friendly Introduction to Numerical Analysis</i> . Pearson. (2006)	4. F. B. Hildebrand <i>Introduction to Numerical Analysis: (2nd edition)</i> . Dover, (2013).
	2. D. R. Kincaid, E.W. Cheney, <i>Numerical Analysis Mathematics of Scientific Computing</i> , The University of Texas at Austin. Brooks/Cole Publishing Company, (1991).	5. M. K. Jain, S. R. K. Iyengar & R. K. Jain, <i>Numerical Methods for Scientific and Engineering Computation (6th edition)</i> . New Age International Publishers Publications. (2012).
	3. C. F. Gerald & P. O. Wheatley. <i>Applied Numerical Analysis (7th edition)</i> , Pearson Education, India, (2008)	6. P. Kandasamy, K. Thilagavathy & G. Gunawathy, <i>Numerical Methods</i> , S.Chand & Sons, 3rd Revised Edition, 2013.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com	1. Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	1. Dr. B.Vennila, SRMIST
	2. Prof. K.C. Sivakumar, IIT Madras, kcskumar@iitm.ac.in	2. Dr. Abdul Haq, SRMIST

Course Code	21MAB209T	Course Name	TRANSFORMS AND COMPUTATIONAL TECHNIQUES	Course Category	B	BASIC SCIENCES				L	T	P	C
										3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1 :	Compute the Fourier series expansion and express sine and cosine series												
CLR-2 :	Analyze Fourier Transforms and its properties and solve discrete-time signal problems using z transforms												
CLR-3 :	Construct and solve partial differential equations using various techniques., Identify partial differential equations and utilize Fourier series techniques to solve one dimensional wave and heat equations												
CLR-4 :	Apply the numerical techniques for solutions of ordinary differential equations												
CLR-5 :	Apply the numerical techniques for solutions of partial differential equations												
Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	Explain the Fourier series expansion of a function in terms of sine and cosine series												
CO-2:	Apply Fourier transforms techniques in signal analysis, Solve discrete-time signal problems using z transforms												
CO-3:	Identify partial differential equations and utilize Fourier series techniques to solve one dimensional wave and heat equations												
CO-4:	To solve the numerical solutions of ordinary differential equations												
CO-5:	To solve the numerical solutions of partial differential equations												

Program Outcomes (PO)												Program Specific outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3

Unit-1 - Fourier Series	12 Hour
Dirichlet's conditions – Fourier Series – Functions having arbitrary periods – Odd and even function - Half range sine and cosine Fourier series - Parseval's identity – Harmonic Analysis.	
Unit-2 - Fourier Transforms and Z Transforms	12 Hour
Fourier transform pair --Fourier sine and cosine transforms – Transforms of simple functions - Convolution theorem (without proof) – Parseval's identity - Z – transforms: Properties of Z transforms – Inverse Z transforms – Convolution theorem (without Proof) – Solution of linear difference equations with constant coefficients using Z-transform	
Unit-3 - Partial Differential Equations and Their Application	12 Hour
Classification of second-order partial differential equations - Linear Partial differential equations of second and higher order with constant coefficients of homogeneous type-Solutions of one dimensional wave equation - One dimensional equation of heat conduction - Steady state conditions with zero boundary	
Unit-4 - Numerical Solutions of First Order Ordinary Differential Equations and Numerical Integration	12 Hour
Solutions of first order simultaneous differential equations by Taylor's series method - Euler's method and its applications - Runge-Kutta method of fourth order (No proof) - Trapezoidal rule – Simpson's one third and Simpson's 3/8th rule.	

Unit-5 - Numerical Solutions of Partial Differential Equations **12 Hour**

Classification of Second order PDE-Solutions of Elliptic Equations- Solutions of Laplace Equations by Liebmann's iterative process- Solutions of Poisson Equations- Solutions of Parabolic equations by Bender-Schmidt formula- Solutions of Parabolic equations by Crank-Nicolson formula- Solutions of Hyperbolic equations by Explicit formula.

Learning Resources	1. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2015.	5. P. Kandasamy, et. al. Engineering Mathematics, Vol.II & Vol.III (4th revised edition), S. Chand & Co., New Delhi, 2000
	2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 43rd Edition, 2015.	6. P.Kandasamy et. al., Numerical Methods, S Chand & Co., New Delhi, 2003.
	3. B.V. Ramana, Higher Engineering Mathematics, 3rd Edition, Tata McGraw Hill New Delhi, 2010.	7. T. Veerarajan, Transforms and Partial Differential Equations, Tata McGraw-Hill, New Delhi, 3rd edition, 2012.
	4. M.K. Venkataraman, Numerical Methods in Science and Engineering, National Publishing Co. 2005	8. B.S. Grewal, Numerical Methods in Engineering and Science, Khanna Publishers, 42 nd editon, 2012.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com	1. Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	1. Dr. V. Subburayan, SRMIST
	2. Prof. K.C. Sivakumar, IIT Madras, kcskumar@iitm.ac.in	2. Dr. N. Balaji, SRMIST

Course Code	21MAB210T	Course Name	STATISTICAL MODELLING	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Statistical Table		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
CLR-1 :	Apply the sampling techniques in engineering field.															1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
CLR-2 :	Describe the measures of central tendency and measures of dispersion.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
CLR-3 :	Understand the basics and importance of estimate of statistical data.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
CLR-4 :	Describe the basics and importance of non-parametric methods in testing hypothesis.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
CLR-5 :	Apply the procedure for Time series analysis and Forecasting.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
Course Outcomes (CO):		At the end of this course, learners will be able to:															3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Sampling Techniques	12 Hour
Random sampling - Sampling from finite and infinite populations - Estimates and standard error (sampling with replacement and sampling without replacement) - Sampling distribution of sample mean - stratified random sampling - Systematic sampling and cluster sampling.	
Unit-2 - Introduction to Statistics	12 Hour
Definition of Statistics - Basic objectives - Applications in various branches of science with examples - Collection of Data: Internal and external data, primary and secondary data - Population and sample - Representative sample - Descriptive Statistics: Classification and tabulation of univariate data - graphical representation - Frequency curves - Descriptive measures - central tendency and dispersion.	
Unit-3 - Estimation theory and Testing Hypothesis	12 Hour
Point estimation - criteria for good estimates (unbiasedness, consistency) - Methods of estimation including maximum likelihood estimation - Sufficient statistic: concept and examples, complete sufficiency and their application in estimation - Test of hypothesis: concept and formulation - Type I and Type II errors - Neyman Pearson lemma.	
Unit-4 - Non-parametric Inference	12 Hour
Comparison with parametric inference - Use of order statistics - Sign test - Wilcoxon signed rank test - Mann-Whitney test - Run test - Kolmogorov-Smirnov test - Spearman's and Kendall's test - Tolerance region.	
Unit-5 - Basics of Time Series Analysis and Forecasting	12 Hour
Basics of Time Series Analysis and Forecasting – Stationary - ARIMA Models: Identification - Estimation and Forecasting – Applications to industrial problems.	

Learning Resources	1. Gun, M. K. Gupta and B.Dasgupta, <i>Fundamentals of Statistics (Vol. I & Vol. II)</i> , World Press, 2016,.	4. I.R. Miller, J.E. Freund and R. Johnson, <i>Probability and Statistics for Engineers</i> , 4th Edition, PHI Learning Private Limited, New Delhi, 2015.
	2. S.C. Gupta, V.K. Kapoor, <i>Fundamentals of Mathematical Statistics</i> , Sultan Chand & Sons, 11th Edition, 2015.	5. S. C. Gupta and V. K. Kapoor, <i>Fundamentals of Applied Statistics</i> , 4th Revised Edition, Sultan Chand & Sons, 2019.
	3. M. Rajagopalan and P. Dhanavanthan, <i>Statistical inference</i> , PHI Learning Private Limited, New Delhi, 2012.	6. Chris Chatfield, <i>The Analysis of Time Series: An Introduction</i> , Sixth edition, Chapman and Hall/CRC, 2004.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com	1. Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	1. Dr. V. Subburayan, SRMIST
	2. Prof. K.C. Sivakumar, IIT Madras, kcskumar@iitm.ac.in	2. Dr.R.Varadharajan, SRMIST

Course Code	21MAB301T	Course Name	PROBABILITY AND STATISTICS	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Statistical Table		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Apply the basic rules and theorems of probability theory and evaluate the expectation and variance using random variables.	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Gain knowledge of theoretical distributions.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Understand how to develop Null and Alternate hypothesis and draw conclusions using hypothesis tests.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-4:	Apply the knowledge of regression lines and analysis of variance.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-5:	Acquire knowledge to solve the problems of process control.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Implement the concepts of probability and random variables.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Identify the random variables and model them using various distributions.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Infer results by using hypothesis testing on large and small samples.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Examine the regression lines and interpret the results in the analysis of variance.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Utilize quality control techniques to solve real-world problems.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 : Probability and One-dimensional Random Variable	12 Hour
Probability concepts, Types of Events, Axioms and theorems - Conditional probability, Baye's theorem (without proof) - Applications of Baye's Theorem. Random variables – Discrete case and continuous case- Mathematical expectation, Variance –discrete case and continuous case - Raw Moments - Central Moments - Moment generating function (MGF) - discrete and continuous random variable.	
Unit-2 : Theoretical Distributions	12 Hour
Discrete distributions – Introduction- Mean and Variance of Binomial Distribution- Fitting a Binomial distribution- MGF of Binomial Distribution- Poisson Distribution- Mean and Variance of Poisson Distribution- Fitting a Poisson distribution- MGF of Poisson distribution- Geometric distribution- mean and variance, Memoryless property- Continuous distributions – Introduction- Uniform distribution – MGF, Mean and Variance- Exponential distribution - MGF, Mean and Variance, Memoryless property- Normal distribution.	
Unit-3: Testing of Hypothesis	12 Hour
Sampling Distributions – Type I and Type II errors- large sample test-Test of significance for single proportion- Test of significance for difference of proportions- Test of significance for single mean- Test of significance for difference of means- Small sample tests- Student's t- test for single mean- t- test for the difference of means- Fisher's F-test- Test of significance for two sample variances- Chi -square tes for the goodness of fit- Chi-square test for the independence of attributes.	
Unit-4 : Correlation, Regression and ANOVA	12 Hour
Correlation and its Properties- Karl Pearson's coefficient of correlation- Spearman's rank correlation coefficient for repeated and non-repeated ranks- Linear Regression lines and Properties- Relation between correlation and regression coefficient- Introduction to Analysis of Variance (ANOVA) - One-way Classification – two-way classification.	
Unit-5: Statistical Quality Control	12 Hour
Introduction – Process control – control charts for variables - \bar{X} and R, \bar{X} and S charts- control charts for attributes: p-chart, np-chart, c- chart and their applications in process control.	

Learning Resources	1. S. Ross, <i>A First Course in Probability</i> , 8th Ed., Pearson Education India, 2010. 2. Johnson. R.A., <i>Miller & Freund's, Probability and Statistics for Engineers</i> , 8th Edition, Prentice Hall India, 2011. 3. Veerarajan T., <i>Probability and Statistics</i> , Tata McGraw-Hill, New Delhi, 2010.	4. Devore (JL), <i>Probability and Statistics for Engineering and the Sciences</i> , 8th Edition, Cengage Learning, 2012. 5. S.C. Gupta, V.K. Kapoor, <i>Fundamentals of Mathematical Statistics</i> , Sultan Chand & Sons, 11th Edition, 2015. 6. Vijay K. Rohatgi., A.K. Md. Ehsanes Saleh, <i>An Introduction to Probability and Statistics</i> , 2nd Edition, Wiley, 2008
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 – (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com	1. Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	1. Dr. B.Vennila, SRMIST
	2. Prof. K.C. Sivakumar, IIT Madras, kcskumar@iitm.ac.in	2. Dr.R.Varadharajan, SRMIST

Course Code	21MAB302T	Course Name	DISCRETE MATHEMATICS	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Enhance the mathematical skills by applying the principles of sets and functions in storage, communication and processing the data			1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2 :	Culminate in extensive use and application of counting strategies in enumeration of data			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3 :	Apply the rules of inference theory to design electronic circuits and to verify computer programs																	
CLR-4 :	Apply the knowledge of algebraic structures and coding theory to solve problems on detection and correction of errors occurring in binary communication channels																	
CLR-5 :	Acquire knowledge to solve problems in communication networks using graph models																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Apply the concepts of set theory and its operations in data structures and mathematical modelling languages			3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Solve problems using counting techniques and understanding the basics of number theory			3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Comprehend and validate the logical arguments using concepts of inference theory			3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Inculcate the curiosity for applying the concepts of algebraic structures to coding theory			3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply graph theory techniques to solve wide variety of real world problems			3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 Set Theory	12 Hour
Sets - Operations on sets - Laws of set theory - Partition of a set - Cartesian product of sets - Relations - Properties - Equivalence relation and partial order relation - Poset - Graphs of relations - Digraphs - Hasse diagram - Closures of relations - Transitive closure and Warshall's algorithm - Functions - Types of functions - Composition of functions - Properties - Inverse of functions - Necessary and sufficient condition for existence of inverse function - Uniqueness of identity - Inverse of composition.	
Unit-2 -Combinatorics and Number Theory	12 Hour
Permutation and combination - Addition and product rules - Principle of inclusion and exclusion - Pigeon-hole principle and generalized pigeon-hole principle - Divisibility and prime numbers - Fundamental theorem of arithmetic - Prime factorization - Division algorithm- Greatest common divisor - Properties - Euclid's algorithm - Least common multiple.	
Unit-3: Mathematical Logic	12 Hour
Propositions and logical operators - Truth tables - Converse, inverse and contrapositive - Tautology and contradiction - Equivalences - Implications - Laws of logic - Inference theory - Rules of inference - Direct method - CP rule - Inconsistency - Indirect method - Principle of mathematical induction.	
Unit-4 : Algebraic Structures and Coding Theory	12 Hour
Groups - Permutation group - Cyclic group - Properties - Subgroup- Group homomorphism - Properties - Ring - Zero divisor - Integral domain- Field -Coding theory - Group code - Hamming codes - Error correction using matrices - Error correction - Decoding group codes.	
Unit-5: Graph Theory	12 Hour
Definitions - Handshaking theorem - Some special graphs - Isomorphism of graphs - Paths, cycles and circuits - Connectivity in undirected graphs - Eulerian and Hamiltonian graphs - Matrix representation of graphs- Isomorphism using adjacency - Digraphs - Trees - Properties - Spanning tree - Kruskal's algorithm - Graph coloring - Chromatic number- Four color theorem (statement only).	

Learning Resources	1. H. Kenneth Rosen, <i>Discrete Mathematics and its Application</i> , Seventh edition, Tata McGraw-Hill Publishing company PVT. Ltd., New Delhi, 2012.	4. C.L. Liu, <i>Elements of Discrete Mathematics</i> , 4th Edition, McGraw Higher ED, 2012.
	2. J.P. Tremblay and R. Manohar, <i>Discrete Mathematical Structures with applications to Computer Science</i> , 35th edition, Tata McGraw Hill Publishing Co., 2008.	5. R.P. Grimaldi, <i>Discrete and Combinatorial Mathematics: An Applied Introduction</i> , 4th Edition, Pearson Education Asia, Delhi, 2007.
	3. Narsing Deo, <i>Graph Theory with applications to Engineering and Computer science</i> , Prentice-Hall of India pvt. Ltd., New Delhi, 2004	6. T. Veerarajan, <i>Discrete Mathematics with Graph Theory and Combinatorics</i> , Tata McGraw Hill, 2015.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 – (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com	1. Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	1. Dr. V. Subburayan, SRMIST
	2. Prof. K.C. Sivakumar, IIT Madras, kcskumar@iitm.ac.in	2. Dr. J. Sasikumar, SRMIST
		3. Dr. L. Shobana, SRMIST

Course Code	21MAB303T	Course Name	BIOSTATISTICS FOR BIOTECHNOLOGISTS	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes			
CLR-1 :	Gain knowledge in measures of central tendency, measures of dispersion, skewness and kurtosis through moments on statistical data	Engineering Knowledge	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2 :	Understand the importance of probability distributions such as Binomial, Poisson and Normal distributions to solve biotechnology related problems.																												
CLR-3 :	Learn how to formulate and test the hypothesis of single means and difference of means, single proportion and difference of proportions for large samples and to understand the sample.																												
CLR-4 :	Gain knowledge on hypothetical tests about means and variances for small samples using the t test and F test, and apply the Chi-square test for goodness of fit and independence of attributes in biotechnological topics. Also, to have knowledge in ANOVA in biotechnology related topics.																												
CLR-5 :	Gain knowledge in correlation and regression lines and the non-parametric tests in biotechnology.																												
Course Outcomes (CO):		At the end of this course, learners will be able to:												Engineering Knowledge	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CO-1:	Explain measures of central tendency and measures of dispersion.																												
CO-2:	Apply probability distributions applicable to biotechnology																												
CO-3:	Examine the given problems relating to the large sample test of mean and difference of mean and Chi-square tests.																												
CO-4:	Infer from hypothesis tests by using the t-test, F- test, Chi-Square test and ANOVA.																												
CO-5:	Evaluate problems on concepts of correlation, regression and non-parametric tests.																												

Unit-1 : Measures on Statistical data	12 Hour
Introduction to discrete types of statistical data - Introduction to continuous types of statistical data- Measures of central tendency-Arithmetic mean, geometric mean, harmonic mean, median, mode - Measures of dispersion - Range, quartile deviation, mean deviation, median deviation, mode deviation and standard deviation- Coefficient of dispersion-Coefficient of variation – Raw moments and central moments and their relation. Measures of skewness and kurtosis - Karl Pearson's coefficient of skewness, Bowley's coefficient of skewness.	
Unit-2 : Probability	12 Hour
Introduction to probability concepts, random experiment, trail, events - Types of events: Impossible, Simple, Mutually Exclusive and Independent events (only definitions, properties- without proof)- Addition and Multiplication Theorems on probability- Total Probability theorem - Baye's Theorem (without proof) and its applications- Introduction to one-dimensional random variable and its types-Expectation(Mean), Variance, Moments and moment generating functions-Binomial Distribution, Poisson Distribution and Normal Distribution.	
Unit-3: Large sample tests	12 Hour
Sampling Theory- Basic concepts- Population, Sample, Sampling distribution, population parameters and sample statistic- Testing of hypothesis, Null and Alternate hypothesis, Single-tailed and Two-tailed tests, Type-I and Type-II errors- Acceptance and Rejection Regions, Level of Significance, Degrees of freedom and Confidence limits – Large sample tests based on the normal distribution (Z-test)-Z-Test for single mean and for the difference of means, Z-Test for single proportion and difference of proportions	
Unit-4 : Small sample tests	12 Hour
Small sample tests based on t- distribution- For single mean and for the difference of means – Paired t-test- F-test for equality of variances-The Chi-square test for goodness of fit and for Independence of attributes using a contingency table. One-way classifications- ANOVA, Two-way classifications- ANOVA.	

Unit-5: Correlation, Regression and Non-Parametric tests **12 Hour**

Karl Pearson's coefficient of correlations - Spearman's rank correlation coefficient-Regression lines and its applications- Non-parametric tests – The sign test – The Wilcoxon signed –ranked test- Rank sum tests: The Man Whitney U test -The Kruskal Wallis test.

Learning Resources	1. Mario F. Triola, <i>Elementary Statistics</i> , Pearson, 13th edition, 2018.	4. Richard I. Levin, David S. Rubin, Masood H. Siddiqui, S. Rastogi, <i>Statistics for Management</i> , Pearson, 8th edition, 2017.
	2. Sheldon M. Ross, <i>Introduction to Probability and Statistics for Engineers and Scientists</i> , Academic press, Sixth Edition, 2021.	5. Bernard Rosner, <i>Fundamentals of Biostatistics</i> , Brooks/core, 8th edition, 2015.
	3. S.C.Gupta and V.K.Kapoor, <i>Fundamentals of Mathematical Statistics</i> , S.Chand & Co, Eleventh Edition, 2018.	6. T. Veerarajan, <i>Probability, Statistics and Random Processes with Queueing Theory and Queueing Networks</i> , 4th Edition, McGraw-Hill Education, New Delhi, 2015.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 – (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com	1. Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	1. Dr. V. Subburayan, SRMIST
	2. Prof. K.C. Sivakumar, IIT Madras, kcskumar@iitm.ac.in	2. Dr.R.Senthamarai, SRMIST

Course Code	21MAB304T	Course Name	PROBABILITY AND APPLIED STATISTICS	Course Category	B	BASIC SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mathematics	Data Book / Codes / Standards	Statistical Table		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1 :	Apply the basic rules and theorems of probability theory such as Bayes' theorem to determine probabilities that help to solve engineering problems and to determine the expectation and variance of a random variable from its distribution.												
CLR-2 :	Appropriately choose, define and/or derive probability distributions such as the Binomial, Poisson and Normal to model and solve real-life engineering problems.												
CLR-3 :	Understand the principles of estimation theory and estimation techniques like a maximum-likelihood estimate.												
CLR-4 :	Learn the basic components of hypothesis testing and perform hypothesis tests on population means, variances and proportions.												
CLR-5 :	Understand how regression analysis can be used to develop an equation that estimates how two variables are related and how the analysis of variance procedure can be used to determine if means of more than two populations are equal.												

Program Outcomes (PO)													Program Specific outcomes		
1	2	3	4	5	6	7	8	9	10	11	12				
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	

Course Outcomes (CO):		At the end of this course, learners will be able to:													
CO-1:	Pertain the knowledge of probability concepts to determine probabilities that help to solve engineering problems	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Gain familiarity in deriving probability distributions such as the Binomial, Poisson, Normal and apply them to the problems involving Science and Engineering.	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Demonstrate competency in Consistency, efficiency and unbiasedness of estimators and method of maximum likelihood estimation.	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Acquire knowledge in formulating and testing hypotheses about means, variances and proportions.	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply the knowledge of Regression analysis, and ANOVA in real-life to problems in Science and Engineering.	3	3	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 : Probability and One-dimensional random variable	12 Hour
Probability concepts- Conditional probability- Baye's theorem (without proof) - Applications of Baye's Theorem-Random variables – Discrete case and continuous case- Mathematical expectation –discrete case and continuous case-Raw moments- Central moments- Moment generating function(MGF)- discrete and continuous random variables.	
Unit-2 : Theoretical Distributions	12 Hour
Discrete distributions – Introduction- Mean and variance of binomial distribution- Fitting a binomial distribution- MGF of binomial distribution- Poisson distribution- Mean and variance of Poisson distribution- Fitting a Poisson distribution- MGF of Poisson distribution- Geometric distribution- mean and variance, Memoryless property- Continuous distribution – Introduction- Uniform distribution – MGF, Mean and variance- Exponential distribution - MGF, Mean and variance, memoryless property- Normal distribution.	
Unit-3: Estimation theory	12 Hour
Introduction to estimation- Point estimation- Criteria for good estimates- Complete sufficiency and their application in estimation- Methods of estimation- Maximum likelihood estimation.	
Unit-4 : Testing of Hypothesis	12 Hour
Sampling Distributions – Type I and Type II errors- large sample test-Test of significance for single proportion- Test of significance for difference of proportions- Test of significance for single mean- Test of significance for difference of means- Small sample tests- Student's t- test for single mean- t- test for the difference of means- Fisher's F-test- Test of significance for two sample variances- Chi-square test for goodness of fit- Chi-square test for the independence of attributes.	

Unit-5: Correlation, Regression and ANOVA **12 Hour**

Correlation and its Properties- Karl Pearson's coefficient of correlation- Spearman's rank correlation coefficient for repeated and non-repeated ranks- Linear regression lines and Properties- Relation between correlation and regression coefficient- Introduction to - Analysis of Variance(ANOVA) – One-way classification- Two-way classification.

Learning Resources	1. S. Ross, A First Course in Probability, 10th Ed., Pearson Education India, 2019.	4. K.Vijay, A.K.Rohatgi, and Md. Ehsanes Saleh, An Introduction to Probability and Statistics, Third Edition, Wiley india Pvt. Ltd. 2015.
	2. R.A. Johnson, I.Miller & J.E.Freund's, Probability and Statistics for Engineers, 9th Edition, Pearson's Education, New Delhi, 2016.	5. Jay L DeVore, Probability and Statistics for Engineering and the Sciences, 8th Edition, Cengage Learning India Pvt. Ltd, 2012.
	3. A. Gun, M. K. Gupta and B.Dasgupta, Fundamentals of Statistics (Vol. I & Vol. II), World Press, 2016.	6. T. Veerarajan, Probability and Statistics, 3rd Edition, Tata McGraw-Hill, New Delhi, 2008.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life Long Learning CLA-2 – (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Madhan Shanmugasundaram, Infosys Technologies, madshan@gmail.com	1. Prof. Y.V.S.S. Sanyasiraju, IIT Madras, sryedida@iitm.ac.in	1. Dr. V. Subburayan, SRMIST
	1. Prof. K.C. Sivakumar, IIT Madars, kcskumar@iitm.ac.in	2. Dr. R. Varadharajan, SRMIST
		3. Dr. B. Vijayakumar, SRMIST



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

**Volume – 20
(Syllabi for Common Courses)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

Contents (Volume - 20)

Syllabi for Common Courses

<u>No</u>	<u>Title</u>	<u>Page No</u>
1	Core Course.....	7
	21CSC206T Artificial Intelligence.....	8
2	Open Elective Courses.....	10
	Aerospace Engineering	
	21ASO301T Elements of Aeronautics.....	11
	21ASO302T Creativity, Innovation. & New Product Development.....	13
	21ASO303T Aviation and Airline Maintenance Management.....	15
	21ASO304T Aircraft General Engineering and Maintenance Practices.....	17
	21ASO305T Flow Visualization Techniques.....	19
	21ASO306T Airport Engineering.....	21
	21ASO307T Molecular Gas Dynamics.....	23
	Artificial Intelligence	
	21AIO351T Introduction to Artificial Intelligence.....	25
	21AIO352T Machine Learning.....	27
	21AIO353T Python for Data Analytics.....	29
	21AIO354T Soft Computing.....	31
	Automation and Robotics & Electronics and Instrumentation Engineering	
	21EIO131J Virtual Instrumentation.....	33
	21EIO132T Analytical Instrumentation.....	35
	21EIO133T Industrial Automation Systems.....	37
	21EIO134T Introduction to Sensors.....	39
	21EIO135T Introduction to MEMS.....	41
	21EIO136J PLC for Industrial Automation.....	43
	21EIO138T Logical Foundation of Cyber Physical Systems.....	45
	Automobile Engineering	
	21AUO101T Hybrid and Electric Vehicles.....	47
	21AUO102T Renewable Sources of Energy.....	49
	21AUO103T Special Type of Vehicles.....	51
	21AUO104T Fuel Cells and Applications.....	53
	21AUO105T Transport Management.....	55
	21AUO106T Composite Materials for Automotive Applications.....	57
	21AUO107T Non-Destructive Testing and Evaluation.....	59

21AUO108T	Advanced Engine Technology.....	61
21AUO109T	New Product Development.....	63
21AUO110T	Automotive Standards and Regulations.....	65
21AUO111T	Automotive Sciences.....	67
21AUO112T	Intelligent Vehicle Technology.....	69
Biotechnology		
21BTO101T	Human Health and Diseases.....	71
21BTO105T	Animal Models for Biomedical Research.....	73
21BTO106T	Waste to Wealth to Wheels.....	75
21BTO107T	Fundamental Neurobiology.....	77
Biomedical		
21BMO121T	Fundamentals of Biomedical Engineering.....	79
21BMO122T	Health Information Systems.....	81
21BMO123T	Basics of Medical Imaging.....	83
21BMO124T	Rehabilitation Engineering.....	85
21BMO125T	Quality Control for Biomedical Devices.....	87
21BMO126T	Biomechanics of Human Movements.....	89
21BMO127T	Digital Healthcare Technology.....	91
Chemical Engineering		
21CHO101T	Sustainable Energy Engineering.....	93
21CHO102T	Petroleum Engineering.....	95
21CHO103T	Fundamentals of Chemical Engineering.....	97
21CHO104T	Process Plant Safety.....	99
21CHO105T	Pollution Abatement.....	101
Civil Engineering		
21CEO301T	Maintenance and Rehabilitation of Structures.....	103
21CEO302T	Disaster Resistant Structures.....	105
21CEO303T	Smart City and Infrastructure.....	107
21CEO304T	Real Estate Management.....	109
21CEO305T	Project Management.....	111
21CEO306T	Environmental Impact Assessment.....	113
21CEO307T	Municipal Solid Waste Management.....	115
21CEO308T	Disaster Mitigation and Management.....	117
21CEO309T	Water Pollution and its Management.....	119
21CEO310T	Global Warming and Climate Change.....	121
21CEO311T	Indoor and Ambient Air Quality Management.....	123
21CEO312T	Intelligent Transportation Systems.....	125
21CEO313T	Traffic Management Systems.....	127

21CEO314T	Traffic Flow Modeling and Simulation Techniques.....	129
21CEO315T	Viscoelasticity.....	131
21CEO316T	Soil Sciences.....	133
21CEO317J	Rural Development and Technology.....	135
21CEO318T	Floods and Flood Management.....	137
21CEO319T	Climate Change and Water Resources Management.....	139
21CEO320T	Principles of Satellite Remote Sensing.....	141
21CEO321T	Spatial Information System.....	143
21CEO322T	Remote Sensing and GIS Application in Engineering.....	145
21CEO323T	Spatial Technology In Engineering.....	147
21CEO324T	GIS and Spatial Analysis.....	149
21CEO325T	Web GIS.....	151
21CEO401T	Building Materials.....	153
21CEO402T	Introduction to Environmental Studies.....	155
21CEO403T	Integrated Waste Management.....	157
21CEO404T	Principles of Sustainable Development.....	159
21CEO405T	Road Safety and Audit.....	161
21CEO406T	Transportation Systems.....	163
21CEO407T	Rheology of Complex Materials.....	165
21CEO408T	Water Conservation and Management.....	167
21CEO409T	Water Quantity and Quality.....	169
21CEO410T	Remote Sensing Surveying.....	171
21CEO411T	Introduction to GIS and Data.....	173
21CEO412T	Web and Mobile GIS.....	175
21CEO413T	Digital Mapping.....	177
Computer Science and Engineering		
21CSO270T	Cyber Security.....	179
21CSO351T	Web Programming.....	181
21CSO352T	Python Programming.....	183
21CSO353T	Mobile Application Development.....	185
21CSO354T	Data Analytics.....	187
21CSO355T	Machine Learning for All.....	189
21CSO356T	Convolutional Neural Networks Foundation.....	191
21CSO357T	Data Visualization Basics.....	193
21CSO358T	Network Security.....	195
21CSO359T	Fundamentals of Information System Security.....	197
21CSO360T	Security Policy Implementation.....	199
21CSO451T	Deep Learning Foundation.....	201

Electronics and Communication Engineering

21ECO101 T	Short Range Wireless Communication.....	203
21ECO102J	Electronics Circuits and Systems.....	205
21ECO103 T	Modern Wireless Communication System.....	207
21ECO104J	PCB Design and Manufacturing.....	209
21ECO105T	Fiber Optics and Optoelectronics.....	211
21ECO106J	Embedded System Design Using Arduino.....	213
21ECO107J	Embedded System Design Using Raspberry PI.....	215
21ECO108J	3D Printing Hardware and Software.....	217

Electrical and Electronics Engineering

21EE0301T	E-Mobility.....	219
21EE0302T	Wearable Technology.....	221
21EE0303T	E-Waste Management.....	223
21EE0304T	Energy Efficient Practices.....	225
21EE0305T	Surveillance Technology.....	227
21EE0306T	Sustainable Development Practices.....	229
21EE0307T	Clean and Green Energy.....	231
21EE0308T	Smart Cities and Communities.....	233
21EE0309T	Electrical Trading.....	235
21EE0310T	Unmanned Aerial Vehicle.....	237

Genetic Engineering

21GEO101T	Behavioral Biology.....	239
21GEO102T	Microbes and Society.....	241
21GEO103T	Biofertilizers – An Entrepreneurial Perspective.....	243
21GEO104T	Computational Genomics.....	245
21GEO105T	Biology for Everyday Life.....	247

Mechatronics Engineering

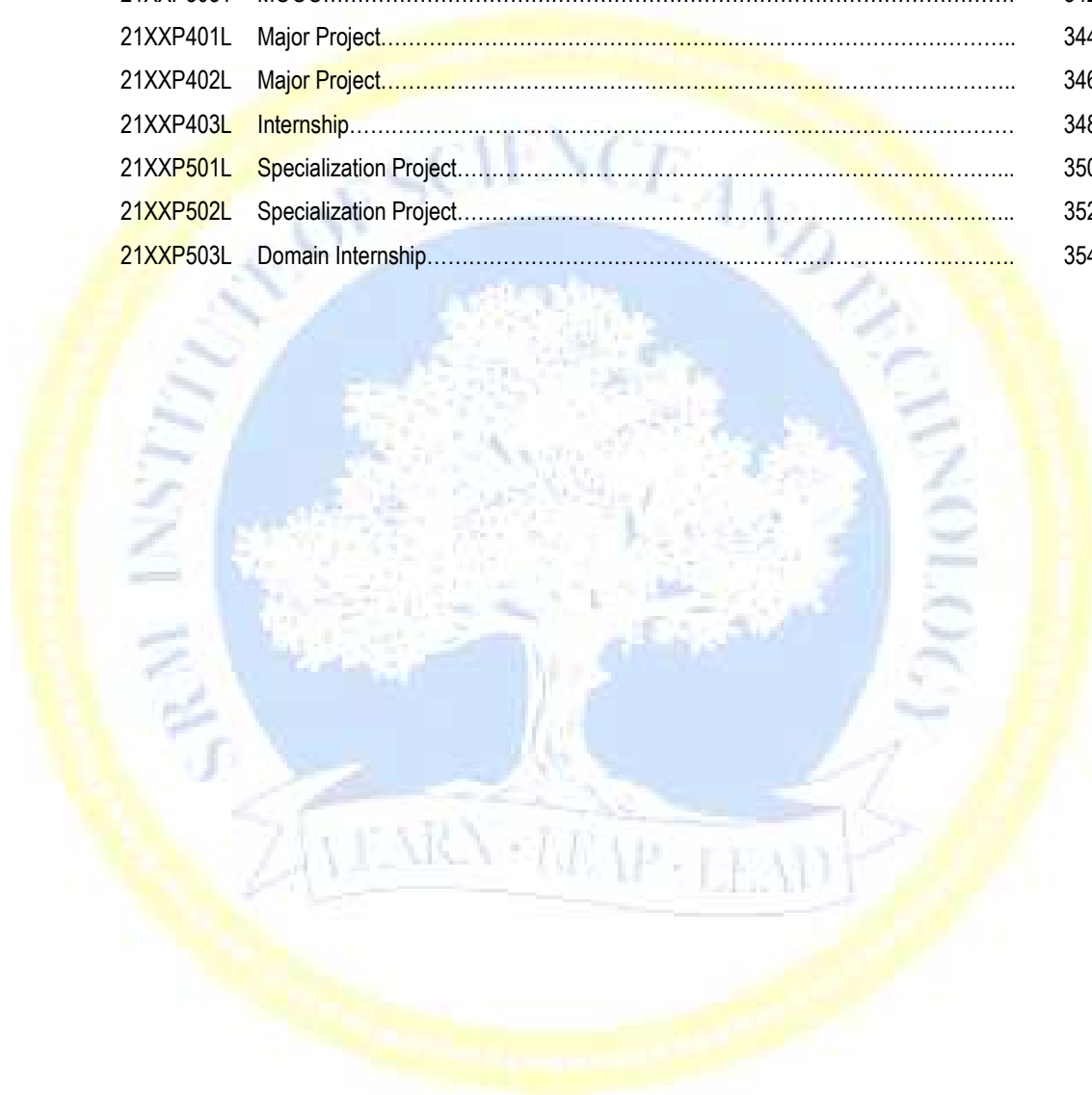
21MHO301T	Smart Farming.....	249
-----------	--------------------	-----

Mechanical Engineering

21MEO101T	Fundamentals of Composite Materials.....	251
21MEO102T	Reverse Engineering and 3D Printing.....	253
21MEO103T	Fundamentals of Biomechanics.....	255
21MEO104T	TQM and Reliability Engineering.....	257
21MEO105T	Occupational Safety and Disaster Management.....	259
21MEO106T	Introduction to Robotics.....	261
21MEO107T	Fundamentals of Nano Engineering.....	263
21MEO108T	Computer Numerical Control Programming and Operation.....	265
21MEO109T	Resource Management Techniques.....	267

21MEO110T	Energy Systems for Sustainable Buildings.....	269
21MEO111T	Environmental Pollution and Abatement.....	271
21MEO112T	Renewable Energy Sources and Applications.....	273
21MEO113T	Electronics Thermal Management.....	275
21MEO114T	Solar Energy for Societal Applications.....	277
21MEO115T	Introduction to Drones.....	279
Nanotechnology		
21INTO301T	Applications of Nanotechnology.....	281
21INTO303T	Micro and Nanoelectronics.....	283
21INTO302T	Solid State Electronic Devices.....	285
21INTO304T	Environmental Nanotechnology.....	287
21INTO305T	Medical Nanotechnology.....	289
21INTO306T	Nanoscale Surface Engineering.....	291
21INTO307T	Nanocomputing.....	293
21INTO308T	Smart Sensor Systems.....	295
21INTO309T	2D Materials and Applications.....	297
21INTO310T	Nano and Microelectromechanical Systems.....	299
21INTO401T	Scientific Research Principles.....	301
21INTO402T	Micro and Nanofluidic Technology.....	303
21INTO403T	Thin film Photovoltaics.....	305
21INTO404T	Nanotechnology in Societal Development.....	307
21INTO405T	Polymer Engineering.....	309
21INTO406T	Industrial Nanotechnology.....	311
21INTO407T	Quantum Computing.....	313
3	Engineering Science Courses.....	315
21DCS201P	Design Thinking and Methodology.....	316
21CSS303T	Data Science.....	318
4	Non Credit Courses.....	320
21PDM201L	Verbal Reasoning.....	321
21PDM202L	Critical and Creative Thinking Skills.....	320
21PDM301L	Analytical and Logical Thinking Skills.....	322
21PDM302L	Employability Skills and Practices.....	324
21LEM201T	Professional Ethics.....	326
21LEM202T	Universal Human Values – Understanding Harmony and Ethical Human Conduct.....	328
21LEM301T	Indian Art Form.....	330
21LEM302T	Indian Traditional Knowledge.....	332

5 Humanities Courses.....	333
21PDH201T Social Engineering.....	334
21GNH401T Behavioral Psychology.....	336
6 Project Work, Seminar, Internship in Industry / Higher Technical Institutions.....	337
21GNP301L Community Connect.....	338
21XXP302L Project.....	340
21XXP303T MOOC.....	342
21XXP401L Major Project.....	344
21XXP402L Major Project.....	346
21XXP403L Internship.....	348
21XXP501L Specialization Project.....	350
21XXP502L Specialization Project.....	352
21XXP503L Domain Internship.....	354



ACADEMIC CURRICULA

Core Course

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC206T	Course Name	ARTIFICIAL INTELLIGENCE	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Infer knowledge in problem formulation with AI.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Exemplify the uninformed and informed search technique procedures for real world problems															
CLR-3:	Understand the adversarial search methods, constraint satisfaction problems and intelligent agents.															
CLR-4:	Demonstrate various knowledge representation techniques															
CLR-5:	Infer knowledge about expert systems.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Formulate a problem as a state space search method and its solution using various AI techniques	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Apply appropriate searching techniques to solve a real-world problem	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Develop various game playing strategies to solve real world adversarial search problems	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Represent various knowledge representation techniques to solve complex AI problems	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Design an expert system to implement advance techniques in Artificial Intelligence	3	2	3	-	-	-	-	-	2	-	-	-	-	-	-

Unit-1- Introduction to AI	9 Hour
AI techniques, Problem solving with AI, AI Models, Data acquisition and learning aspects in AI, Problem solving- Problem solving process, formulating problems, Problem types and characteristics, Problem space and search, Toy Problems – Tic-tac-toe problems, Missionaries and Cannibals Problem, Real World Problem – Travelling Salesman Problem	
Unit-2- Basic Introduction to Data Structure and Search Algorithms	9 Hour
Basic introduction to stacks, queues, trees and graphs - General Search Algorithms – Searching for solutions – Problem-solving agents – Control Strategies – Uninformed Search Methods – Breadth First Search – Uniform Cost Search - Depth First Search -Depth Limited Search – Informed search - Generate and test - Best First search - A* Algorithm	
Unit-3 - Adversarial Search Problems and Intelligent Agent	9 Hour
Adversarial Search Methods (Game Theory) - Mini max algorithm - Alpha beta pruning - Constraint satisfactory problems – Constraints – Crypt Arithmetic Puzzles – Constraint Domain – CSP as a search problem (Room colouring). Intelligent Agent – Rationality and Rational Agent – Performance Measures – Rationality and Performance – Flexibility and Intelligent Agents – Task environment and its properties – Types of agents.	
Unit-4- Knowledge Representation	9 Hour
Knowledge Representation -Knowledge based agents – The Wumpus world – Propositional Logic - syntax, semantics and knowledge base building - inferences – reasoning patterns in propositional logic – predicate logic – representing facts in logic: Syntax and semantics – Unification – Unification Algorithm - Knowledge representation using rules - Knowledge representation using semantic nets - Knowledge representation using frames inferences - Uncertain Knowledge and reasoning Methods.	

Unit-5 – Planning and Expert System **9 Hour**

Planning – planning problem – Simple planning agent – Blocks world problem – Mean Ends analysis Learning - Machine learning - Learning concepts, methods and models Introduction to expert system – architecture of expert systems.

Learning Resources	1. Parag Kulkarni, Prachi Joshi, <i>Artificial Intelligence –Building Intelligent Systems</i> , 1st ed., PHI learning, 2015	3. Deepak Kemhani, <i>First course in Artificial Intelligence</i> , McGraw Hill Pvt Ltd, 2013
	2. Stuart Russel and Peter Norvig, <i>“Artificial Intelligence: A Modern Approach”</i> , Fourth Edition, Pearson Education, 2020.	4. Data Structures Schaum's Outlines Series, Seymour, Lipschutz, 2014.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	15%	-	15%	-	15%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	25%	-	25%	-	25%	-
Level 5	Evaluate	20%	-	20%	-	20%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Tejas Gowda, Co-Founder & Chief Data Scientist, TenzAI	1. Dr. T. Senthilkumar, Associate Professor, Amrita School of Engineering, Amrita Vishwa Vidyapeetham	1. Dr. A. Alice Nithya, SRMIST
		2. Dr. K. Senthil Kumar, SRMIST

ACADEMIC CURRICULA

Open Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21ASO301T	Course Name	ELEMENTS OF AERONAUTICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Describe the art of flying	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Discuss the various types of aircraft configuration, control systems and instruments															
CLR-3:	Explain about the atmosphere and variation in properties, aircraft flight and different speed regimes															
CLR-4:	Explain the basics of aircraft structures and the aerospace materials															
CLR-5:	Describe about the various propulsion systems used in aerospace industry.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Discuss the evolution of aircraft and their types	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-2:	Describe the various types of aircraft configuration, control systems and instruments	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Describe about the atmosphere and variation in properties, aircraft flight and different speed regimes	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Explain the basics of aircraft structures and the aerospace materials	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-5:	Demonstrate about the various propulsion systems used in aerospace industry.	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-

Unit-1 - History of Flight	9 Hour
Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years	
Unit-2 - Aircraft Configurations and its Controls	9 Hour
Different types of flight vehicles, Classifications-Components of an airplane and their functions - Conventional control, powered control- Basic instruments for Flying -Typical systems for control actuation	
Unit-3 - Basics of Aerodynamics	9 Hour
Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aerofoils, Mach number, Manoeuvres	
Unit-4 - Basics of Aircraft Structures	9 Hour
General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and Strains-Hooke's law- stress-strain diagrams - elastic Constants-Factor of Safety.	
Unit-5 - Basics of Propulsion	9 Hour
Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust Production – Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space	

Learning Resources	5. Anderson, J.D., <i>Introduction to Flight</i> , McGraw-Hill; 8th edition, 2015	8. Sadhu Singh, <i>Internal Combustion Engines and Gas Turbine</i> , SS Kataria & Sons, 2015
	6. E Rathakrishnan, <i>Introduction to Aerospace Engineering: Basic Principles of Flight</i> , John Wiley, NJ, 2021	9. Kermode, <i>Flight without Formulae</i> , Pitman; 4th revised edition 1989.
	7. Stephen.A. Brandt, <i>Introduction to aeronautics: A design perspective</i> , 2nd edition, AIAA Education Series, 2004.	10. McKinley, J.L., R.D. Bent, <i>Aircraft Power Plants</i> , McGraw Hill 1993 11. Clancy L.J., <i>Aerodynamics</i> , 2nd ed., Sterling book house 1975

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	50%	-	50%	-	50%	-
Level 2	Understand	50%	-	50%	-	50%	-
Level 3	Apply	-	-	-	-	-	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
2. Wg.Cdr K. Manoharan (Retd), Blue Dart Aviation Ltd., manoharank@bluedart.com	2. Dr. A. P. Haran, Park College of Engineering & Technology, ap_haran@rediffmail.com	1. Dr. T. Selvakumaran, SRMIST
3. Wg.Cdr R. Annamalai, Chief training co-ordinating officer IAF, Tambaram. annamalai.ramasamy2@gmail.com	3. Dr. S. Nadaraja Pillai, Sastra university Thanjavur, nadarajapillai@mech.sastra.edu	2. Mr. G. Mahendra Perumal, SRMIST

Course Code	21ASO302T	Course Name	CREATIVITY, INNOVATION. & NEW PRODUCT DEVELOPMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Explain the process of technological innovation, creativity and problem-solving methods	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Discuss the ideas, criteria and techniques for project selection															
CLR-3:	Identify the project evaluation techniques and describe the factors for product screening															
CLR-4:	Discuss the importance of patent search and patent laws, as well as the role and classifications of IPR.															
CLR-5:	Explain the steps involved in new product development process															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe the technological innovation process and identify the need for creativity & innovation in engineering	3	1	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-2:	Explain the project selection ideas as well as the various criteria and measures adopted during project selection	3	1	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-3:	Describe the factors for product screening and identify the project evaluation techniques	3	2	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-4:	Explain IPR & its types and discuss the objective of patent laws, WIPO, TRIPS, WTO, PCT	3	1	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-5:	Describe the process of new product development and discuss the need, purpose & methods of marketing research	3	2	-	-	-	-	-	-	-	-	-	1	-	-	-

Unit-1 - Introduction	9 Hour
Introduction-The process of technological innovation-Factors contributing to successful technological innovation-Examples for the factors-Technological milestones-Technological evolution-The need for creativity for individual and nation-The need for innovation for individual and nation-Creativity -Obstacles-Problem solving-Obstacles-Creativity -keys and questions-Problem solving-keys and questions-Brain Storming-Examples-Different techniques for creative intelligence-Detailed explanation with examples-Case Study on technology innovation-Example	
Unit-2 - Project Selection	9 Hour
Collection of ideas-Categories of ideas-Different routes for collecting ideas-Examples-Taking different views, Combining the unusual-Examples-Adapt, adopt & improve - Breaking the rules - Challenge the assumptions - sking searching questions - Increasing the yield - Implementation methods - Purpose and types, Indian National Technology Missions-Detailed explanation-Project selection criteria -Analysis methods-Case Study-on project selection - Example	
Unit-3 - Project Evaluation	9 Hour
Introduction to project evaluation-Preliminary Methods-Screening Methods-Examples-Product life cycle-Different organizations-Product evaluation profile- Stability factors-Growth factors-Marketability factors-Research factors-Development factors-Position factors- Production factors-Value Engineering-Need for value engineering-Case Study on project evaluation - Example	
Unit-4 - New Product Developments	9 Hour
Evaluation of IPR-4 traditional forms-Definition of IPR-Development of 7 types of IPR-Need for IPR in India-Patentable Innovation-Obligations-Enforcement Measures-Patent search and its advantages-IP Council-International Treaties-Conventions-WIPO-TRIPS- WTO-PCT-Case Study-4 on IPR-Example	

Unit-5 - New Product Planning	9 Hour
Design of product prototype-Factors of design-Requirement of design-Design process-Functional design-Functional margins-Test and Qualification-Types of tests and their significance-Test plan-Issues in concluding a test-Quality standards-Product Strategy-Six-sigma Practice Procedure-Implementation-Marketing- methods-Marketing- research-Case Study -5 on product development-Example	

Learning Resources	1. Keelen A.L., <i>New Product Planning and Development</i> , International Correspondence Schools Division, Scranton, Pennsylvania, 1969 2. Paul Sloane, <i>The Leader's Guide to Lateral Thinking Skills</i> , 2nd ed., Kogan Page India, New Delhi, 2008, Department of Space: IPR Manual, Bangalore, 2007 3. Osho, <i>Creativity – Unleashing the Forces Within</i> , St Martin's Griffin, New York, March, 2007 4. Abdul Kalam.A.P.J., Arun Tiwari, "Wings of Fire", Universities Press, Hyderabad,1999, Edward de Bono, <i>How to have a beautiful mind</i> , Vermilon, London, 2004 5. Khandwalla, R.N., <i>Fourth Eye (Excellence through creativity)</i> , Wheeler Publishing, Allahabad, 1992. 6. Rajiv.V.Dharaskar, <i>Innovation-Growth Engine for Nation. Nice Buzzword but often Misunderstood</i> , www.dharaskar.com Annamalai.N., www.creativitysphere
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	50%	-	50%	-	50%	-
Level 2	Understand	50%	-	50%	-	50%	-
Level 3	Apply	-	-	-	-	-	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. D. Saji, National Aerospace Laboratories, Bangalore, saji@nal.res.in	1. Dr. V. Arumugam, Madras Institute of Technology, Chennai, arumugam.mitaero@gmail.com	1. Dr. S. Gurusideswar, SRMIST
2. Dr. Manoj Kumar Buragohain, Defense Research and Development Organization, Hyderabad,ragohainm@yahoo.com	2. Dr. K. Vadivuchezhian, National Institute of Technology Karnataka, Surathkal, vadivuchezhian_k@yahoo.co.in	2. Dr. K. Saravanakumar, SRMIST

Course Code	21ASO303T	Course Name	AVIATION AND AIRLINE MAINTENANCE MANAGEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Explain the concepts of Air transportation and Airline management	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Explain the concept of Airline forecasting and fleet planning															
CLR-3:	Discuss the significance of airline scheduling and equipment maintenance															
CLR-4:	Describe the concepts of Aircraft reliability and aging aircraft maintenance															
CLR-5:	Discuss the aviation supporting organization and state regulatory															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe the organization details in air-transportation	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-2:	Describe the forecasting methods in airline	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-3:	Summarize the scheduling process and maintenance of aircraft	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Explain the aging aircraft maintenance	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Summarize the aviation supporting organizations and state regulatory	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-

Unit-1 - Air Transportation	9 Hour
International Aviation Association - IATA – General Aviation Classification - Factors Affecting General Aviation Industry - Aircraft Uses - Airport classification - Airline Management Levels of Management Functions of management - Chart Line management	
Unit-2 - Airline Managerial Aspect	9 Hour
Airline Forecasting - Fleet Planning - Aircraft Selection Process - Passenger Capacity - Load Factor - Passenger Fare and Tariffs - Influence of Geographical, Economic and Political Factors on Routes and Route Selection - Fleet Commonality - Factors Affecting Fleet - Choice Valuation and Depreciation - Budgeting - Cost planning - Aircrew Analysis - Route Analysis - Aircraft evaluation	
Unit-3 - Airline Scheduling	9 Hour
Mission of Airline scheduling - Equipment maintenance - Maintenance system of a jet aircraft - Objective of ground service - Ground operations and facility limitations - Schedule planning and coordination - Traffic flow - Schedule salability - Schedule Adjustment - Chain reaction effect - Load factor leverage - Equipment's and types of schedule - Preparing flight plans - Aircraft scheduling in line with aircraft maintenance practice - Hub and spoke scheduling	
Unit-4 - Aircraft Reliability	9 Hour
Parameters to monitor Maintenance schedule - Maintenance program - Condition monitoring maintenance -ETOPS - Maintenance versus Conventional Maintenance - ETOPS for Non-ETOPS Airplanes - Aircraft depressurization - Aging Aircraft Maintenance in aging aircraft - Operating cost associated with maintenance - Helicopter maintenance - Maintenance schedule	
Unit-5 - Aviation Supporting Organizations	9 Hour
organization - State regulatory - Responsibilities and functions of FAA - DGCA - functions of DGCA - Turbine engine monitoring - On board maintenance system - Life usage monitoring - Technology in aircraft maintenance - Introduction and Functions of Technical Publications, Airline Libraries, Control of Publications, Document Distribution	

Learning Resources	1. John G Wensveen, <i>Air Transportation – A Management Perspective</i> , Ashgate Publications, 8th ed., 2015	3. <i>Indian Aircraft Manual</i> , DGCA, sterling book House, Mumbai, reprint 2014
	2. Friend C.H., <i>Aircraft Maintenance Management</i> , Longman aviation technology, 2nd ed., 1992	4. <i>Aviation maintenance management</i> Harry.A.Kinnison, Second edition McGraw-Hill 2013 5. PS Senguttuvan, <i>Fundamentals of air transport management</i> , excel books, reprint 2010

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	50%	-	50%	-	50%	-
Level 2	Understand	50%	-	50%	-	50%	-
Level 3	Apply	-	-	-	-	-	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Wg.Cdr retd. Manoharan, Continuing Airworthiness Manager, Blue Dart Aviation. manoharank@bluedart.comS	1. Dr. V.Arumugam, Madras Institute Of Technology Campus, Anna University, Chennai, arumugam.mitaero@gmail.com	1. Dr. S. Sivakumar, SRMIST
2. Wg.cdr R.Annamalai, Chief training co-ordinating officer IAF, Tambaram annamalai.ramasamy2@gmail.com	2. Dr.S.Nadaraja pillai, Sastra university Thanjavur, adarajapillai@mech.sastra.edu	2. Mr. K. Iyenthezhuthon, SRMIST

Course Code	21ASO304T	Course Name	AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Identify ground handling tools and equipment's to perform ground handling operation of aircraft	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Maintain the aircraft ground servicing units															
CLR-3:	Summarize the safety aspects and improve the human relations in working environment.															
CLR-4:	Work in the planning process environment of maintenance industry															
CLR-5:	Maintain the tools, accessories and components															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Explain the operation of various ground handling equipment's and its procedures	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-2:	Restate the utility of aircraft ground servicing units and their maintenance	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Describe the various aspects of human performance factors	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-4:	Discuss about different maintenance operational procedures	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Explain the various precision instruments and special tools	3	-	-	-	-	-	-	-	-	-	-	1	-	-	-

Unit-1 - Aircraft Ground Handling	9 Hour
Mooring, jacking, levelling and towing operations – Preparation – Equipment – precautions - Engine starting procedures – Piston engine, turboprops and turbojets - Engine fire extinguishing. - Ground Power Units.	
Unit-2 - Maintenance and Handling of Ground Equipments	9 Hour
Air Starter Unit - Portable Hydraulic Test Stand - Electric power supply equipment - Air-conditioning Unit - Oil Pressure Unit - Jacks, Cranes, Ladders, Platforms, Trestles & Chocks.	
Unit-3 - Human Performance and Limitations	9 Hour
The need to take human factors into account, Incidents attributable to human factors/human error, Murphy's law. Vision, Hearing, Information processing, Attention and perception, Memory, Claustrophobia and physical access.	
Unit-4 – Inspection	9 Hour
Inspection Process, Purpose, Types - Inspection intervals – Techniques – Checklist - Special inspection – Publications, bulletins, various manuals – FAR Air worthiness directives. - Type certificate Data Sheets – ATA specifications.	
Unit-5 - Aircraft Hardware and Materials	9 Hour
Hand tools – Precision instruments – Special tools and equipment in an airplane maintenance shop - Identification terminology – Specification and correct use of various aircraft hardware - American and British systems of specifications – Threads, gears, bearings – Drills, tapes & reamers.	

Learning Resources	1. Airframe and Power plant Mechanics, General Hand Book, Federal Aviation Administration, and AC65 - 9A.	3. Michael J.Kroes, William A.Watkins ad Frank Delp, Aircraft Maintenance and Repair, 7 th ed., Tata McGraw Hill, New Delhi, 2013.
	2. Airframe and Power plant Mechanics, Airframe Hand Book, Federal Aviation Administration, and AC65- 15A.	4. CAP 715 – An Introduction to Aircraft Maintenance Engineering Human Factors for JAR 66, Civil Aviation Authority, UK.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	50%	-	50%	-	50%	-
Level 2	Understand	50%	-	50%	-	50%	-
Level 3	Apply	-	-	-	-	-	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Wg.Cdr retd. Manoharan, Continuing Airworthiness Manager, Blue Dart Aviation.manoharank@bluedart.com	1. Dr. V.Arumugam, Madras Institute Of Technology Campus, Anna University, Chennai. arumugam.mitaero@gmail.com	1. Dr. S. Sivakumar, SRMIST
2. Wg.cdr R.Annamalai, Chief training co-ordinating officer IAF, Tambaram annamalai.ramasamy2@gmail.com	2. Dr.S.Nadaraja Pillai, Sastra university Thanjavur, nadarajapillai@mech.sastra.edu	2. Mr. G. Mahendra Perumal, SRMIST

Course Code	21ASO305T	Course Name	FLOW VISUALIZATION TECHNIQUES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Describe the flow visualization techniques in fluid flows	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Select the appropriate equipment required for performing flow visualization experiment															
CLR-3:	Identify the techniques for performing flow visualization in air and water															
CLR-4:	Visualize the density gradients and shocks in compressible flows.															
CLR-5:	Examine the laser based optical techniques for flow visualization applications.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the principles of fluid flows for flow visualization application.	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	List the equipment required for flow visualization experiments	3	2	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-3:	Perform flow visualization in air and water	3	2	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-4:	Illustrate the flow field in supersonic flows	3	2	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-5:	Apply advanced flow visualization techniques to fluid flows	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Fluid Flows	9 Hour
Brief history of fluid mechanics, Properties of fluids, fluid statics, flow kinematics, types of flows, Fluid Flow description, Conservation laws, Continuity and Navier-Stokes equation, Bernoulli's equation and its applications, Boundary layer and separation, Reynolds number and Mach number	
Unit-2 - Flow Visualization Set-Ups and Equipments	9 Hour
Wind Tunnels and their classification - Subsonic and Supersonic Wind Tunnels, Smoke Tunnel, Hele-Shaw apparatus, Reynolds apparatus, Water Tunnel, Photographic equipment and techniques, Lab Demonstration of various set-ups	
Unit-3 - Flow Visualization in Incompressible Flows	9 Hour
Flow visualization in air – Smoke generator, Smoke rake technique, Smoke-wire technique, Surface oil flow visualization, Tufts Visualization, Flow Visualization in water – Conventional and Fluorescent dyes, Methods of dye injection, Hydrogen bubble technique, Lab Demonstration of visualizations	
Unit-4 - Flow Visualization in Compressible Flows	9 Hour
Optical Techniques, Gladstone-Dale Relation, Shadowgraph, Schlieren, Lab demonstration of Schlieren Technique, Background Oriented Schlieren (BOS)	
Unit-5 - Advanced Laser Based Optical Techniques	9 Hour
Particle Image Velocimetry (PIV) - PIV Setup components and procedure - Image Correlation and Post processing of PIV Data, Stereo PIV and Tomo PIV, Planar Laser Induced Fluorescence for combustion applications, Pressure Sensitive Paints, Temperature Sensitive Paints	

Learning Resources	1. Rathakrishnan, Ethirajan. <i>Instrumentation, measurements, and experiments in fluids</i> . CRC press, 2007.	4. Barlow, Jewel B., William H. Rae, and Alan Pope. <i>Low-speed wind tunnel testing</i> . John Wiley & sons, 1999.
	2. Smits, Alexander J. <i>Flow visualization: techniques and examples</i> . World Scientific, 2012.	5. Discetti, Stefano, and Andrea Ianiro, eds. <i>Experimental aerodynamics</i> . CRC Press, 2017.
	3. Tropea, C., Yarin, A. L., & Foss, J. F. (Eds.). (2007). <i>Springer handbook of experimental fluid mechanics</i> . Berlin: Springer.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	60%	-	60%	-	60%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Saurav Kumar Ghosh, CSIR-NAL, Bangalore skghosh@nal.res.in	1. Dr. Lakshmana Dora C, IIT Hyderabad Ichandrala@mae.iith.ac.in	1. Dr. K K Bharadwaj, SRMIST
2. Dr. Raja S, CSIR-NAL, Bangalore, raja@nal.res.in	2. Dr. Arun Kumar Perumal, IIT Kanpurakp@iitk.ac.in	2. Dr. S Senthilkumar, SRMIST

Course Code	21ASO306T	Course Name	AIRPORT ENGINEERING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Explain about airports and surveys	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Describe about airport planning and forecasting															
CLR-3:	Contrast and design runway and taxiways															
CLR-4:	Explain air traffic control tower and terminal areas and Air cargo															
CLR-5:	Discuss about heliports, STOL ports and vertiports															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe airports and surveys involved	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Explain airport planning and forecasting	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-3:	Differentiate interpret and design runway and taxiways	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-
CO-4:	Describe about air traffic control tower and terminal areas	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Differentiate interpret about heliports, STOL ports and vertiports	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-

Unit-1 - Airport Survey	9 Hour
National and International Organizations - Aircraft Characteristics - Civil and military aircrafts - Airport Definitions- Categories and Codes of airports - Flying Activities - Scheduled and non-scheduled flights - Airport Survey - Objectives and types of survey - Drawings to be Prepared - Types of plan	
Unit-2 - Airport Planning	9 Hour
Improvement of existing Airport - Airport site selection - Factors affecting size of airport - Aviation Forecasting - Airport obstructions - Imaginary surface - Objects with actual height - Airport zones - Zoning Laws- Environmental considerations - Factors influenced by airport activity - Pollution, Social factor	
Unit-3 - Runway and Taxiway Design	9 Hour
Runway orientation - Change in direction of runway - Basic runway length - Runway patterns - Comparison of runway patterns - Taxiway design - Layout of taxiways - Geometric standards for taxiway - Exit taxiways - Location of exit taxiway - Design of exit taxiways - Apron Types - Fillets - Separation Clearance - Bypass or turnaround taxiway	
Unit-4 - Terminal Area and ATC and Air Cargo	9 Hour
Terminal building - Passenger Flow- Apron - Hangars - Typical airport layout - Air Traffic Control - Flight Rules - ATC Network - ATC Aids - Automation in ATC- Factors affecting the size of cargo terminal - Apron cargo handling	
Unit-5 - Visual Aids, Heliport and STOL Ports, Vertiports	9 Hour
Requirements of pilot for visual aids - Airport Marking - Guidance to pilots during landing - elements of airport lighting- Heliport - Planning of heliport - Elevated heliport - Marking and lighting of heliport - STOL ports - Characteristics of STOL - Aircraft Planning of STOL Port - Runway and taxiway of STOL port - Lighting of STOL Port - Marking of STOL Port -Planning and design of Vertiports	

Learning Resources	1. Rangwala. Airport Engineering, Charotar Publishing House Pvt. Ltd.; 17th Edition (January 2018)	3. Norman J. Ashford, Saleh A. Mumayiz, Paul H. Wright. Airport Engineering: Planning, Design and Development of 21st - Century Airports", 4th ed., CBS Publishers & Distributors. April 2011
	2. FAA Advisory Circular - Airport Design 150/5300-13B - March 2022	4. Airport Engineering - planning and design- Saxena S.C.CBS Publishers & Distributors

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	50%	-	50%	-	50%	-
Level 2	Understand	50%	-	50%	-	50%	-
Level 3	Apply	-	-	-	-	-	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Wg.Cdr retd. Manoharan, Continuing Airworthiness Manager, Blue Dart Aviation.manoharank@bluedart.com	1. Dr. V.Arumugam, Madras Institute Of Technology Campus, Anna University, Chennai, arumugam.mitaero@gmail.com	1. Dr. S. Sivakumar, SRMIST
2. Wg.cdr R.Annamalai, Chief training co-ordinating officer IAF, Tambaram annamalai.ramasamy2@gmail.com	2. Dr.S.Nadaraja pillai, Sastra university Thanjavur, nadarajapillai@mech.sastra.edu	2. Mr. K. Iyenthezuthon, SRMIST

Course Code	21ASO307T	Course Name	MOLECULAR GAS DYNAMICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Aerospace Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Discuss need for molecular description of fluid flow, binary collision and the Boltzmann equation	Engineering Knowledge	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Explain the significance of elastic and inelastic collision																											
CLR-3:	Interpret the chemical reactions and thermal radiation with respect to engineering problem																											
CLR-4:	Describe importance of collisionless flow																											
CLR-5:	Explain the numerical technique for microscopic and mesoscopic method																											
Course Outcomes (CO):		At the end of this course, learners will be able to:												1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CO-1:	Define the importance of molecular perspective fluid flow, binary collision and need for Boltzmann equation.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-												
CO-2:	Explain the difference between inelastic and elastic collision and its significance	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-												
CO-3:	Examine the role of bimolecular reactions and termolecular reactions in chemical reaction	2	-	-	-	-	-	-	-	-	-	-	2	-	-	-												
CO-4:	Describe the significance of collisionless flow.	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-												
CO-5:	Demonstrate the need for mesoscopic and microscopic numerical technique for fluid flow	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-												

Unit-1 - Introduction to Kinetic Theory	9 Hour
Gaskinetic theory, Molecular model, the simple dilute gas, real gas effects, macroscopic properties in a simple gas. Equilibrium Kinetic theory: Distribution function, phase space distributions, macroscopic averages, the Maxwell-Boltzmann distribution	
Unit-2 - Binary Collision	9 Hour
The Boltzmann Equation: The evaluation of the phase space distribution function, the Boltzmann collision integral, The H-theorem, BGK approximation. Elastic collision dynamics, collision models, Maxwell model. Inelastic collision models: Larsen-Borgnakke model, The general Lasren-Borgnakke distribution, vibrational and electronic energy, gas-surface interaction.	
Unit-3 - Chemical Reaction and Thermal Radiation	9 Hour
Collision theory for bimolecular reactions, reaction cross-sections for given reaction rates. Extension to termolecular reactions, chemical equilibrium, The equilibrium collision theory. The dissociation reaction, recombination reaction, the exchange and ionization reactions. Classical model for rotation radiation, bound-bound thermal radiation	
Unit-4 - Collisionless Flows	9 Hour
Bimodal distributions, molecular effusion and transpiration, one-dimensional flows, Transfer of normal, tangential momentum, transfer of translational energy, free molecular heat transfer, recovery temperature, Stanton number and thermal recovery factor. Thermophoresis, flows with multiple reflection, test-particle Monte Carlo method, variance reduction	
Unit-5 - Computational Techniques for Mesoscopic and Microscopic Methods	9 Hour
Direct Simulation Monte Carlo, Lattice Boltzmann Method: Lattice gas automata (LGA), LGA to lattice Boltzmann equation, algorithm, boundary and initial conditions. Molecular Dynamics: the force calculation, integrating equations of motion, solutions methods.	

Learning Resources	<ol style="list-style-type: none"> Gombosi, Tamas I., and Atmo Gombosi. Gaskinetic theory. No. 9. Cambridge University Press, 1994. Bird, Graeme A., and J. M. Brady. Molecular gas dynamics and the direct simulation of gas flows. Vol. 5. Oxford: Clarendon press, 1994 Kruger, Ch H., and W. G. Vincenti. "Introduction to physical gas dynamics." John Wiley & Sons (1965). Frenkel, Daan, et al. "Understanding molecular simulation." Computers in Physics 11.4 (1997): 351-354. Anderson, John David. Modern compressible flow: with historical perspective. Vol. 12. New York: McGraw-Hill, 1990.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	60%	-	60%	-	60%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mrs. Smrutisudha Sahoo, DRDO s.sahoo.pxe@gov.in	1. Dr. Rakesh Kumar, Indian Institute of Technology Kanpur rkm@iitk.ac.in	1. Dr. Malaikannan G, SRMIST
2. Mr. Dhanabal K, S & I Engineering Solutions Pvt. Ltd. dhanabal@sandi.co.in	2. Dr. Arun Kumar P, Indian Institute of Technology Kanpur akp@iitk.ac.in	2. Dr. Aravindh Kumar S M, SRMIST

Course Code	21AIO351T	Course Name	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Analyze the various characteristics of Intelligent agents	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Organize different search strategies in AI															
CLR-3:	Incorporate knowledge in solving AI problems															
CLR-4:	Construct in different ways of designing software agents															
CLR-5:	Plan various applications of AI.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Use appropriate search algorithms for any AI problem	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Represent a problem using first order and predicate logic	3	3	3	-	2	3	-	-	-	-	-	-	-	-	-
CO-3:	Provide the apt agent strategy to solve a given problem	3	3	2	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Design software agents to solve a problem	3	1	3	-	2	3	-	-	-	-	-	-	-	-	-
CO-5:	Develop application that uses Artificial Intelligence.	3	1	3	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction	9 Hour
Introduction, Definition, Future of Artificial Intelligence, Characteristics, Typical Intelligent agents, Problem solving approach, Search strategies, Uniformed and informed, Heuristics, Local search, Algorithm and optimization problems, Constraint satisfactory problems, Constraint propagation, Back tracking search, Game playing, Optimal decision	
Unit-2 – Predicate Logic and Knowledge Representation	9 Hour
Alpha beta pruning, First order predicate logic, Porlog programming, Unification, Forward Chaining, backward chiming Resolution, Knowledge Representation, Events, Mental Events, Mental Objects, Reasoning Systems, Reasoning with default information, Typical AI Problems	
Unit-3 – Intelligent Agents	9 Hour
Architecture for intelligent agents, Agent communication, Negotiation, Bargaining, Argumentation, Agents, Trust, Reputation, Multi agent systems, AI applications, Language Models, Information Retrieval, Information extraction, Natural language processing, Machine translation, Speech recognition, Robot Hardware, Perception	
Unit-4 – Inference Engine	9 Hour
Planning, Moving, Frames, Scripts, Goals, Plans, Inheritance in Taxonomies, Description logics, Formal concept analysis, Conceptual graphs, Hierarchies in domain, Knowledge based reasoning, Agents, Facts of knowledge, Logic and inference, Formal logic, Propositional logic	
Unit-5 – Optimization Techniques	9 Hour
Resolution method, first order logic, second order logic, Genetic algorithms, Travelling salesman problem, Neural networks, Ant colony optimization, Generate and search, Depth first search – Breadth First Search, Quality of Solution, Depth bounded DFS, Hill climbing, Beam search	

Learning Resources	1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Third Edition, 2009.	5. William F. Clocksin and Christopher S. Mellish, Programming in Prolog: Using the ISO Standard, Fifth Edition, Springer, 2003.
	2. Bratko, —Prolog: Programming for Artificial Intelligence, Fourth edition, Addison- Wesley Educational Publishers Inc., 2011	6. Gerhard Weiss, —Multi Agent Systems, Second Edition, MIT Press, 2013.
	3. M. Tim Jones, —Artificial Intelligence: A Systems Approach (Computer Science) II, Jones and Bartlett Publishers, Inc.; First Edition, 2008	7. David L. Poole and Alan K. Mackworth, —Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press, 2010.
	4. Nils J. Nilsson, —The Quest for Artificial Intelligence, Cambridge University Press, 2009.	8. "A First Course in Artificial Intelligence", Deepak Khemani, McGraw Hill Education, 2013.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Marriappan Vaithilingam, Senior Director of Engineering, Fresh works	1. Dr. Udendran, Dept. of CSE., Bharathidasan University, Tiruchirappalli	1. Dr. A. Alice Nithya, SRMIST
		2. Mr. Joseph James, SRMIST

Course Code	21AIO352T	Course Name	MACHINE LEARNING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		
CLR-1:	Explore the fundamentals of machine learning along with its mathematical concepts			
CLR-2:	Provide deeper understanding of various tools and techniques for Machine learning Algorithms and outputs			
CLR-3:	Apply linear learning models to perform classification in machine learning			
CLR-4:	Understand the various Clustering Methods			
CLR-5:	Learn and Understand the Tree based machine Learning Algorithms			
Course Outcomes (CO):		At the end of this course, learners will be able to:		
CO-1:	Understand the concepts of machine learning			
CO-2:	Learn and understand tools and libraries of machine learning			
CO-3:	Implement machine learning models using supervised learning algorithms			
CO-4:	Implement machine learning models using unsupervised learning algorithms			
CO-5:	Implement the tree-based machine learning techniques and to appreciate their capability			

Program Outcomes (PO)												Program Specific outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3

Unit-1 - Machine Learning	9 Hour
Introduction - Types of Machine Learning, Supervised Learning, Unsupervised Learning, Reinforcement learning, The Curse of dimensionality, Over fitting and under fitting, Linear Regression, Bias and Variance tradeoff, Testing – cross validation, Regularization, Learning Curve, Classification - Error and noise, Parametric vs. non-parametric models	
Unit-2 – Regression Methods	9 Hour
Platform for machine learning, Machine learning python libraries, training data – testing data – validation data, k-fold cross validation Features, Performance metrics, MSE, accuracy, confusion matrix, precision, recall, F- score, Linear Regression with multiple variables, Logistic Regression	
Unit-3 – Classification	9 Hour
Ridge Regression, Maximum likelihood estimation (least squares), principal component analysis, Bayesian classifier, Support vector machine, Support vector machine and kernels, Multi class classification, K nearest neighbour classification, K nearest neighbour classification	
Unit-4 – Clustering	9 Hour
Measuring (dis)similarity, Evaluating output of clustering methods, Spectral clustering, Hierarchical clustering, Agglomerative clustering, Divisive clustering, Choosing the number of clusters - Clustering datapoints and features, Bi-clustering, Multi-view clustering, K-Means clustering, K-medoids clustering	
Unit-5 - Decision Trees	9 Hour
Decision tree representation, Basic decision tree learning algorithm, Inductive bias in decision tree, Decision tree construction, Issues in decision tree, Classification and regression trees (CART), Random Forest, Multivariate adaptive regression trees (MART).	

Learning Resources	1. Kevin P. Murphy, —Machine learning: A Probabilistic Perspective, MIT Press, 2012. 2. Ethem Alpaydin, —Introduction to Machine Learning, Prentice Hall of India, 2005 3. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997. 4. Sebastian Raschka, Vahid Mirjalili, Python Machine Learning and deep learning, 2nd edition, kindle book, 2018	5. Carol Quadros, Machine Learning with python, scikit-learn and Tensorflow, Packet Publishing, 2018. 6. Gavin Hackeling, Machine Learning with scikit-learn, Packet publishing, O'Reilly, 2018.
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Marriappan Vaithilingam, Senior Director of Engineering, Fresh works	1. Dr. Udendran, Dept. of CSE., Bharathidasan University, Tiruchirappalli	1. Mr. C. Arun, SRMIST
		2. Mr. Joseph James, SRMIST

Course Code	21AIO353T	Course Name	PYTHON FOR DATA ANALYTICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Introduce a range of topics and concepts related to data and data analysis process.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the basic data structures involved in python to perform exploratory data analysis															
CLR-3:	Apply EDA for different file formats.															
CLR-4:	Understands data visualization using python															
CLR-5:	Provides an exposure to basic machine learning techniques to solve real world problems															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand different types of data and starts working in python environment	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Understand various data structures involved in python and perform exploratory data analysis	3	3	2	-	-	2	-	-	-	-	-	-	-	-	-
CO-3:	Apply the concepts of EDA in various datasets.	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Formulate and use appropriate visualization techniques for their data	2	3	2	-	-	2	-	-	-	-	-	-	-	-	-
CO-5:	Formulate and use appropriate models of data analysis to solve hidden solutions to business-related challenges	-	-	-	3	2	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Python	9 Hour
Python Data Structures and Functions, Basic Python Programs, Introduction to Data Analysis, Understanding the nature of Data, Types of Data, Data – Information; Information - Knowledge, Types of Data, Application using Python Data structures and libraries, Quantitative Data Analysis, Qualitative Data Analysis, Scipy: Numpy, Pandas, Matplotlib, Applications using Python libraries	
Unit-2 - Numpy Library	9 Hour
Numpy Installation, Narray, Create an array and Types of data, Basic Operations: Arithmetic Operators, Matrix Product, Increment and Decrement Operators, Operations on Numpy array, Application using Numpy and its functions, Shape and array manipulation, Vectorization, structured arrays, Pandas library: Installation, Introduction to Pandas data structures, Application using Python Panda library, Function application and mapping, Sorting and ranking, Correlation and covariance, Hierarchical Indexing and leveling, Applications using Panda library functions	
Unit-3 - Pandas	9 Hour
Reading data from csv, xml, text and html files, Writing data in CSV, Html, Excel, files, Json data, Data preparation - Concatenating, Applications illustration of loading external data using Panda, Data transformation- Removing duplicates, Mapping Discretization and binning: Detecting and filtering outliers, Permutation – random sampling - String manipulation, Application using Panda library, Data Aggregation- Group by, Hierarchical grouping, Advanced data aggregation, Application illustrating data aggregation function using Panda	
Unit-4 - Data Visualization with Matplotlib Library	9 Hour
Matplotlib – Installation and architecture, Pyplot, plotting window, Using Kwargs and adding elements to the chart, Application using different plotting techniques, Line charts, Bar charts- Pie charts, Application using different plotting techniques, Histograms - Polar charts, Mplot 3D toolkit: 3D surfaces, Scatter plots and bar charts in 3D, Multi-panel plot, Application using different plotting techniques	

Unit-5 - Machine Learning with Sci-kit Learn	9 Hour
Sci-kit learn library, Machine Learning - Supervised learning with sci-kit learn, Application of Supervised learning, Linear Regression, Logistic Regression, Application using regression techniques, Support Vector Machines, Support Vector Classification, Support Vector Regression, Application using Support Vector machine	

Learning Resources	1. Fabio Nelli, Python Data Analytics with Pandas, Numpy and matplotlib (Second edition), Apress 2. Wes McKinney, Python for Data Analysis, 2nd Edition, O'Reilly Media, Inc. (https://learning.oreilly.com/library/view/python-for-data/9781491957653/) 3. Jake vanderplas, Python Data Science Handbook: Essential tools for Working with Data, O'Reilly Media, 2016 4. Charles R. Severance, "Python for Everybody Exploring Data Using Python", Charles Severance, 2016.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Senthilnathan, Co-founder, Tenzai, Bangalore	1. Dr. E. Sivasankar, Assistant Professor, Department of CSE, NIT, Trichy	1. Mr.C.Arun, SRMIST
		2. Mr. Joseph James, SRMIST

Course Code	21AIO354T	Course Name	SOFT COMPUTING	Course Category	0	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Computational Intelligence	Data Book / Codes / Standards			Nil

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	Understand the ideas of fuzzy sets, fuzzy logic and use of heuristics based on human experience												
CLR-2:	Gain knowledge on neural networks with examples												
CLR-3:	Gain knowledge on the mathematical background for carrying out the optimization associated with neural network learning												
CLR-4:	Gain knowledge on genetic algorithms and other random search procedures useful while seeking global optimum in self-learning situations												
CLR-5:	Introduce case studies utilizing the above and illustrate the intelligent behavior of programs based on soft computing												
Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	Analyze a given computational task to recognize the appropriateness through fuzzy sets												
CO-2:	Design a fuzzy based soft computing system to address the computational task												
CO-3:	Analyze a given computational task to solve it through neural network												
CO-4:	Apply Genetic Algorithm operations for solving a computational task												
CO-5:	Design and implement a soft computing system to achieve a computational solution												

Program Outcomes (PO)												Program Specific outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3

Unit-1 - Introduction to Soft Computing	9 Hour
Evolution from Conventional AI to Computational intelligence, Evolutionary Search Strategies Fuzzy Sets, Fuzzy Membership Functions, Operations, Relations, Fuzzy Extension Principle Basics of Fuzzy Logic, Problem solving using Fuzzy Rules, Fuzzy Reasoning, Mamdani's Representation.	
Unit-2 - Fuzzy Inference Systems	9 Hour
Fuzzification, Application of Fuzzy Operators on Antecedent part of Rules, Evaluation of Fuzzy Rules, Defuzzification, and Problems associated to Fuzzy controller, Cruise Controller and Air Conditioner Controller, Convergence of efficiency parameter, Boltzmann's Machine Learning Algorithm, Back Propagation Algorithm.	
Unit-3 - Neural Networks	9 Hour
Neural Networks in Computer Science, Biological model, McCulloch-Pitts Model, The Perceptron Model, Widrow-Hoff's Delta Rule, XOR Problem, Curse of Dimensionality, Dimensionality Reduction, Activation Functions, Learning by Neural Nets.	
Unit-4 - Advanced Search Strategies	9 Hour
Natural Evolution, Chromosomes, Systematic approach of Elitism (Selection- Crossover- Mutation), Development of Genetic Algorithm, Fitness Function, Population, GA operators, Parameters, Convergence, Pattern Classifiers, Layered Feed Forward Neural Networks, Solution for XOR Problem, Hebb's Rule, Competitive Learning Methods (Kohonen's Self Organizing Maps and Learning Vector Quantization), Pattern Associators (Hopfield nets), Back Propagation Networks, Generalized Delta Rule	

Unit-5 - Hybrid Systems	9 Hour
Neuro-Fuzzy Modelling, Control, Feedback control, Neuro fuzzy control, Neuro-fuzzy Reinforcement Learning, Gradient Free Optimization (GA operators), Gain Scheduling , Case study: Color Recipe Prediction,	

Learning Resources	<ol style="list-style-type: none"> 1. Sandhya Bansal & Rajiv Goel "Fundamentals of Soft Computing", 1st Edition, Notion Press Publication, 2020 2. Saroj koushik & Sunita Tiwari "Soft Computing, Fundamentals, Techniques and Applications" 1st Edition, McGraw Hill Publication, 2018 3. Samir Roy and Udit Chakraborty, "Introduction to Soft Computing: Neuro-Fuzzy and Genetic Algorithms" Pearson Education, 2013. 4. J.S.R. Jang, C.T.sun and E. Mizutani, "Neuro-fuzzy and Soft Computing: A computational Approach to Learning and Machine Intelligence, Pearson Education, 2004. 5. D.E.GoldBerg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Pearson Education, 2013. 6. S.N.Sivanandam, S.N.Deepa, "Priciples of Soft Computing", 2nd Edition, John-Wiley India, 2011. 7. G.J.Klir and B.Yuan, "Fuzzy Sets and Fuzzy Logic: Theory and Applications", Second Reprint, PHI, 2000. 8. J.A.Freeman and D.M.Skapura, "Neural Networks: Algorithms, Applications and Programming Techniques", Pearson Education, 2011
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Senthilnathan, Co-founder, Tenzai, Bangalore	1. Dr. E. Sivasankar, Assistant Professor, Department of CSE, NIT, Trichy	1. Dr. C.Lakshmi, SRMIST

Course Code	21EIO131J	Course Name	VIRTUAL INSTRUMENTATION	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand various building elements of virtual instrumentation.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Know the basics of creating VI programs.															
CLR-3:	Impart knowledge on usage of arrays and clusters.															
CLR-4:	Introduce various graphs and structures used in developing VI program.															
CLR-5:	Understand the concepts of data acquisition by interfacing modules.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Explain the procedure for creating virtual instrumentation program	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Select the appropriate condition loops for the given application	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Examine the usage of arrays and clusters.	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Compare the data from graphs and charts.	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Use different DAQ for data acquisition.	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - INTRODUCTION TO VIRTUAL INSTRUMENTATION	12 Hour
Introduction to graphical system design (GSD) model - Virtual instrument and traditional instrument - Hardware and software in virtual instrumentation - Design and virtual instrumentation advantages - Comparison of graphical programming with textual programming - Creating and saving a VI - Front panel toolbar, palettes, controls, and indicators - Block diagram, terminals, nodes, functions, wires, data types and data flow program. Practice: 1. Creating Virtual Instrumentation for simple applications 2. Programming exercises for loops and charts	
Unit-2 - MODULAR PROGRAMMING AND LOOPS	12 Hour
Creating an Icon - Building a connector pane - Displaying SUBVIs - Creating SUBVIs - Editing SUBVIs - Repetition and Loops - Shift Registers - Feedback nodes - Local and global variables. Practice: 1. Programming exercises for clusters and graphs 2. Programming exercises on case and sequence structures, file Input / Output.	
Unit-3 - ARRAYS AND CLUSTER	12 Hour
Creating one-dimensional array – Deleting - Inserting and replacing into arrays - Array functions - Auto indexing - Creating clusters control and constant - Cluster operations - Assembling and disassembling clusters - Conversion between arrays and clusters Practice:	

1. Data acquisition through Virtual Instrumentation.
2. Developing voltmeter using DAQ cards.
3. Developing signal generator using DAQ cards.
Unit-4 - PLOTTING DATA AND STRUCTURES
12 Hour
Types of graphs and charts - Customizing graphs and charts - Types of structures sequence, flat sequence, stacked sequence, event, timed, diagram disable - Basic of file I/O format
Practice:
1. Simulating reactor control using Virtual Instrumentation.
2. Real time temperature control using Virtual Instrumentation
3. Real time sequential control of any batch process.
Unit-5 - DATA ACQUISITION
12 Hour
Introduction to analog and digital signals - DAQ hardware - Analog and digital inputs and outputs - DAQ software architecture - DAQ assistant - Selecting and configuring a data acquisition device - Case study.
Practice:
1. Data Acquisition using DAQs.
2. Data Acquisition using NIELVIS
3. Mini project

Learning Resources	1. Jerome, Jovitha, "Virtual Instrumentation and LABVIEW", PHI Learning, New Delhi, 1st ed., 2010. 2. Sanjay Gupta and Joseph John, "Virtual Instrumentation using LabVIEW", Tata Mc Graw – Hill Publishing Company Limited, New Delhi, 1st ed., 2005. 3. Kevin James, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control", Newnes, 2000.	4. Gary Johnson, "LABVIEW Graphical Programming", McGraw Hill, 2nd ed., 1997. 5. Lisa K. Wells and Jeffrey Travis, "LABVIEW for Everyone", PHI, 1997. 6. S. Gupta, J.P. Gupta, "PC Interfacing for Data Acquisition and Process Control", ISA, 2nd ed., 1994.
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	20%	20%	-
Level 2	Understand	20%	-	-	20%	20%	-
Level 3	Apply	30%	-	-	30%	30%	-
Level 4	Analyze	30%	-	-	30%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Manoj Gupta, Mitsubishi Electric India, Manoj.Gupta@asia.meap.com	1. Dr.K.Srinivasan, NIT, Trichy, srinikn@nitt.edu	1. Dr. C. Likith Kumar, SRMIST
2. Mr. Gautham, Schneider Electric, gautham.r@se.com	2. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	

Course Code	21EIO132T	Course Name	ANALYTICAL INSTRUMENTATION	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the principle and theory of analytical instruments.	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Know the quantitative analysis of dissolved components.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Provide the concept of separation science and its applications.															
CLR-4:	Impart the knowledge on various spectroscopic techniques and its instrumentation															
CLR-5:	Identify the engineering problems associated with Radiation Techniques.															

Course Outcomes (CO):	At the end of this course, learners will be able to:	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CO-1:	Summarize the principles and theory of instrumental analysis	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Apply the principles of various chemical analysis instruments in industries	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Analyze and understand the operation of various radio chemical methods of analysis	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Illustrate the operation of instruments based on optical properties	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Outline the engineering problems associated with Radiation Techniques	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Chemical Instrumental Analysis	9 Hour
Introduction to chemical instrumental analysis - Sampling systems - pH measurement - Reference electrodes and secondary electrodes and types - Indicator electrodes - pH meters - Direct reading type pH meter - Null detector type pH meter - Ion selective in chemical industries - Types of conductivity meters - Air pollution monitoring instruments	
Unit-2 - Gas Analyser	9 Hour
Dissolved oxygen analyzer - Silica analyzer - Moisture measurement - Oxygen analyzer - Methods of oxygen analyzers - Paramagnetic oxygen analyzer - Electro analytical method – CO monitor, types of CO monitor - NO2 analyzer, H2S analyzer - Dust and smoke measurement - Thermal analyzer, importance of thermal analyzers	
Unit-3 - Chromatography	9 Hour
Chromatography, basic working of chromatography - Gas chromatography - Chromatographic column - Detection system, recording system - Liquid chromatography - High pressure liquid chromatography - Liquid chromatographic column working - Types of recording system - Detector types, factors influencing the selection of detectors	
Unit-4 - Spectrophotometer	9 Hour
Spectral methods of analysis - Electromagnetic spectrum – UV visible spectrophotometers - Beer's law - Derivations of beer's law - Single beam and double beam instruments - IR spectrophotometers - IR radiation sources – Monochromators - FTIR spectrometers - atomic absorption spectrophotometer	
Unit-5 - Magnetic Resonance Techniques	9 Hour
NMR spectrometers - Mass spectrometers - Double focusing spectrometers - Time of flight analyzers - Quadrupole mass analyzers - Nuclear radiation detectors - GM counter - Proportional counter - Solid state detectors- Scintillation counter	

Learning Resources	1. Khandpur. R.S, "Handbook of Analytical Instruments", Tata McGraw Hill publishing Co. Ltd., 2006 2. Bella. G, Liptak, "Process Measurement and analysis", CRC press LLC. 2003. 3. Francis Rousseau and Annick Rouesac, "Chemical analysis Modern Instrumentation Methods and Techniques", John wiley & sons Ltd.2007.	4. James W.Robinson, "Undergraduate Instrumental Analysis", Marcel Dekker, 2005 5. Dwayne Heard, "Analytical Techniques for atmospheric measurement", Blackwell Publishing, 2006.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Manoj Gupta, Mitsubishi Electric India, Manoj.Gupta@asia.meap.com	1. Dr.K.Srinivasan, NIT, Trichy, srinikkn@nitt.edu	1. Dr. Vibha.K, SRMIST
2. Mr. Gautham, Schneider Electric,gautham.r@se.com	2. Dr. J. Prakash, MIT, Chennai, prakait@rediffmail.com	

Course Code	21EIO133T	Course Name	INDUSTRIAL AUTOMATION SYSTEMS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Introduce the hardware components of programmable logic controller	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Provide knowledge on PLC programming using various function blocks															
CLR-3:	Understand distributed control system in process automation															
CLR-4:	Impart basic information on operator interface in distributed control system															
CLR-5:	Understand the hardware components and communication in SCADA															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Summarize the working of programmable logic controller	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Write basic ladder logic program for control application	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Outline the various local control unit architecture in distributed control system	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Analyze the various operator displays used in distributed control system	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Describe the various elements of SCADA system	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - PLC Hardware Components	9 Hour
Parts of a PLC - PLCs versus computers - PLC size and application - Fixed and modular I/O - Discrete I/O, analog I/O, special I/O modules - Electromagnetic control relays - Contactors - Motor starters - Manually operated switches - Mechanically operated switches - Sensors - Output control devices - Seal-In circuits - Electrical interlocking circuits	
Unit-2 - Plc Programming	9 Hour
PLC programming language - Wiring diagram - Ladder logic program -On-delay timer instruction - Off-delay timer instruction - Retentive timer - Cascading timer - Up-counter - Down-counter - Cascading counters - Combining counter and timer functions - Math operation - Data compare instructions.	
Unit-3 - Distributed Control System	9 Hour
Evolution of DCS - DCS architecture - Local control unit architecture - Comparison of different LCU architectures - LCU language requirements - LCU process interfacing issues - Security requirements - Security design approach - Redundant controller design.	
Unit-4 - Operator Interface	9 Hour
Operator Interfaces - Requirements - Low level operator interface - High level operator interface - Hardware elements in the operator interface - Operator displays - Engineering interface requirements - Low level engineering interface, high level engineering interfaces	
Unit-5 - Scada Elements	9 Hour
SCADA basics introduction - Elements of SCADA - Functionality of SCADA - Key features - Remote terminal unit - Analog and discrete control - Monitoring signals - Master terminal unit - RTU/MTU communication - System components - Communication protocols.	

Learning Resources	1. Frank D. Petruzella, "Programmable Logic Controller", Tata McGraw Hill 5th ed., 2017. 2. Bolton. W, "Programmable Logic Controllers", 6th ed., Elsevier Newnes, 2016. 3. Krishna Kant, "Computer-based Industrial Control", Prentice Hall, New Delhi, 2nd ed., 2011. 4. Lukcas M.P, "Distributed Control Systems", Van Nostrand Reinhold Co., New York, 1986	5. Stuart Boyer A, "SCADA : Supervisory control and data Acquisition", ISA-The Instrumentation, Systems, and Automation Society, 4th ed. 2016 6. NPTEL Video Lecture series on "Industrial Automation and Control "by Prof. S. Mukhapadhyay, IIT Kharagpur.
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Manoj Gupta, Mitsubishi Electric India, Manoj.Gupta@asia.meap.com	1. Dr.K.Srinivasan, NIT, Trichy, srinikn@nitt.edu	1. Dr. J. Sam Jeba Kumar, SRMIST
2. Mr. Gautham, Schneider Electric, gautham.r@se.com	2. Dr. J. Prakash, MIT, Chennai, prakait@rediffmail.com	

Course Code	21EIO134T	Course Name	INTRODUCTION TO SENSORS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Introduce different types of Sensing physical quantity and their basic principle and sensing characteristics	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Gain knowledge on the construction and principle of motion, proximity and ranging sensors															
CLR-3:	Impart the knowledge of basic principles of force, magnetic and heading sensors															
CLR-4:	Understand the concepts of optical, pressure and temperature sensors															
CLR-5:	Provide the different types of sensors employed in various applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Familiarize the transduction principles and label their characteristics of the measurement system	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Describe the principle of motion, proximity and ranging sensors	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Recall the performance of force, magnetic and heading sensors	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Outline the working principles optical, pressure and temperature sensors	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Select the type of sensors used in various real time applications	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Fundamentals and Sensor Characteristics	9 Hour
Introduction on Sensor - General concepts and terminology of measuring systems, transducer classification, general input-output configuration, static and dynamic characteristics of a measuring system, and statistical analysis of measurement data, classification of sensors	
Unit-2 - Motion, Proximity and Ranging Sensors	9 Hour
Motion Sensors – Potentiometers – Resolver - Encoders – Optical, magnetic, inductive, capacitive, LVDT – RVDT – Synchro – Microsyn, accelerometer – GPS - Bluetooth, range sensors – RF beacons - Ultrasonic ranging - Reflective beacons - Laser Range Sensor (LIDAR).	
Unit-3 - Force, Magnetic and Heading Sensors	9 Hour
Strain Gage - Load Cell - Magnetic Sensors - Types, principle, requirement and advantages - Magneto resistive – Hall effect – Current sensor heading sensors – Compass, gyroscope, inclinometers	
Unit-4 - Optical, Pressure and Temperature Sensors	9 Hour
Photo conductive cell, photo voltaic, photo resistive - LDR – Fiber optic sensors – Pressure – Diaphragm – Bellows - Piezoelectric – Tactile sensors, Temperature – IC, Thermistor - RTD – Thermocouple - Acoustic sensors – Flow and level measurement - Radiation sensors - Smart sensors - Film sensor - MEMS & Nano Sensors - LASER sensors	
Unit-5 - Miscellaneous	9 Hour
Moisture, humidity, wind chill indicator, radioactive count rate, smoke sensor, infrared, microwave, air purity, fire detector - Imaging sensors - Non-destructive monitoring - Pressure sensitive paint (PSP) measurements for aerodynamic applications	

Learning Resources	1. Patranabis D, "Sensors and Transducers" 2nd ed., PHI Publications, 2021	4. Murthy DVS, "Transducers & Instrumentation", 2nd ed., Prentice Hall of India, 2008
	2. Ian Slinchar, "Sensors and Transducers", 3rd ed., Newnes (an imprint of Butterworth-Heinemann Ltd), 2000	5. Ernest O. Doebelin, Dhanesh N. Manik, Doebelin's Measurement Systems: 7th ed., Tata McGraw Hill, 2019
	3. S. J. Prosser, E. Lewis, "Sensors and Their Applications XII", 1st ed., CRC Press, 2014.	6. NPTEL Lecture notes on "Sensors and Actuators" by Prof Hardick J Pandiya, IISc Bangalore

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Manoj Gupta, Mitsubishi Electric India, Manoj.Gupta@asia.meap.com	1. Dr.K.Srinivasan, NIT, Trichy, srinikn@nitt.edu	1. Dr.A.Vimala Juliet, SRMIST
2. Mr. Gautham, Schneider Electric, gautham.r@se.com	2. Dr. J. Prakash, MIT, Chennai, prakaiit@rediffmail.com	

Course Code	21EIO135T	Course Name	INTRODUCTION TO MEMS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Know the importance of microsystem technology and the operating principle of various micro sensors and actuators	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Impart knowledge of MEMS materials and their properties															
CLR-3:	Introduce different MEMS fabrications steps and procedures															
CLR-4:	Explore packaging process and solutions															
CLR-5:	Gain knowledge on the implementation of MEMS and microsystems in various industries.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Summarize the fundamental concepts in MEMS technology	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Familiarize the various MEMS material and their properties	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Understand the fabrication and machining tools needed for MEMS structure development	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Explain the various process involved in packaging	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply MEMS and microsystem concepts to real-time challenges	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Overview of Mems and Microsystems	9 Hour
Evolution of MEMS - Microsystems Vs MEMS – Microsystem and miniaturization – Scaling laws in MEMS – Engineering sciences for Microsystem Design and Fabrication - MEMS products - Working principle of MEMS and microsystems.	
Unit-2 - Materials for Mems	9 Hour
Substrate and Wafers- Active substrate Materials-Silicon as a substrate – Silicon Compounds : Silicon dioxide, Silicon carbide , Silicon nitride polycrystalline silicon, Silicon Piezo resistors, Gallium Arsenide, Piezoelectric crystals, Polymers	
Unit-3 - Process of Micro Machining	9 Hour
Introduction, basic tools, photolithography – Light sources, photoresist development, ion implantation, diffusion, oxidation - CVD – PVD - Sputtering – Deposition by epitaxy – Etching - Bulk micro manufacturing - Surface micromachining LIGA process.	
Unit-4 - Packaging in Mems	9 Hour
Key Design and packaging considerations - Die-attach process – Wiring and interconnects – Types of packaging solutions - Quality control, reliability, and failure analysis.	
Unit-5 - Applications of Mems and Microsystems	9 Hour
In automotive Industry - Aerospace industry - Biomedical Industry - Consumer products - Telecommunication industry - Pressure sensors – Acceleration sensor and gyroscopes – Gas Sensor - In photonics application - Projection display with the digital Micro mirror device - Fibre-optic communication devices - In life sciences –Microfluidics lap-on-chip components - Micro- needles, micro –electrode array - In RF- Applications Resonator, switches.	

Learning Resources	1. H. Tai-ran, "Designs, Manufacture and Nanoscale engineering" John Wiley Publications, 2008	3. V. Choudary, K Iniewski, "MEMS – Fundamental Technology and Application", ISBN 9781138072305, 2013
	2. Williams. K, Maluf.N "An Introduction to Microelectromechanical Systems Engineering", second edition Artech House Publishers; 2nd ed., 2004.	4. Stephen D. Senturia, "Microsystem Designs" Kulwer academic publisher , 2001

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Manoj Gupta, Mitsubishi Electric India, Manoj.Gupta@asia.meap.com	1. Dr.K.Srinivasan, NIT, Trichy, srinikn@nitt.edu	1. Dr.A.Vimala Juliet, SRMIST
2. Mr. Gautham, Schneider Electric, gautham.r@se.com	2. Dr. J. Prakash, MIT, Chennai, prakait@rediffmail.com	

Course Code	21EIO136J	Course Name	PLC FOR INDUSTRIAL AUTOMATION	Course Category	O	OPEN ELECTIVE										L	T	P	C				
																2	0	2	3				
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil																
Course Offering Department	Electronics and Instrumentation Engineering			Data Book / Codes / Standards			Nil																
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes					
CLR-1:	Introduce the need for process automation technologies.					1	2	3	4	5	6	7	8	9	10	11	12						
CLR-2:	Provide the fundamental knowledge for ladder logic programming					Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3			
CLR-3:	Identify applications of timers and counters in process automation																						
CLR-4:	Understand the various math and data manipulation instructions used in PLC																						
CLR-5:	Provide the knowledge of commissioning, maintenance and their importance in industries																						
Course Outcomes (CO):		At the end of this course, learners will be able to:																					
CO-1:	Summarize the need for process automation technologies					3	3	-	-	-	-	-	-	-	-	-	-	-	-	-			
CO-2:	Apply logical principle in ladder logic program for control applications					2	3	-	-	-	-	-	-	-	-	-	-	-	-	-			
CO-3:	Use timer and counter function blocks in PLC programming for process automation					3	3	-	-	-	-	-	-	-	-	-	-	-	-	-			
CO-4:	Use data manipulation instructions in PLC programming					3	3	-	-	-	-	-	-	-	-	-	-	-	-	-			
CO-5:	Summarize the troubleshooting techniques of PLC					3	3	-	-	-	-	-	-	-	-	-	-	-	-	-			
Unit-1 - Introduction to PLC																				12 Hour			
Evolution of PLCs - Architecture of PLC – PLC vs PC - PLC size and applications - PLC wiring - Discrete and analog I/O, Field I/O devices - Sinking and sourcing - Electrical interlocks																							
Practice:																							
1. Basics of PLC ladder logic programming																							
2. Implementation of code converters																							
Unit-2 - PLC Programming																				12 Hour			
PLC programming languages - Ladder logic, function block diagram, instruction list - Instruction addressing - Branch instructions – Relays – Contactors - Manually operated switches - Mechanically operated switches																							
– Proximity sensor, magnetic reed switch, light sensors, velocity and position sensors																							
Practice:																							
1. Implementation of MUX and DEMUX Automatic control of bottle filling system using PLC																							
2. Water level control system																							
Unit-3 - Timers and Counters																				12 Hour			
Timer instructions - On-delay, off-delay timer instruction - Retentive timers - Cascading timers - Counter instructions - Up and down counters - Cascading counters - Combining timers and counters - Simple exercises																							
Practice:																							
1. Traffic light control system																							
2. Sequential operation of stepper motor																							

Unit-4 - Data Manipulation and Math Instructions	12 Hour
Data manipulation - Data transfer operations - Data compare instructions - Data manipulation programs - Numerical data I/O interfaces - Math Instructions - Addition, subtraction, multiplication and division instructions - Other word-level math instructions Practice: 1. Bottle filling system 2. Material handling system	
Unit-5 - Troubleshooting of PLC	12 Hour
Electrical noise - Leaky inputs and outputs – Grounding - Voltage variations and surges - Program editing and commissioning - Preventive maintenance – Troubleshooting - Input and output malfunctions - Comparative study of industrial PLCs - Case studies Practice: 1. Program for lighting sequence (using timers and counters) 2. Design of smart room	

Learning Resources	1. Frank D. Petruzella, "Programmable Logic Controller", Tata McGraw Hill, 5th ed., 2017 2. M.P. Groover, "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education, 5th ed., 2009 3. Bolton. W, "Programmable Logic Controllers", Elsevier Newnes, 6th ed., 2016 4. NPTEL Video Lecture Notes on "Industrial Automation and Control" by Prof. S. Mukhopadhyay, IIT
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	20%	20%	-
Level 2	Understand	20%	-	-	20%	20%	-
Level 3	Apply	30%	-	-	30%	30%	-
Level 4	Analyze	30%	-	-	30%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Manoj Gupta, Mitsubishi Electric India, Manoj.Gupta@asia.meap.com	1. Dr.K.Srinivasan, NIT, Trichy, srinikn@nitt.edu	1. Dr. R. Bakiya Lakshmi, SRMIST
2. Mr. Gautham, Schneider Electric, gautham.r@se.com	2. Dr. J. Prakash, MIT, Chennai, prakait@rediffmail.com	

Course Code	21EIO138T	Course Name	LOGICAL FOUNDATION OF CYBER PHYSICAL SYSTEMS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electronics and Instrumentation Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12			
CLR-1:	Provide the basic concepts of cyber-physical system and modeling of a continuous system			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Understand the basic concepts of discrete modeling of a system																	
CLR-3:	Impart the adequate information about hybrid system and state machines																	
CLR-4:	Know the sensor networks in CPS																	
CLR-5:	Explore the knowledge about security issues in CPS																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Summarize the basic concepts of cyber physical systems and modeling in continuous domain			3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Illustrate the discrete model of continuous system			3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Analyze the hybrid system and its interactions			3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Select the sensor networks for CPS			3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Examine the CPS design for specific applications			3	-	3	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Continuous Dynamics Modeling	9 Hour
Structure of cyber-physical systems - Design process - Modeling design – Analysis - Newtonian mechanics - Actor models - Properties of systems, causal systems - Memoryless systems - Linear-time invariant – Stability - Feedback control - Proportional control systems - Tracking error - Transformation to equivalent model, physical dynamics, Modeling and simulation tools - Multiple models - Uncertainty quantification - Problems stabilization using proportional control – Problems - BIBO stability analysis	
Unit-2 - Discrete Dynamics Modeling	9 Hour
Discrete systems - Discrete signals - Event triggered - Modeling actors as function - Notion of state - Finite-state machines, transitions, reaction – Hysteresis - Time scale variance - Update functions - Software tools for FSM, determinacy - Receptiveness, extended state machines, moore and mealy machines - Traffic light controller - Non-determinism - Formal model - Uses of non-determinism, - Environmental modeling, specifications	
Unit-3 - Hybrid Systems and State Machines	9 Hour
Modal models combining discrete and continuous dynamics - Actor model for state machines - Actor representation of FSM - Continuous inputs- Thermostat example - State refinements, Notations of hybrid systems, - Classes of hybrid systems - Timed automata - Higher order dynamics - Timed automation variant of traffic light controller - Hybrid system model for mass system - Supervisory control - Automated guided vehicle, Composition of state machines, Concurrent composition - Side-by-side synchronous composition - Side-by-side asynchronous composition - Shared variables - Cascade composition, General composition - Hierarchical state machines	

Unit-4 - Sensor Networks in CPS		9 Hour
Traditional sensor networks vs WSNs - Sensors employed by CPS - Types of sensors - Smart sensors - Wireless sensor networks(WSNs) - Distributed WSNs - Sensor networks for Internet of Things (IoT) - Architecture of WSNs for CPS applications - Sensor network as Service-Oriented Architecture (SOA) - Semantic modeling of sensor network and sensor attributes, sensing resource management and task scheduling - Design of WSNs for CPS applications, sensing capacity of sensor networks - Optimum deployment of wireless sensor nodes for CPS applications - Routing techniques, WSNs for CPS applications, transforming WSNs to cyber-physical systems - emerging cyber-physical systems - Intelligent health care cyber system - Health care monitoring and tracking - Intelligent rescue cyber system - Position–navigation–timing monitoring and tracking - Intelligent transportation cyber system- Transportation - Monitoring and tracking		
Unit-5 - Security Issues in CPS		9 Hour
Workflow of CPS - Monitoring, networking - Computing, actuation - Case studies on CPS security breaches - Stuxnet, maroochy water breach - Slammer worm, automobile attacks -health care, manufacturing sector, smart grid - Security objective for CPS - Challenges in CPS security - Real-time requirements - Intrusion detection techniques - Requirement for security in CPS - Sensing security, storage security, communication security, actuation security - Feedback security - Prominent attacks on security for CPS - Denial-of-service attack - Man-in-the-middle attack - Defensive mechanism against attack in CPS		
Learning Resources	1. AncaMolnos, "Model Implementation Fidelity in Cyber-Physical System Design", Springer,2017	
	2. Gaddadevara Matt Siddesh et.al, "Cyber-Physical Systems – A Computational Perspective", CRC Press, 2016.	
	3. Rajeev Alur, "Principles of Cyber-Physical Systems", MIT Press,2015	
	4. E.A.Lee, S.A.Sashia, "Introduction to Embedded Sytems : A Cyber-Physical Systems Approach", 2011	
	5. NPTEL Video Lecture series on "Foundations of cyber-physical systems" by Prof. Soumyajit Dey, IIT Kharagpur	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. T.A.Balaji, Robert Bosch, Coimbatore, Balaji.TAnanthanpillai@in.bosch.com	1. Dr.K.Srinivasan, NIT, Trichy, srinikkn@nitt.edu	1. Dr.G.Y. Rajaa Vikhram, SRMIST
2. Mr. Vijayarajeswaran, MD, Vi micro Pvt.Ltd, vijay@vimicrosystems.com	2. Dr.S.Latha, TCE, Madurai, sleee@tce.edu	

Course Code	21AU0101T	Course Name	HYBRID AND ELECTRIC VEHICLES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Automobile Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Provide an insight into how electric vehicle operate	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Demonstrate the functional requirements of Battery management system in detail.															
CLR-3:	Demonstrate how Electric and Hybrid Vehicle vary as per design requirements															
CLR-4:	Perform the detailed analysis on the drives and driveline.															
CLR-5:	Selection of the appropriate drive and driveline system for the different cases															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Learn the basic concepts of electric vehicle technology and electric vehicles.	3	-	-	-	-	-	2	-	-	-	-	-	-	-	-
CO-2:	Develop and analyze hybrid and electric drive trains.	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Interpret various vehicle power sources in hybrid vehicle technology	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Analyze data to determine appropriate design calculation for hybrid system under study.	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply the concepts in sizing the electric motors	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Electric Vehicle Propulsion and Energy Sources	9 Hour
Basic concepts and problems concerning the electrification in Mobility- Functional components in an electric and hybrid vehicle- Vehicle Mechanics – Kinetics - Dynamics & Roadway Fundamentals- Propulsion System Design - Force Velocity Characteristics, Calculation Of Tractive Power And Energy Required- Electric Vehicle Power Source - Battery Capacity - Battery Construction and Types- State of Charge and Discharge- Calculation of Specific Energy and Specific Power & Ragone Plot Relationship- Battery Modeling - Run Time Battery Model, First Principle Model- Battery Management System- SOC Measurement, Battery Cell Balancing- Traction Batteries - Nickel Metal Hydride Battery, Li-Ion, Li-Polymer Battery.	
Unit-2 - Electric Vehicle Powerplant and Drives	9 Hour
Basic concepts of electric vehicle power plant- Power and Torque plot- Construction of Induction Machines, Operating cycle and application in traction- Construction of Permanent Magnet Machines - Construction of Switch Reluctance Machines- Role of Power Electronic Converters-DC/DC Converters- Description of Buck Boost Converter- Isolated DC/DC Converter- Functional Requirements and Operating limits- Two Quadrant Chopper – Switching Modes- AC Drives- PWM- Current Control Method - Role of Switch Reluctance Machine Drives- Voltage Control- Current Control.	
Unit-3 - Hybrid and Electric Drivetrains	9 Hour
Functional requirements of Hybrid Vehicle- Operational difference between the Fully Electric, Hybrid, and Mild Hybrid- Topological Phenomena and Social Importance of e-mobility Role of modern drivetrain and the conversion efficiency and power consumption- Description of Hybrid Traction- Description of Electric Traction.- Topological Optimization for Hybrid Traction- Topological Optimization for Electric Traction- Power Flow Control & Energy Efficiency Analysis- Configuration and Control of DC Motor Drives- Induction Motor Drive.- Permanent Magnet Motor Drives, Switch Reluctance Motor Drives, Drive System Efficiency	

Unit-4 - Electric and Hybrid Vehicle Design	9 Hour
Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refueling Systems, Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles. Steering and Suspension system. Choice of Tires.	
Unit-5 - Electric and Hybrid Vehicles –Case Studies	9 Hour
Parallel Hybrid, Series Hybrid -Charge Sustaining- Parallel Hybrid, Series Hybrid –Charge Depleting- Hybrid Vehicle Case Study –Toyota Prius, Honda Insight, Chevrolet Volt- 42 V System for Traction Applications- Lightly Hybridized Vehicles and Low Voltage System- Electric Vehicle Case Study - GM EV1, Nissan Leaf, Mitsubishi Miev- Hybrid Electric Heavy-Duty Vehicles, Fuel Cell Heavy Duty Vehicles	

Learning Resources	1. Iqbal Husain, "Eclectic and Hybrid vehicles Design Fundamentals," 2. CRC Press, second edition 2013, ISBN 9781439811757	3. James Larminie, John Lowry, "Electric vehicle technology Explained" Second Edition, Wiley 2012, ISBN-13: 978-1119942733
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.G.Giri, Managing Director, Atalon ,giri@atalon.co.in	1. Dr.S.Jeevananthan, Professor, Electrical and Electronics Engineering, PTU, drsj_eee@pec.edu.in	1. Mr S. Madhan Kumar, SRMIST
	2. Mr. Sam Jebakumar, SRM IST, jebakumj@srmist.edu	2. Dr. Carunaiselvane, SRMIST

Course Code	21AU0102T	Course Name	RENEWABLE SOURCES OF ENERGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Automobile Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Explain the concept of wind energy	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Create insight on solar energy and its application	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Evaluate the use of geothermal and hydro power for power generation															
CLR-4:	Analyze the biomass energy and ocean energy															
CLR-5:	Develop knowledge on various energy conversion devices															

Course Outcomes (CO):	At the end of this course, learners will be able to:	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CO-1:	Apply the knowledge of using wind energy for power production	3	3	-	-	-	-	2	-	-	-	-	-	-	-	-
CO-2:	Analyze the economy of using solar power	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Rationalize geo thermal and hydro power plants	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Perceive the concept of biomass and ocean energy for power production	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Demonstrate the working of various energy conversion devices	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Wind Energy	9 Hour
Introduction- Renewable energy sources- statistics and technologies- Wind Energy – Introduction - Application of wind energy- Transformation of wind energy - Wind Turbines - Operating characteristics- Wind power plant- Utilization of wind power- Trends in wind energy utilization	
Unit-2 - Solar Energy	9 Hour
Basic properties of solar energy- Application of solar energy- Transformation of solar energy - Solar heat collectors- Solar photovoltaic collectors- Application of solar collectors- Solar power plant- Economic study- Trends in solar energy utilization	
Unit-3 - Geothermal and Hydro power	9 Hour
Geothermal – Resources, Types of wells- Method of harnessing power and its potential in India- Hydropower – Properties and availability- Transformation of water energy- Hydro power plants- Applications of hydro power plants- Special hydropower plants- Economic study- Trends in hydro power utilization	
Unit-4 - Ocean energy and Biomass based energy	9 Hour
Ocean Energy – Principle, Utilization- Setting of power plants- Thermodynamic cycles- Tidal and wave energy- Biomass - Principle of biomass conversion- Anaerobic/aerobic digestion- Biogas digestors, gas yield and combustion characteristics- Utilization for cooking and economic aspects- Utilization in IC engine	
Unit-5 - Energy Conversions	9 Hour
Need for direct energy conversion (DEC), carnot cycle- Limitations and principle of DEC- Thermo electric generators- Seebeck, peltier and joule Thompson effect and application- Magneto hydrodynamic generator (MHD) – Working principle- MHD accelerator, MHD engine- Electron gasdynamic conversion- Fuel cell – basic principle- Hybrid vehicle – Basic principle.	

Learning Resources	1. Boyle, Godfrey. 2004. <i>Renewable Energy</i> (2nd edition). Oxford University Press.	3. <i>Systems and Sustainability: Power for a Sustainable Future</i> . Oxford University Press, 619 pages (ISBN: 0-19-926179-2)
	2. Boyle, Godfrey, Bob Everett, and Janet Ramage (eds.) 2004. <i>Energy</i>	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts

Course Code	21AUO103T	Course Name	SPECIAL TYPE OF VEHICLES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Automobile Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Define and Classify earth moving equipment	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Identify the special vehicles used in construction site															
CLR-3:	Identify the special type of vehicles, their applications															
CLR-4:	Define the principles and design considerations of farm equipment															
CLR-5:	Understand the concept of designing Combat Vehicles															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Acquire the knowledge of earth moving machines their construction and application	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Suggest Suitable equipment appropriate for material handling in Construction site.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Acquire the knowledge of construction and operation of special type vehicle.	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Classify Farm Machineries and recognize the concept of tractor design	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Demonstrate the concept of design for Military vehicles and its communication system	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Earth Moving Machines	9 Hour
Introduction of Earth moving equipment- capacity and applications of earthmovers- Basic considerations for equipment selection- Bulldozers- Constructional details and operations and applications - Types of Bulldozers- Cable and Hydraulic Dozers- Running and Steering Gears- Dump Traction-Introduction, types. Rigid Dump Trucks Constructional Details- Articulated Dump Trucks Constructional Details- Loaders: Single Bucket ConstructionalDetails, Applications- Multi Bucket Constructional Details, Applications- Skid steer loaders constructional details and applications- Trenchers- Introduction- Principles and operations- criteria for selection of prime mover from dumpers- criteria for selection of prime mover for front end loaders	
Unit-2 - Construction Equipment	9 Hour
Scrapers – Introduction-, Constructional Details, Applications and their types- Graders- Introduction- Motor graders Constructional Details, Applications-Classifications of Motor graders- Bush Cutters – Introductions- Bush Cutters- Constructional Details, Applications- Stumpers –Introduction- Constructional Details, Applications-. Dozer- Introduction, Constructional Details, Applications- Rippers -Constructional Details, Applications- DraglineExcavator –Introduction- - Constructional Details, Applications- Vibratory roller – introduction-, Constructional details and applications- Concrete mixer– Constructional details and application.	
Unit-3 - Special Purpose Vehicles	9 Hour
Introduction to special application machines- Power Shovel – Introduction and types, Constructional details and applications- Drag lines- Revolving shovels – constructional details and applications- Stripper Shovels - constructional details and applications- Capacity Of Shovels- Ditchers – Introduction, constructional details and applications- Articulated vehicles- constructional details and applications- Ambulance- fire extinguishing vehicle- Hover craft- oil tankers- Introduction to tankers- Special features and constructional details of tankers- gun carriers – Introduction- constructional details	

Unit-4 - Farm Equipments	9 Hour
Classification of farm equipment- Introduction to tractors- lay out of wheeled tractor- Classification of tractors- Wheeled Tractor - Constructional Details, Applications- Crawler Tractor - Constructional Details, Applications- Recent Trends In Tractor Design- Power transmission system In Caterpillar Tractor. – Mechanism- Steering system- Accessories of wheeled tractors- Hydraulic control system- Power take off unit.- Motor Grader: Recent Trends- Control Mechanism Of A Caterpillar Motor Grader- Ride and stability characteristics- Safety features in tractors- Human factors in tractor design- Procedure of testing and standard code for testing of tractor performances	
Unit-5 - Defence Vehicles	9 Hour
Selection and design for military vehicles - combat systems Design Vehicle Configuration detection, tracking, and identification systems- commercialmarine vehicles- passenger ship, cargo ships, oil and chemical tankers, Manned and Un Manned Submersible - Introduction of naval combat systemsCommunication Systems, Surveillance and Tracking Radar, Radar Designs. Free space optical communication, Fiber optics communication, Wireless/cellular communications...	

Learning Resources	<ol style="list-style-type: none"> Wong J, "Terramechanics and Off-Road Vehicle Engineering", Butterworth-Heinemann, 2009 "Off the Road Wheeled and Combined Traction Devices", -Ashgate Publishing Co. Ltd. 1998 Construction Equipment Management for Engineers, Estimators, and Owners, 1st Edition, CRC Press, 2006 Rodhiev and Rodhiev, "Tractors and Automobiles", MIR Publishers, Moscow, 1984 Abrosimov. K. Bran berg.A. and Katayer.K, "Road making Machinery", MIR Publishers, Moscow, 1971. RoviraMás, Francisco, Zhang, Qin, Hansen, Alan C, "Mechatronics and Intelligent Systems for Off-road Vehicles", Springer, 2011
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. R. Siva GM GMMCO – Caterpillar	1. Dr. Ganesh P, Professor SVCE vinaganesh@svce.ac.in	1. Mr.S. Yokeshwaran, , SRMIST
2. Mr. Ravindran R Senior Manager GMMCO	2. Mr. S. Sunil Assistant Professor Dept of Automobile MIT ssunil@mitinida.edu	2. Dr.K.Kamalakkannan , SRMIST

Course Code	21AU0104T	Course Name	FUEL CELLS AND APPLICATIONS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Automobile Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Impart knowledge on fuel cell technology and applications	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Know the concept of electrochemistry in fuel cells	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Distinguish different types of fuel cells and operations															
CLR-4:	Inferring different hydrogen production techniques															
CLR-5:	Identify the application of fuel cells in power generation															

Course Outcomes (CO):	At the end of this course, learners will be able to:	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CO-1:	Understand the basics of fuel cell technology	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Infer the concepts of fuel cell electrochemistry	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Classify the major types of fuel cells and their modes of operation	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Categorize the methods of production, storage and utilization of hydrogen as a fuel	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Gain knowledge on application of fuel cells in power cogeneration	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Fuel Cells and Fuel Cell Thermodynamics	9 Hour
Introduction and overview of fuel cell technology- A simple fuel cell, fuel cell advantages and disadvantages- Basic fuel cell operation- Layout of a Real Fuel Cell- The Hydrogen-Oxygen Fuel Cell with Liquid Electrolyte.- Difference between fuel cell and batteries, fuel choice- Overview of types of fuel cells (with emphasis on PEMFC and DMFC technology- Fuel cell thermodynamics: Thermodynamics review- Application of first and second law to fuel cells- Heat Potential of a fuel- Enthalpy of reaction,- Work potential of a fuel: Gibbs free energy- Predicting reversible voltage of a fuel cell under nonstandard-state conditions- Basic Parameters of Fuel Cells- Fuel cell efficiency.- Comparison with Carnot efficiency	
Unit-2 - Fuel Cell Electrochemistry	9 Hour
Introduction to electrode kinetics - Fuel cell reaction kinetics- Conversion of chemical energy to electricity in a fuel cell- Reaction rate of fuel cell- Butler -Volmer equation.- Fuel cell charge transfer- Mass transfer in fuel cells- Implications and use of fuel cell polarization curve- Activation polarization, ohmic Polarization- Concentration Polarization, polarization losses.	
Unit-3 - Types of Fuel Cells	9 Hour
Classification of fuel cells- Polymer electrolyte membrane fuel cell (PEMFC)- Electrodes and Electrode Structure in PEMFC- Water Management in the PEMFC-PEM Fuel Cell Cooling and Air Supply- Direct methanol fuel cells (DMFC)- Anode, cathode Reaction and Catalysts in DMFC- Methanol Production, Storage, and Safety- Alkaline fuel cell (PAFC)- Types of Alkaline Electrolyte Fuel Cell- Electrodes for Alkaline Electrolyte Fuel Cells- Molten Carbonate fuel cell (MCFC)- Solid Oxide fuel cell (SOFC) - Comparison of fuel cell, Performance behavior.	
Unit-4 - Hydrogen Production, Storage and Utilization	9 Hour
Hydrogen : Its merit as a fuel, Production methods: from fossil fuels, electrolysis, thermal decomposition- photochemical, photocatalytic- Hydrogen storage methods:- Onboard hydrogen storage- Chemical storage - physical storage of hydrogen- Storage in metal and alloy hydrides- Carbon nanotubes- Glass capillary arrays- pipeline storage- hydrogen utilization..	

Unit-5 - Application of Fuel Cells in Power Cogeneration **9 Hour**

Balance of fuel cell power plant, - Fuel cell power plant structure- Cogeneration- Fuel cell electric vehicles- Fuel cell in Motor cycles and bicycles, airplanes- Case study: fuel cell vehicles with electric vehicles- Case study: different fuel cell powered Indian vehicles- Fueling stations- Fuel processor and fuel cell stack- Water, Thermal managements- Safety issues and cost expectation.

Learning Resources	1. O'Hayre, R. P., S. Cha, W. Colella, F. B. Prinz, "Fuel Cell Fundamentals", Wiley, 3rd edition 2016	3. Bagotsky .V.S, "Fuel Cells", Wiley, 2009.
	2. Viswanathan. B, Aulice Scibioh, M, "Fuel Cells – Principles and Applications", Universities Press (India) Pvt., Ltd., 2009.	4. Detlef Stolten, "Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications", 2011.

Learning Assessment

Learning Assessment	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts

Course Code	21AU0105T	Course Name	TRANSPORT MANAGEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Automobile Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Acquire knowledge about Motor Vehicle Act and Laws Governing Transport system	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Familiarize with Transport system and Tax Structure.															
CLR-3:	Know the various methods of fare charging and fleet management															
CLR-4:	Acquire knowledge in Intelligent Transport System															
CLR-5:	Familiarize with insurance policies and vehicle maintenance.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe the Motor vehicle Act	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-
CO-2:	Demonstrate the Functions of Transport System and Tax Structure	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-
CO-3:	Analyze the cost of operation	-	-	-	-	-	-	3	-	-	-	3	-	-	-	-
CO-4:	Provide conceptual design for Intelligent Transport System	-	-	-	-	-	-	-	-	-	3	3	-	-	-	-
CO-5:	Recognize the importance of vehicle maintenance.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Motor Vehicle Act	9 Hour
Introduction – Motor Vehicle Act- Traffic rules and signals – fitness certificate- Registration of vehicle- Permit insurance- Constructional regulations of vehicles- Government administration structure – personal, Authorities. Responsibilities of Driver, public – offences- Accidents – causes and analysis – preventive measures- State and interstate permits- Test for competence to drive- Licensing of Drivers and conductors- Rules regarding construction of motor vehicles. - Laws Governing to use of Motor vehicle.	
Unit-2 - Transport systems and Taxation	9 Hour
Transport systems - Modes of transport systems. Road Network Architecture in India- Advantages of Motor Transport- Areas of improvement in Motor Transportation- Principal function of Administration- Functions of Traffic and Engineering divisions- Chain of responsibility- Forms of ownership by stateGovernment- Public body undertakings- Forms of ownership by municipality, private undertakings- Taxation – objectives- Motor Vehicle Tax Structure in India - Impact of GST on Automotive sector - Trends in revenue generated by Road Transport.	
Unit-3 - Passenger Transport operation	9 Hour
Introduction – Passenger Transport operation- Structure of passenger transport organization- Requirement on fleet management- Problems on fleet management-Fleet maintenance- Public relations – propaganda- Publicity and passenger amenities- Parcel traffic- Theory of Fares- Basic principle of fare charging- Method of drawing up of a fare table- Various types of fare collecting methods- Estimating the cost for transport vehicles- Different rates for different type of service- Principal features of operating cost- Operation cost – revenues- Economics – records.	
Unit-4 - Intelligent Transport System	9 Hour
Introduction – Computerized Vehicle routing and Scheduling System - Advance technique in Traffic management- Traffic demand Forecast - ITS Draft Policy - Conceptual Design of Intelligent Transport System - ITS for Traffic Control - ITS for Public Transport - ITS for Highways Traffic navigation- Global positioning system	

Unit-5 - Vehicle Maintenance and insurance	9 Hour
Introduction – vehicle Maintenance and insurance- Preventive maintenance system in Transport industry- Tyre maintenance procedure Causes for uneven tyre wear- Remedies for tyre wear Maintenance procedure for better fuel economy- Design of Bus depot layout- Insurance types – significance- Comprehensive Insurance- Third party insurance- Furnishing of particulars of vehicle involved in accident- MACT – hit and run case- Solatium fund- Duty of Driver in case of accident- Surveyor and loss assessor- Surveyor's report.	

Learning Resources	1. "Motor vehicle Act" – Govt of India publications. 2. Shrivastava s k, "Transport Development in India", S Chand &co Pvt Ltd., New Delhi 3. John Duke, "Fleet Management", Mc Graw Hill, USA - 1984	4. Government Motor vehicle Act – Eastern Book Company, Lucknow –1989 5. Kitchin. L. D –Bus operation – ILLiffie and sons Co., London, 3rd edition -1992 6. Ministry of Road Transport & Highways, Government of India (morth.nic.in)
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. G.Thanigai Arasu Deputy General Manager Technical Leader Transversal RNTBCI thanigai.arasu@rntbci.com	1. Dr.R.Elansezhan, Pondicherry Engineering College, elansezhianr@gmail.com 2. Mr. S. Sunil Assistant Professor Dept of Automobile MIT ssunil@mitnida.edu	1. Mr.S. Yokeshwaran, SRMIST 2. Dr.R.Rajendran, SRMIST

Course Code	21AU0106T	Course Name	COMPOSITE MATERIALS FOR AUTOMOTIVE APPLICATIONS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Automobile Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes			
CLR-1:	Study matrix material, reinforcements of polymer matrix composites, metal and ceramic matrix composites		1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Understand the fundamentals of composite material strength and its mechanical behavior																	
CLR-3:	Develop knowledge on processing, interfacial properties and application of composites																	
CLR-4:																		
CLR-5:																		
Course Outcomes (CO):		At the end of this course, learners will be able to:	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CO-1:	Understand the basics of reinforcements and matrix material		3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Use of mathematical techniques to predict the macroscopic properties of different laminates		3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Choose suitable material to design composites		3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Select suitable manufacturing process for different types of composites		3	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Compare/evaluate the relative merits of using various conventional and composite materials For important engineering and other applications.		3	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Composites	9 Hour
Fundamentals of composites- Need for composites- Classification, Advantages, Disadvantages, Properties and Particulate of composites-Fibre reinforced Composite- Elastic Behavior under Longitudinal Loading- Problems on Elastic Behavior under Longitudinal Loading- Elastic Behavior under Transverse Loading- Problems on Elastic Behavior under Transverse Loading- Longitudinal Tensile Strength- Transverse Tensile Strength- Discontinuous Fiber Reinforced Composites- Applications of composite	
Unit-2 - Polymer Matrix Composites	9 Hour
Reinforcement material-Fibres- Glass fibre, Carbon fibre-Processing- Aramid fibre and Boron fibre-Processing- Properties and Application- Particle reinforcement- Nano reinforcement- Polymer matrix material- Thermosetting resins, thermoplastic resins- Fillers-Additives- Pre-Processed Material- Molding compound- Prepegs-PMC processes- Hand layup, Spray up processes- Compression molding, Injection molding- Autoclave molding- Resin transfer molding- Pultrusion, Filament winding- Properties of PMCs- Automotive Application of PMCs.	
Unit-3 - Metal Matrix Composites	9 Hour
Metallic Matrix Matrix- Selection of reinforcement- Processing of MMC- Liquid state processes- Stir Casting, Squeeze Casting- Slurry Casting, Melt Infiltration- Spray deposition- Solid state processes- Powder Metallurgy technique- Hot Pressing- Diffusion Bonding- Gaseous state processes- Deposition techniques- Machining and joining of MMCs- Properties of MMCs- Parameters affecting properties of MMC- Interfacial Problems- Automotive Application of MMCs.	
Unit-4 - Ceramic Matrix Composites	9 Hour
Ceramic Matrix Material- Failure Behavior of CMCs- Toughening of CMCs- Processing of CMCs- Ceramic Particle Based Processes- Cold Compaction- Slurry Impregnation- Sol-gel Processing- Reaction Bonding Processes- In Situ Ceramic Composite Processing- Melt Processing- Polymer Infiltration and Pyrolysis- Properties of CMCs- Automotive Application of CMCs	

Unit-5 - Carbon /Carbon composites	9 Hour
Carbon /Carbon composites- Carbon Fiber Reinforcements- Matrix Systems-Thermosetting- Thermoplastic and Gaseous precursor- Processing of C/CComposites- Thermosetting Resin Based Processing- Thermoplastic Pitch Based Processing- Chemical Vapor Infiltration- Properties of C/C Composites- Oxidation Protection of C/C composites- Application of C/C Composites- Nanocomposites- Polymer Nanocomposites- Metal Nanocomposites- Ceramic Nanocomposites- Nanocomposites- Properties and Applications	

Learning Resources	<ol style="list-style-type: none"> 1. Krishnan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer, 2012. 2. Mallick, P.K. and Newman.S, Composite Materials Technology, Hanser Publishers, 2003. 3. M. Balasubramanian, "Composite Materials and Processing", CRCpress, Taylor and Francis Group, 2014. 4. Sanjay K Mazumdar, "Composites Manufacturing: Materials, Product and Process Engineering", CRC Press, New York, 2010. 5. ASM Handbook – Composites, Vol-21, 2001
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr S. Srinivasan, Ashok Leyland, srinchand@gmail.com	1. Dr.R.Elansezhian, Pondicherry Engineering College, elansezhianr@gmail.com	1. Dr.R.Rajendran, SRMIST,
2. Mr.A.Venugopal, WABCO, venugopal.a@wabco-auo.com	2. Dr.T.R.Tamilarasan, Crescent Institute of Science and Technology tamilarasanr@crescent.education	2. Dr.J.Chandradass, SRMIST,

Course Code	21AU0107T	Course Name	NON DESTRUCTIVE TESTING AND EVALUATION	Course Category	0	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Automobile Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12			
CLR-1:	Understand the basic principle, importance and applications of various NDT techniques	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Acquire proper skills and equip with proper competencies to locate flaws in various Materials and products.															
CLR-3:	Equip themselves familiar with industrial applications															
CLR-4:																
CLR-5:																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand various Non-Destructive Techniques to detect defects	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Apply scientific and technical knowledge to the field of non-destructive testing	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Use the relevant non-destructive testing methods for various engineering practice	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Recognize and achieve high levels of professionalism in their work	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Engage in lifelong learning, thought process and development	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Overview of NDT	9 Hour
Introduction to NDT- Comparison of Destructive and Non Destructive Methods- Overview of Non Destructive Testing Methods- Casting Defects- Welding Defects- Visual Testing-Principle and Tools- Optical Aid used for Visual Inspection--Microscope, Rigid Borescope Mini and Hybrid Borescope- Optical Aid used for Visual Inspection-Extendable borescope, Endoscope, Telescope and Holography- Merits and Demerits of Visual Testing	
Unit-2 - Surface NDE Methods	9 Hour
Liquid Penetrate Testing-Principle, Characteristics and types of penetrants- Developers-Function, Properties and types- Cleaning Methods and Emulsifiers-Liquid penetrant Testing procedure and Interpretation of results- Penetrant Removal Process, Advantage and Limitation of Liquid penetrate Test- Magnetic Particle Testing-Introduction, Method of Magnetization- Procedure for Magnetic Particle Testing- Residual Magnetism- Demagnetization-Method of Demagnetization	
Unit-3 - Thermography and Eddy Current Testing	9 Hour
Principle of Thermography- IR-radiation-Properties, Factors affecting Thermal measurements- Contact and non-contact temperature sensors- Non Contact Thermography System- Advantages, Disadvantages and applications of Thermography- Eddy Current Testing-Introduction and principle- Factors affecting eddy current- Instrumentation of eddy current testing- Types of probes- Advantages, Limitations and application of eddy current testing	
Unit-4 - Ultrasonic Testing (UT) and Acoustic Emission	9 Hour
Ultrasonic Testing-Introduction, Basic Properties of sound beam, Acoustic Impedance- Ultrasonic Transducers- Inspection Methods-Transmission and pulse-echo method- Inspection Methods- Angle beam pulse echo method- Ultrasonic Flaw Detection Equipment, Mode of Display-A-Scan, B-scan, C-scan- Advantages, limitations and application of Ultrasonic testing method- Acoustic Emission Testing-Principle and Technique- Instrumentation of Acoustic Emission Testing- Applications.	

Unit-5 - Radiography	9 Hour
Radiography- Principle- Electromagnetic radiation sources- Radiation Attenuation and Effect of radiation on film- Radiographic Imaging- Inspection Techniques- Single wall and double wall penetration techniques- Inspection Techniques-Multiwall penetration technique- Advantages, disadvantages and applications of radiography- Real time Radiography-Microfocal Radiography- Advantages and limitations of Microfocal Radiography- Xero Radiography.	

Learning Resources	<ol style="list-style-type: none"> 1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non- Destructive Testing", Narosa Publishing, 3rd Edition, 2014 2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010 3. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Park, Ohio, USA, 200, Volume- 1, 2018.. 4. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005 5. Charles, J. Hellier, "Handbook of Nondestructive evaluation", McGraw Hill, New York, 2nd Edition, 2013.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.C.Subash, Mahindra and Mahindra, SUBASH.C@mahindra.com	1. Dr.P.Jawahar, Assistant Professor, NIT Agartala, drjawahar.me@nita.ac.in	1. Dr.J.Chandradass, SRMIST
2. Mr. R. Silambarasan, RNTBCI, silambarasan.ramadoss@rntbci.com	2. Dr. D. Muruganandham, SVC of Tech, svctvp@gmail.com	2. Dr.P.BaskaraSethupathi, SRMIST,

Course Code	21AUO108T	Course Name	ADVANCED ENGINE TECHNOLOGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Automobile Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Explore the sustainable development, energy conservation, efficiency and environmental Preservation.	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Provide a comprehensive reference to understand the current trends in Advanced engines	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:																
CLR-4:																
CLR-5:																

Course Outcomes (CO):	At the end of this course, learners will be able to:	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CO-1:	Acquire knowledge about the Thermodynamic Analysis of SI Engine Combustion process.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Acquire knowledge about the Thermodynamic Analysis of CI Engine Combustion process.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Understand the Various Fuel injection system for SI & CI engine	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Gain knowledge about the engine modification required for alternative fuels.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Acquire knowledge about recent trends in IC engines.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Spark Ignition Engines	9 Hour
Introduction to Spark ignition engines- Air-Fuel Ratio Requirements- Design of Carburetor- Carburetor –Fuel Jet Size and Venture Size- Stages of Combustion- Normal and Abnormal Combustion- Factors Affecting Knock- Combustion Chambers- Introduction To Thermodynamic Analysis of SI Engine- Thermodynamic Analysis Of SI Engine- Thermodynamic Analysis Of SI Engine Combustion Process- Recent Developments In SI Engines.	
Unit-2 - Compression Ignition Engines	9 Hour
Introduction to Compression Ignition Engines- Stages of Combustion in CI Engine- Normal and Abnormal Combustion – Factors Affecting Knock-Direct and Indirect Injection Systems- Combustion Chambers- Turbo Charging- Introduction To Thermodynamic Analysis Of CI Engine- Thermodynamic Analysis Of CI Engine- Combustion Process in CI Engines- Recent Developments In CI Engines	
Unit-3 - Fuel systems	9 Hour
Introduction to Fuel Injection System- Fuel Injection System Functions And Components- Petrol Injection - Open Loop Systems- Mono Point And Multi Point Injection System- Direct Injection Systems- Fuel Injection In-Line, Rotary Pumps- Testing-Governing- Injection Lag- Fuel Injector - Types Of Injection Nozzle-Fuel Spray Characteristics- Fuel Injection Timing- Factors Influencing Fuel Spray Atomization, Penetration And Dispersion Of Diesel- Electronic Engine Management system- Common Rail Direct Injection Diesel Engine	
Unit-4 - Alternate Fuels	9 Hour
Introduction to Engine Modifications For Alternative Fuels, Alternative fuels Properties, Suitability- Alcohols as a Fuel for IC engines- Vegetable Oils And Bio- Diesel- Bio-Gas- Natural Gas- Liquefied Petroleum Gas- Hydrogen as a fuel in IC engines- Engine Modifications- Performance, emission and combustion characteristics of SI engines, Performance, emission and combustion characteristics of CI engines- Alternative fuels used in CI engines.	

Unit-5 - Recent Trends **9 Hour**

Recent Trends- Homogeneous Charge Compression Ignition Engine- Lean Burn Engine- Stratified Charge Engine- Surface Ignition Engine- Four Valve and Overhead Cam Engines- Alternative Power Sources: Wankel Rotary Engine- Sterling Engine, Gas Turbine Engine.

Learning Resources	1. Heinz Heisler, "Advanced Engine Technology", SAE International Publications, USA, 1998	4. Patterson D.J. and Henein N.A, "Emissions from combustion engines and their control", Ann Arbor Science publishers Inc, USA,
	2. Ganesan V. "Internal Combustion Engines", Third Edition, Tata McGraw-Hill, 2007	5. Gupta H.N, "Fundamentals of Internal Combustion Engines", Prentice Hall of India, 2006
	3. John B Heywood. "Internal Combustion Engine Fundamentals", Tata McGraw-Hill 1988	6. Ulrich Adler, "Automotive Electric / Electronic Systems", Published by Robert Bosch GmbH, 1995

Learning Assessment

Learning Assessment	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. Saravanan, Mahindra Research Valley, n.saravanan@mahindra.com	1. Dr.S. Premnath, Sri Venkateswara College of Engineering, prem@svce.ac.in	1. Dr. C. Prabhu SRMIST
2. Mr.P.MohamedAzarudeen, Renault Nissan Technology and Business Centre, mohamedazarudeen.pakkirmohideen@rntbci.com	2. Dr.S.RamKumar, Vel Tech Rangarajan Dr.Sagunthala R&D Institute of Science and Technology, drsramkumar@veltech.edu.in	2. Dr. T.Prakash, SRM IST

Course Code	21AU0109T	Course Name	NEW PRODUCT DEVELOPMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Automobile Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12			
CLR-1:	understand the new product process	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	learn and apply the concepts and tools necessary through case examples and assignments															
CLR-3:	actually use the new product development process by conceiving your own new product or service and introductory launch plan															
CLR-4:																
CLR-5:																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Familiarize with the Concept of Design thinking	3	-	3	3	-	-	-	-	-	-	3	-	3	-	-
CO-2:	Understand the importance of new product development to firm performance	3	-	-	-	-	-	-	-	-	-	3	-	3	-	-
CO-3:	Learn methods of generating, evaluating and testing product ideas	3	-	-	3	-	-	-	-	-	-	3	-	3	-	-
CO-4:	Identify relevant, components, and, plan, a product launch	3	-	-	-	-	-	-	-	-	-	3	-	3	-	-
CO-5:	Learn methods of evaluating and monitoring the success of a launch	3	-	-	-	-	-	-	-	-	-	3	-	3	-	-

Unit-1 - Design Thinking	9 Hour
Concept of Design thinking - Role within NPD and Innovation- Principles and the "Mindset" of Design Thinking- Design Thinking Tools-Nine Criteria of an Inspirational Design- Personas: Powerful Tool for Designers	
Unit-2 - New Product Resources	9 Hour
Technological Research Basic concepts and need for Intellectual Property Patents Patent Search Patent Laws International Code For Patents Intellectual Property Rights(IPR Copyrights Geographical Indications Need for developing products – the importance of engineering design – types of design –the design process – relevance of product lifecycle issues in design –designing to codes and standards- Identifying customer needs –voice of customer –customer populations- hierarchy of human needs-need gathering methods – affinity diagrams - Collection Of Ideas Purpose Of Project - Selection Criteria Screening Ideas For New Products - Creative design Model Preparation Testing Cost evaluation Patent application	
Unit-3 - New Product Planning and Development	9 Hour
Design Of Prototype Testing of prototype Quality Standards Marketing Research Introducing New Products Integrate process design Managing costs Robust design Integrating CAE, CAD, CAM tools Journeys In Product Development Product Development Process Tools Scoping Product Developments Technical And Business Concerns Understanding Customer Needs Establishing Product Function involve customer in development and managing requirements process management and improvement Plan and establish product specifications	
Unit-4 - Assessing the Market Demand for the Product	9 Hour
Why Assess the Market Demand? Methods for Assessing the Initial Demand- Expert Evaluation Technique- Jury of Executive Opinion- Delphi Method- Sales Force Composite-Supply Chain Partner Forecasting- Decision Tree Diagram- Market Potential-Sales Requirement Method- Graphical Displays of Data- Constant Mean Model- Linear Model-Quadratic Model -Exponential Model	

Unit-5 - Product Architecture	9 Hour
Establishing the Product architecture creation clustering geometric layout development fundamental and incidental interactions related system level design issues secondary systems architecture of the chunks creating detailed interface specifications	

Learning Resources	1. Paul trott "Innovation Management and New Product Development" 5th Edition Sep 2011 2. Barclay, Z. Dann, P. Holroyd, "New Product development" I, Published by BH Butterworth-Heinemann a division of Reed Educational and professional publishing limited.2000 3. Marc Annacchino "New Product Development " 1st Edition Sep 2003
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. P. Poongukamaran, MD TICEL	1. Mr. S. Sunil Assistant Professor Dept of Automobile MIT ssunil@mitinida.edu	1. Mr. S. MadhanKumar. SRMIST
2. Mr. G.Thanigai Arasu Deputy General Manager Technical Leader Transversal RNTBCI thanigai.arasu@rntbci.com	2. Mr. Muthuvel Assistant Professor Sairam Engineering College muthuvel.rd@sairam.edu.in	2. Mr. S. Yokeshwaran, SRMIST

Course Code	21AU0110T	Course Name	AUTOMOTIVE STANDARDS AND REGULATIONS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Automobile Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Impart knowledge on basics of automobile standards and regulations	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Know the various safety standards on collision.															
CLR-3:	Gain knowledge about various safety standards in automotive electrical systems.															
CLR-4:	Understand the regulations used in hybrid and electric vehicles.															
CLR-5:	Impart knowledge on regulations used in gaseous fuel vehicles.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Gain knowledge about basic automobile standards and regulations	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Gain knowledge about standards for safety during collision	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Understand the various standards used for automotive electrical systems	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Gain knowledge about the regulations used for hybrid and electric vehicles	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Gain knowledge about the regulations used for gaseous fuel vehicles	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - General Automotive Standards and Regulations	9 Hour
Procedure for Type Approval and Certification of Vehicles for Compliance to Central Motor Vehicles Rules- Speed Limitation Devices and Its Specifications- Arrangement of Foot Controls of Vehicles- Starting Grade-Ability - Method of Measurement and Requirements- Protective Helmets for Motor Cycle Riders- Protective Helmets and Visors for Motorcycle Riders – Specification- Two Wheeled Vehicles – Location, Identification and Operation of Controls, Tell-Tales and Indicators- Procedure for Type Approval and Establishing Conformity of Production for Safety Critical Components- NCAP And BNVSAP Ratings, Requirements for School Buses	
Unit-2 - Collision Safety Standards	9 Hour
Bumper Fitment on Vehicles – Test Methods- Safety Belt Assemblies, Safety Belt Anchorages –Specifications- Seats, their Anchorages and Head Restraints Specifications, Survival Space for the Protection of the Occupants- Requirements for Behaviour of Steering Mechanism of a Vehicle in a Head-On Collision- Procedure for Determining the "H" Point and The Torso Angle in Seating Positions of Motor Vehicles. Requirements for the Protection of the Occupants in the Event of an Offset Frontal Collision	
Unit-3 - Automotive electrical Standards	9 Hour
Testing Procedure and Requirements for Headlamp Beam- Approval of Front Position Lamps, Rear Position Lamps, Stop Lamps, Direction Indicators, Rear Registration Plate Illuminating Devices and Reversing Lamp- Provisions Concerning the Approval of Headlamps Equipped with Gas Discharge Light Sources-Provisions Concerning the Approval of Light Emitting Diode(LED) Light Sources For use in Approved Lamp Units- Lighting, Signalling & Indicating Systems on Motor Vehicles- Performance Requirements of Lighting and Light-Signalling Devices	

Unit-4 - Electric and Hybrid Vehicle Standards	9 Hour
Battery Operated Vehicles – Requirements for Construction and Functional Safety- Measurement of Electrical Energy Consumption.- Method of Measuring the Range Measurement of Net Power and the Maximum 30 Minute Power and Speed- Electric Power Train - Requirements for Construction and Functional Safety-Measurement of Electrical Energy Consumption- Method of Measuring the Range- Measurement of Net Power and The Maximum 30 Minute Power and Speed- CMVR Type Approval for Hybrid Electric Vehicles, CMVR Type Approval of Vehicles Retrofitted with Hybrid Electric System.	
Unit-5 - CNG, LPG Vehicles and Engine Emission Standards	Hour
Safety and Procedural Requirements for Type Approval of CNG Operated Vehicles- Safety and Procedural Requirements for Type Approval of CNG Operated Vehicles- Safety and Procedural Requirements for Type Approval of LPG Operated Vehicles- Code of Practice for use of LPG Fuel in Internal Combustion Engine to Power 4 Wheeled Vehicles- Code of Practice for use Of LPG Fuel in Internal Combustion Engine to Power 2 & 3 Wheeled Vehicles. Bharath and Euro Emission Norms.	

Learning Resources	1. ARAI publications “Automotive industry standards”, April 30,2016.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.K.V. Simmom, Royal Enfield, kvsimmon1@royalenfield.com	1. Dr..A.Samuel Raja, Thiyagarajar college of EngineeringMadurai, samuel1973@tce.edu	1. Dr. T. Praveenkumar, SRMIST
2. Mr.R.Srikanth, Altair, srikanth.r@altair.com	2. Mr. N.Ravikumar, Crescent Institute of Science and Technology, ravikumar@crescent.education	2. Dr. K. Kamalakkannan, SRMIST

Course Code	21AU0111T	Course Name	AUTOMOTIVE SCIENCES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Automobile Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes				
CLR-1:	Understand the ability and information to follow recent developments about the internal combustion engine technology															1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Describe methods for reduction of exhaust emissions, and their relations to fuel quality and engine performance															Engineering Knowledge	Analysis	Development of	Investigations of problems	Tool Usage	Team and society	Environment & sustainability	Communication	Team Work	Professionalism	Management & Finance	Life-Long Learning			
CLR-3:	Demonstrate competency in skills related to automotive technology.																													
CLR-4:																														
CLR-5:																														

Course Outcomes (CO):		At the end of this course, learners will be able to:														
		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:		Understand the Insights in Internal Combustion Engine	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:		Summarize the Knowledge in Engine Cycles	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:		Compare the technology in emissions	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:		Demonstrate the Relationship in Velocity, Acceleration and Speed	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:		Explain the technology of Vehicle Characteristics	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Internal combustion engines	9 Hour
Internal combustion engines- Engine power and Brake power- Engine power and Brake power- Mean effective pressure- Horsepower PS – the DIN- Indicated power Mean effective pressure- Cylinder pressure vs. crank angle- Mechanical efficiency of an engine- Morse test- Characteristic curves of engine performance- Volumetric efficiency- Torque vs. engine speed- Specific fuel consumption vs. engine speed- Brake power, torque and SFC compared- Thermal efficiency- Indicated thermal efficiency- Brake thermal efficiency petrol vs. diesel- Heat energy balance	
Unit-2 - Theoretical engine cycles	9 Hour
Theoretical engine cycles- The constant volume cycle (Otto cycle)- Thermal efficiency of the theoretical Otto cycle- Thermal efficiency in terms of compression ratio r- Effect of compression ratio on thermal efficiency- Relative efficiency- Diesel or constant pressure cycle- The dual combustion cycle- Operation of dual combustion cycle- Comparison between theoretical and practical engine cycles- The Stirling engine regenerator- A double-acting Stirling engine- The gas turbine- Summary of formulae- Simple Problems	
Unit-3 - Fuels and combustion & emissions	9 Hour
Fuels and combustion & emissions- Products of combustion- Relevant combustion equations- Air-fuel ratio Petrol engine combustion- Detonation, Pre-ignition- Octane rating- Compression ignition engine combustion chambers- Diesel fuel-Flash point- Pour point-Cloud point- Exhaust emissions-Factors affecting exhaust emissions- Emissions and their causes- Methods of controlling exhaust emissions- Exhaust gas recirculation- Catalysts- Diesel particulate filters- Liquefied petroleum gas (LPG)- Zero emissions vehicles (ZEVs).	
Unit-4 - Velocity and acceleration, speed	9 Hour
Speed and velocity Acceleration- Velocity-time graph Uniform velocity- Uniform acceleration- Equations of motion and their application to vehicle technology- Force, mass and acceleration- Relation between mass and weight- Inertia- Motion under gravity- Angular (circular) motion- Equations of angular motion- Relation between angular and linear velocity- Centripetal acceleration- Accelerating torque- Model problem I and II.	

Unit-5 - Vehicle Characteristics	9 Hour
Load transfer under acceleration- Static reactions- Vehicle under acceleration- Vehicle acceleration – effect of load transfer- Front wheel drive- Maximum acceleration – rear wheel drive- Four wheel drive – fixed- Four wheel drive – with third differential- Accelerating force – tractive effort- Tractive resistance- Power required to propel vehicle- Gradeability- Vehicle power on a gradient- Vehicle on a curved track- Overturning speed- Skidding speed	

Learning Resources	1. Allan Bonnick "Automotive Science and Mathematics" Published by Elsevier Ltd First edition 2008 2. Willard W. Pulkrabek "Engineering Fundamentals of the Internal Combustion Engine" Pearson; 2 edition (10 June 2003) 3. N. K. Giri "Automobile Technology" Khanna Publishers; 2nd edition (2002)
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Amarnath, Rampal india, amar@rambalindia.net	1. Dr.Arulselvan, MIT Chennai, arul@annauniv.edu.	1. Dr.K.Kamalakkanan, SRMIST,

Course Code	21AU0112T	Course Name	INTELLIGENT VEHICLE TECHNOLOGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Automobile Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Acquire knowledge of about Intelligent vision system	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Know the architecture of Intelligent transportation system	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Impart the techniques of adaptive control															
CLR-4:	Know the architecture for autonomous vehicles															
CLR-5:	Study the autonomous vehicle cases															

Course Outcomes (CO):	At the end of this course, learners will be able to:	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CO-1:	Understand the intelligent vision system used in automobiles	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Understand the architecture of intelligent transportation system	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Understand adaptive control techniques of an autonomous vehicle	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Understand about the successful autonomous vehicle projects	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Know the case studies of Autonomous vehicle	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Intelligent Vision System	9 Hour
Vision Based Driver Assistance System –Vehicle optical Sensor- Vision Based Driver Assistance System –Laser Radar- Non Contact ground velocity detecting Sensor- Road Surface Recognition Sensor- Vehicle Sensors for Electronic Toll Collection System- Vehicle Sensors for Electronic Toll Collection System- Components of a Vision Sensor System- Driver Assistance on Highways –Lane Recognition- Driver Assistance on Highways –Lane Recognition- Driver Assistance on Highways –Traffic Sign Recognition- Driver Assistance on Highways –Traffic Sign Recognition-Driver Assistance in Urban Traffic-Stereo Vision- Driver Assistance in Urban Traffic- Shape base analysis- Driver Assistance in Urban Traffic- Pedestrian Recognition	
Unit-2 - Vehicle Information System and Intelligent Transportation	9 Hour
Intelligent Transportation System (ITS) – Vision for ITS Communications- Multimedia communication in a car- Current ITS Communication Systems and Services- Vehicle to Vehicle Communication Systems- Road to Vehicle Communication- Systems- Inter Vehicle Communication- Intra Vehicle Communication- VANETS-Devices- Optical Technologies- Millimeter Wave technologies	
Unit-3 - Adaptive Control Techniques for Intelligent Vehicle	9 Hour
Automatic Control Of Highway Traffic And Moving Vehicles- Adaptive Control Overview- Gain Scheduling- Model Reference Adaptive Control- Self-Tuning Adaptive Control System Model- System Identification Basics- Recursive Parameter Estimation- Estimator Initialization- Design Of Self-Tuning Controllers- Generalized Minimum Variance (GMV) Control- Pole Placement Control- Model Predictive Control Overview and example.	
Unit-4 - Decisional Architectures for Autonomous Vehicles	9 Hour
Control Architectures- Motion Autonomy- Deliberative Architectures - Reactive Architectures- Hybrid Architecture Overview- Overview of Sharp Architecture- Models Of Vehicles- Concepts Of Sensor Based Maneuver- Reactive Trajectory Following Parallel Parking- Platooning- Main Approaches To Trajectory Planning - Non-Holonomic Path Planning	

Unit-5 - Autonomous Vehicle and Case Studies		9 Hour
DARPA Challenge Case Study- ARGO Prototype Vehicle- The Gold System- The inverse Perspective Mapping- Lane Detection- Obstacle Detection-Vehicle Detection- Pedestrian Detection- Software systems architecture- Computational Performances- ARGO Prototype vehicle Hardware- Functionalities- ARGO Prototype vehicle- Data acquisition System- Processing System- Control System Overview		
Learning Resources	1. LjuboVlacic, Michel Parent and Fumio Harashima, "Intelligent Vehicle Technologies", Butterworth- Heinemann publications, Oxford, 2001-ISBN 0 7506 5093 1 2. Ronald K Jurgen, "Automotive Electronics Handbook ", Automotive Electronics Series, SAE, USA, 1998	3. NicuBizon, Lucian D Ascalescu And NaserMahdaviAbatabaei "Autonomous Vehicles

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.G.Giri, Managing Director, Atalon .giri@atalon.co.in	1. Dr. SathishKumar. P, Assistant Professor, sathish.p@nitpy.ac.in, NIT, Karaikal	1. Dr. Carunaiselvane, SRMIST
		2. Dr.T.Praveenkumar, SRMIST

Course Code	21BTO101T	Course Name	HUMAN HEALTH AND DISEASES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Explain the basic structural organization of human health system	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Summarize the etiology of human infectious diseases	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Describe immune system and nervous system of human body and diseases related to it																	
CLR-4:	Impart knowledge on genetic diseases																	
CLR-5:	Indicate the high risk diseases associated with modern society																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Explain the structural organization of human system and concepts in human diseases	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-		
CO-2:	Differentiate the disease-causing agents and explain the life style related diseases	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-		
CO-3:	Describe the immune and neural system and related diseases.	-	2	-	-	3	-	-	-	-	-	-	-	-	-	-		
CO-4:	Integrate the genetical makeup with genetical disorders	-	2	-	-	3	-	-	-	-	-	-	-	-	-	-		
CO-5:	Apply the knowledge of disease and their symptoms in developing monitors and diagnostic device	-	2	-	-	3	-	-	-	-	-	-	-	-	-	-		

Unit-1 - Human System and Cell Structure and Function	9 Hour
Introduction to human health, Anatomy and Physiology, Respiratory system, Circulatory System, Digestive System, Excretory system, Reproductive system, Fertilization and Cell structure, Embryogenesis Tissue types, How body gets energy, ATP Synthesis, Cell metabolism, Cell cycle, Checkpoints in cell division, Cell division -Mitosis and Meiosis, Growth factors- overview, Types and function	
Unit-2 - Infections and Life Style Diseases	9 Hour
Infectious Diseases, Bacterial toxins, virulence of bacterial infection, Antibiotic resistance strains, An overview of replication cycle of virus, Effect of virus infection in the host cell, Epidemiology, Roots of spreading, Emerging and reemerging virus. Life style diseases: High risk disease of modern society, Obesity, Hypertension and diabetics, Neoplasm, Oncogenes and tumor suppressor genes, Types of cancer, Stages of cancer, Cancer in future, Life style and cancer risk	
Unit-3 - Immune Disorders	9 Hour
Immune system, Physical chemical and cellular barrier, Types of Immune cell, Humoral and cell mediated immunity, Cells Involved in inflammation, Inflammatory Process, Immune disorders, Abscesses, ulcer, cellulitis And Allergy, Autoimmunity, Immunodeficiency. Nervous system, Parkinson's, Alzheimer's disease	
Unit-4 - Genetical Diseases	9 Hour
Mendelian genetics, Genetics of simple and complex traits, Hereditary disease, Karyotype preparation and analysis Chromosome abnormality, Thalassemia, Cystic fibrosis, Duchene Muscular dystrophy, Sickle cell anemia, Indian genetic disease database, Human gene mutation database, Principle class of metabolic disorders, Inherited Metabolic disorders, Metabolic syndrome, Risk factors, Lysozyme storage disease: Molecular basis, List of proteins involved in LSD, Balanced nutrition and Malnutrition, Deficiency disease	

Unit-5 - Diseases Diagnosis and Treatment	9 Hour
Disease Diagnosis, Treatment strategy, Biomedical Instruments, Biosensors, Sources of drug- plants and microbes, Drug Designing, Computer aided drug designing, Vaccines, Route of administration, Vaccines types, Recommendation by age, Vaccines – Recent advancement, Immunotherapy, Immunotherapeutic approaches currently in use, Stem cell therapy, Gene therapy	

Learning Resources	1. Goodenough and McGuire, Biology of Humans: Concepts, Applications and issues, 4th ed., Benjamin Cummins/Pearson Publisher, 2011	2. Marianne Neighbors, Ruth Tannehill, Human Diseases, 4th ed., Jones Cengage learning, 2015 3. Marianne Neighbors, and Ruth Tannehill-Jones Human Diseases, 5th ed Delmar Cengage Learning 2018
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr. Lilly M saleena, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. R. B. Narayanan, Anna University, Chennai arbeen09@gmail.com	2. Dr. Rpriya Swaminathan , SRMIST

Course Code	21BTO105T	Course Name	ANIMAL MODELS FOR BIOMEDICAL RESEARCH	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes						
CLR-1:	Understand the basics animal Biology.	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3				
CLR-2:	Describe the various animal models and their requirement in biomedical research																															
CLR-3:	Learn the models available for various human diseases																															
CLR-4:	Learn to do pilot experiments to evaluate their working/living environment																															
CLR-5:	Learn different ethical and regulatory issues with animal models and design an alternative model to replace animal models																															
Course Outcomes (CO):		At the end of this course, learners will be able to:												-	2	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-1:	Define the fundamentals of animal experiments	-	2	2	2	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-				
CO-2:	Outline the various animal models available for biomedical research	-	2	2	2	-	-	-	-	-	-	-	-	-	3	3	2	-	-	-	-	-	-	-	-	-	-	-				
CO-3:	Explain the similarities between animal models and humans	-	2	2	2	-	-	-	-	-	-	-	-	-	3	3	2	-	-	-	-	-	-	-	-	-	-	-				
CO-4:	Design and evaluate pilot experiments to study their environment	-	-	3	3	2	-	-	-	-	-	-	-	-	3	3	2	-	-	-	-	-	-	-	-	-	-	-				
CO-5:	Prepare alternative models to replace animal models and comply with ethical issues	-	3	3	3	2	-	-	-	-	-	-	-	-	3	3	2	-	-	-	-	-	-	-	-	-	-	-				

Unit-1 - Basics of Animal Biology	9 Hour
Introduction to biology of animals, Classification of Animals (Invertebrates and Vertebrates), Structure and organs, Human evolution, Darwinism theory, History of animals and research	
Unit-2 - Animal Models in Biomedical Research	9 Hour
Animal models, Need for Animal models, Living and Non-living animal models for research, Selection of animal models, Non-Invertebrate animal models (Drosophila and C.elagans), Vertebrate animal models (Rats, mice, Primates, Cow, Dog and Sheep), Genetically engineered animals	
Unit-3 - Animal Models for Human Diseases	9 Hour
Animal models for cataracts and retinitis pigmentosa, Atherosclerosis and myocardial infarction, cardiac and cardiovascular disease, metabolic syndrome, diabetes and obesity, liver diseases, skin disorders and regeneration, Neurodegenerative disorders, Cancer	
Unit-4 - Animal Models in Preclinical Studies	9 Hour
Drugs and compound administration, need for animal models to test new compounds prior clinical study, Oral administration, Nasal Dosage, Inhalation, Invasive administrations (intravenous, intraperitoneal, intraocular, intramuscular, subcutaneous), non-invasive drug administration, Skin adsorption, selecting appropriate drug administration route, understanding the route of exposure in toxicity cases, Human-animal equivalent dose calculations,	
Unit-5 - Regulatory and Ethical Issues in Animal and Human Research	9 Hour
Animals in laboratory environment, Regulations and ethics in Animal research, Biohazards, Biosafety levels, and Radiation Safety, Breeding and animal husbandry, 3Rs for humane animal research, Alternative animal models (cell and tissue cultures, organoids), Limitations and ethical issues on human research, Ethical issues in using human samples and animal models, Application of computational models to replace animal models, Simulations and animal models	

Learning Resources	1. Hau J, Van Hoosier GL Jr, Handbook of Laboratory Animal Science, Volume I: Essential Principles and Practices" 2nd ed., CRC Press: Boca Raton, FL, 2003	3. The Guide for Care and Use of Animals in Research, Eight Edition, 2011
	2. Micheal Conn P, Animal Models for the Study of Human Disease, 2nd ed., Academic Press, 2017	4. Jerome Y Yager, Animal Models of Neuro-developmental Disorders, Human Press, 2015

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr.R.A. Nazeer, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. R. B. Narayanan, Anna University, Chennai, arbeen09@gmail.com	2. Dr. Harinarayana Ankamreddy, SRMIST

Course Code	21BTO106T	Course Name	WASTE TO WEALTH TO WHEELS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Identify the applications of engineering concepts for sustainable waste management	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Demonstrate of energy conversion technology for fuel application															
CLR-3:	Examine the significance of eco-friendly process in waste management															
CLR-4:	Prescribe the concepts of zero-waste process in industrial waste disposal methods															
CLR-5:	Analyze the important wastes to energy conversion															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the waste and formulate methodology for waste segregation	-	3	-	2	-	-	2	-	-	-	-	-	-	-	-
CO-2:	Evaluate the National policy towards novel biofuel production and energy security	3	-	3	2	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Compare and plan thermo-chemical conversion process for waste to energy conversion	3	2	2	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Demonstrate bioprocessing techniques to convert waste to biofuel and value-added chemicals	-	-	3	2	2	-	2	-	-	-	-	-	-	-	-
CO-5:	Utilize novel recent technologies for efficient waste management to meet the mandates of Global and National policy	-	-	-	2	-	2	2	-	-	-	-	-	-	-	-

Unit-1 - Wastes: A Boon or Bane?	9 Hour
Waste generation sources - Classification of wastes - Waste Management pyramid - Characterization of wastes - 4R principle - Modern Waste collection tools -Environmental and climatic change issues - Rapid urbanization, depletion of fossil reserves, need for energy security - Impact of wastes on biodiversity	
Unit-2 - Waste Bioeconomy	9 Hour
Transforming from fossil-based economy to a sustainable circular bio-economy - Global and Indian perspective - waste as the core element for the future economic models - drivers for the bioeconomy - futuristic needs, scope and opportunities envisaged in the business and economic realm	
Unit-3 - Technologies/Processes that can be Applied for Biogenic Wastes Valorization	9 Hour
Circular economy in a waste biorefinery model for the production of biobased products including bioenergy - Thermal processing of wastes: Combustion, Co-generation/co-firing - Pyrolysis and torrefaction - Hydrolysis and plasma treatment for waste to energy conversion - Catalytic conversion process - Syngas production- Bioenergy-Biochar energy cycle - Land fill and flue gas recovery for its commercial application	
Unit-4 - Insights into Bioenergy	9 Hour
Classification of Biofuels - Liquid, Gaseous and Solid - Bioethanol Hexose and Pentose sugar conversion to ethanol- Bioethanol plant design and its components- Bio refinery demonstration projects of Bioethanol- Biodiesel - Biodiesel from vegetable oils/ non-edible oils - Transesterification process-Oleaginous microorganisms-Algal Biofuel - Algal based technologies for biofuel and value added chemical preparation - Biobutanol - ABE Fermentation for Butanol production - Pyrolysis bio-oil/bio-char -Bio-alkanes and alkenes from waste biomass - Gaseous Biofuel - Bio-synthetic natural gas (SNG)- Biomethanation process- Microbiology of anaerobic digestion- Dimethyl ether (DME)-Biohydrogen- Biological Processes for Hydrogen Production- Dark fermentation and algal based technologies	

Unit-5 - Technologies for Waste Management and Government Policies			9 Hour
Smart Bins - Robotic hand for waste segregation using image acquisition and analysis - Unmanned Aerial Vehicle (UAV) for landfill waste forecasting - AI and Sensor Technology for waste segregation - Robotic ocean waste collection and reutilization - Activities of Ministry of Energy, Government of India and International Energy Agency - Potential Benefits of Replacing Fossil Fuels with Biofuel, Biomass and Biogas			
Learning Resources	1. Peter Lacy , Jakob Rutqvist, Waste to Wealth, The Circular Economy Advantage, Springer, 2015 2. Online resources: https://onlinecourses.nptel.ac.in/noc21_ch09/preview	3. Reeta Rani Singhania, Rashmi Avinash Agarwal, R. Praveen Kumar, Rajeev K Sukumaran, Waste to Wealth, Springer, 2018	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Kirti Singh, Camlin Fine Sciences Ltd., New Delhi	1. Dr. Rintu Banerjee IIT Kharagpur, rb@agfe.iitkgp.ernet.in	1. Dr.B.Samuel Jacob, SRMIST
2. Dr.D.Gunaseelan, Alvotech Pvt., Ltd., Iceland	2. Dr. Vinod Kumar, Cranfield University, UK, vinod.kumar@cranfield.ac.uk	2. Dr.K.Ramani, SRMIST

Course Code	21BTO107T	Course Name	FUNDAMENTAL NEUROBIOLOGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Recall the brain function from its organization	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Discuss the synaptic structure and function															
CLR-3:	Understand different types of learning and memory, influence of sleep and ageing															
CLR-4:	Analyze genetic variations in brain development and behavior															
CLR-5:	Study the brain pathology															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe the fundamental organization of brain and its functions	2	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO-2:	Explain the synaptic composition and neurotransmitter release cycle	2	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO-3:	Analyze different domains of learning and synaptic protein maintenance	2	2	-	-	3	-	-	-	-	-	-	-	2	-	3
CO-4:	Summarize the role of genes in brain development and functions	3	2	-	-	3	-	-	-	-	-	-	-	3	-	3
CO-5:	Understand the neuropathological conditions across the age groups	3	2	-	-	3	-	-	-	-	-	-	-	3	-	3

Unit-1 - Introduction to Brain and Neuronal Types	9 Hour
Basics of Neurobiology- Understanding brain function- Orientation of Central nervous system- Peripheral nervous system- Levels of Neural organization- Concept of functional units- Cellular basis of Neurobiology- Clinical issues in neurobiology- Neuron terminology- Cell biology of neurons and glia- Differentiation of axon and dendrite- Synaptic organization- Sensorimotor, autonomic and enteric divisions- Synapses and spines- Inhibitory interneurons and classification- Inhibitory projection neurons- Excitatory neurons- Neuroglia and glial sheaths	
Unit-2 - Transmission of Nerve Impulse	9 Hour
Membrane potential- Action potential- Resting potential- Electrochemical basis of nerve function- Electrical and Thermodynamic Forces in Passive Distribution of Ions- Hyperpolarization or Depolarization- Chemical basis for neuronal communication- Ion pumps and Ion gradients- Ion channels and transporters- Hyperpolarization- Activated Ionic Currents- Membrane excitability- Neurotransmitters- Receptors of neurotransmitters- Synthesis of neurotransmitters and neuropeptides- Synaptic vesicle cycle- Release and metabolism of neurotransmitters- Molecular mechanisms nerve terminal- Molecular signaling in neurons	
Unit-3 - Functions of Brain-Learning and Memory	9 Hour
Brain energy metabolism at the cellular level- Sensory systems- Receptors to perceptions- Chemical and somatic senses- Molecular and neural basis of visual perception- Organization of autonomic nervous system and functions- Nature of motor system and its functions- Reflexes and fixed motor responses- Locomotion- Epigenetics of the brain- Epigenetics in brain disorders- Sleep, dreaming and wakefulness- Reward and motivation- Emotion and addiction- Aging and synaptic degradative pathways- Cognitive impairment- Learning and memory- Language, communication and consciousness	

Unit-4 - Circuits of Neuroendocrinology, Neuroimmunology and Role of Neurogenetics	9 Hour
Nature of central systems- Survey methods- Neuroendocrine circuits- Functions of neuroendocrine system- Neuroendocrine tumors- Global epidemiology of neuroendocrine tumors- Neuro-immune circuits- Neuro-immune functions- Neuroendocrine-immune interactions in neurological disorders- Neuroendocrine-immune interactions in autoimmune diseases- Developmental genetics of the brain- Genes for human brain development- Genes in neurological disorders- Genes and behavior- Drugs and the brain- Role of Environmental factors in neurodevelopment- Exposure of lead and methyl mercury in neurodevelopmental disorders- Neurotoxins-	
Unit-5 - Diseases of Brain	9 Hour
Disorders of the nervous system- Developmental disorder- Autism, Intellectual disability, Dyslexia, ADHD- Mental Disorder- Schizophrenia- Degenerative disorders- Alzheimer's disease- Parkinson's disease- Psychiatric disorder- Depression and anxiety- Stroke- Epilepsy- Implications of neuropharmacology- Novel therapeutic targets- Neural Plasticity, Goat Brain Dissection- Understanding brain by Artificial Intelligence- Neural network for analyzing brains network	

Learning Resources	1. Larry Squire, Darwin Berg, Floyd E. Bloom, Sascha du Lac, Anirvan Ghosh, Nicholas C. Spitzer, <i>Fundamental Neuroscience</i> , 4th ed., Academic Press, 2012	2. Michael Aschner, Lucio G. Costa, <i>Environmental factors in Neurodevelopmental and neurodegenerative disorders</i> , Academic Press, 2015
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. C. N. Ramchand, Saksin Life sciences Pvt Ltd, Chennai, ramchand@saksinlife.com	1. Prof. K Subramaniam, IITM, Chennai, subbu@iitm.ac.in	1. Dr. Anil Annamneedi, SRMIST
2. Dr. Karthik Periyasamy, Scientist, Biocon, karthik.periyasamy@biocon.com	2. Prof. R. B. Narayanan, Anna University, Chennai, arbeen09@gmail.com	2. Dr. R. Vasantharekha, SRMIST

Course Code	21BMO121T	Course Name	FUNDAMENTALS OF BIOMEDICAL ENGINEERING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biomedical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Recall the basics of physiology	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Recognise basic aspects of biomedical recorders															
CLR-3:	Tabulate the various patient monitoring systems used in health care															
CLR-4:	Interpret the physics behind x-ray imaging, computed tomography (CT) and magnetic resonance imaging															
CLR-5:	Describe the properties and techniques involved in Therapeutic Equipment's															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Recall the basics of physiology	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Recognise basic aspects of biomedical recorders	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Tabulate the various patient monitoring systems used in health care	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Interpret the physics behind x-ray imaging, computed tomography (CT) and magnetic resonance imaging	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Describe the properties and techniques involved in Therapeutic Equipment's	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Fundamentals of Biomedical Instrumentation	9 Hour
Anatomy and Physiology-Physiological system of the body-Sources of Biomedical signals-Basic Block diagram of medical instrumentation system-General constraints in design of medical instrumentation system-Origin of -bioelectrical signals-Electrocardiogram-Electroencephalogram-Electromyogram-Recording electrodes-Silver-silver chloride electrodes-Electrodes for ECG-Electrodes for EEG-Electrodes for EMG-Microelectrodes	
Unit-2 - Biomedical Recorders	9 Hour
Electrocardiograph-Block diagram of an ECG machine- The ECG leads-Effects of Artifacts on ECG recording-Block diagram of -microprocessor based ECG machine-Phonocardiograph (PCG)-Origin of heart sound- Electroencephalograph- Block diagram description of Electroencephalogram-Electromyography-Biofeedback Instrumentation	
Unit-3 - Patient Monitoring Systems	9 Hour
Introduction to cardiac monitor-Basic Block diagram of Bedside patient monitoring systems-Basic block diagram of Central monitors-Measurement of heart rate-Average heart rate meters-Instantaneous heart rate meters Measurement of pulse rate-Blood pressure measurement-Direct methods of monitoring blood pressure-Blood pressure-Indirect methods of monitoring blood pressure-Automatic blood pressure measuring apparatus using korotkoffs method-Ultrasonic method-Measurement of Respiration rate-Displacement method-Apnea detectors	
Unit-4 - Diagnostic Imaging Systems	9 Hour
Basics of diagnostic radiology-Nature of X-rays-Production of X-rays-Stationary anode tube-Rotating anode tube-Block diagram of an X-ray machine-Introduction to computed tomography-Basic principles of CT-Introduction to Nuclear imaging-Single photon emission computed tomography-Positron emission tomography-Principle of NMR imaging, spin polarization-Resonance, relaxation, spin echoes, gradient echoes-Introduction to ultrasound-Modes of ultrasound	

Unit-5 - Therapeutic Equipments	9 Hour
Need for cardiac pacemaker-External and Implantable pacemaker-Need for Defibrillators-DC defibrillator-Implantable defibrillator-Principle of surgical diathermy-Surgical diathermy machine-Short wave diathermy-Microwave diathermy and Ultrasonic unit-Working of hemodialysis machine-Principle of peritoneal dialysis-Need for anesthesia-Working principle of anesthesia machine-Mechanics of respiration-Ventilators and types of ventilators-Automated Drug delivery system-Infusion pumps-Implantable Infusion system	

Learning Resources	<ol style="list-style-type: none"> 1. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Bio-Medical Instrumentation and measurements", Pearson Education, PHI Learning Private limited, India, 2nd edition, 2007. 2. John G. Webster, "Medical Instrumentation application and design", Wiley India Pvt Ltd, India, 4th edition, 2015 3. R.S. Khandpur, "Handbook of Biomedical instrumentation", Tata McGraw Hill Publishing Co Ltd., 3rd edition, 2014. 4. Jerrold T. Bushberg, John M. Boone, "The essential physics of medical imaging", Lippincott Williams & Wilkins, 3rd edition, 2011. 5. Rongguang Liang, "Biomedical optical imaging technologies: Design and applications", Springer Science & Business Media, 1st edition, 2012 6. Nadine Barrie Smith, Andrew Webb, "Introduction to medical imaging: Physics, Engineering and clinical applications", Cambridge University Press, 1st edition, 2010. 7. M. A. Flower (Editor), "Webb's Physics of medical imaging, Second Edition", CRC Press, Taylor & Francis Group, ISBN:978-0-7503-0573-0, 2nd edition, 2016.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	10%	-	10%	-
Level 2	Understand	20%	-	10%	-	10%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	10%	-	10%	-
Level 6	Create	-	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Sri Lanka & Maldives	1. Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University	1. Dr. P. Vinupritha, SRMIST

Course Code	21BMO122T	Course Name	HEALTH INFORMATION SYSTEMS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biomedical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Write about the basic of health information	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Express the use new methods in health information acquisition and medical records															
CLR-3:	Identifying different architecture of HIS															
CLR-4:	Demonstrate strategies in HIS data management regulations															
CLR-5:	Incorporate Health information system for the hospital benefit and apply HIS usage in Indian context															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Define role of information technologies in potentially revolutionizing healthcare delivery, administration, education, and research	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Describe the Integration of existing & emerging technology in healthcare	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-3:	Practice the architecture standards in HIS	-	-	2	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Interpret the acceptance testing & issues on standards in HIS	-	-	1	-	2	-	-	-	-	-	-	-	-	-	-
CO-5:	Implement health information for computer aided diagnostic purposes and apply Health Information in hospital context	2	-	1	-	-	-	-	-	-	-	-	2	-	-	-

Unit-1 - Foundations of Health Information Management	9 Hour
Health Care Systems-Evolution Health Care-Health Informatics-Information Management Profession in Hospitals- Importance of confidentiality-Personal and Impersonal data-Health Information Infrastructure-Health Information Systems-Standalone Information System-Clinical Decision Support System(CDSS)-Hospital Information System(HI-Related Parties in HIS-Profit & Nonprofit healthcare stakeholders ; Provider (Hospital)-Payers(Insurance Companies) ; Employers ; Practitioners ; Public Health Officials; Educator	
Unit-2 - Medical Records and Other Documents	9 Hour
A Brief Introduction to Medical record history-Physical Record - Data expected in record-Health Insurance Portability and Accountability Act (HIPAA)-Problems-advantages of Physical Records-Modules in Hospital – Information System(HIS)-Admission/Discharge/Transfer (ADT) system-Scheduling & Registration-Pharmacy System-Embedded CDSS-Connecting Teleradiology- Laboratory Information System(LIS)-Electronic Health Record Data- Dangers of Large Databases-Internal Data – Clinical, Administrative-Use of internal data-External Data – Comparative, Expert Data,-External Data- Knowledge Base	
Unit-3 - Architecture and Interfacing for Healthcare Technology	9 Hour
Complexity of systems in healthcare-Wireless networks-LAN security-overcoming LAN security vulnerabilities-Middleware-Different products in Middleware-Network Interoperability-Platform interoperability-Database Interoperability-GUI/MUI Interoperability-Multi-Location Enterprise-Inter-enterprise health care solution-Timely Admissions, Discharges, and Transfers-Connectivity to Another Health Plan-Information Systems Life Cycle- Information Systems Life Cycle-Health Care Informatics-Project management in health Informatics	

Unit-4 - Regulations and Computer Aided Detection	9 Hour
Computer-Aided Diagnostics-Computer-Aided detection-Electronic Health Record Data-Database Presentation and Statistics-Health Record Data-Representing data-Public Health Informatics-Patient EHR Databases -in public health-Clinical decision support systems-Clinical decision support systems-Privacy and patient protection concerns-Privacy and patient protection concerns-Implementing Computerized Physician Order Entry-Issues and Ethics in HIS-Privacy and health Law-Predicting Uncertainty-Risk management in HIS-Risk management in HIS	
Unit-5 - Future of His and Technology	9 Hour
eHealth, mHealth-Equipment used in eHealth, mHealth data-Social Media, and Telemedicine-Improved use of Telemedicine-Parts of telemedicine-Connecting rural India through telemedicine-Voice enabled--recordings in health-disease progression modeling-Handheld Technologies in Healthcare at home-Handheld Technologies in Healthcare at hospital-Integrating Handheld Technologies at hospital-Technology for personalized medicine- Automated Patient Identification-Automated Patient Identification in medicine-Bar Coding, and Smart Cards-Appling Bar Coding, and Smart Cards in research in Hospital-Impact of HIS on – Research-Impact of Technology on Policy, and Public Health	

Learning Resources	<ol style="list-style-type: none"> 1. Winter, A., Haux, R., Ammenwerth, E., Brigl, B., Hellrung, N., Jahn, F., "Health Information Systems-Architectures and Strategies", 2nd Edition Number , Springer-Verlag London, 2011 2. Mervat Abdelhak Mary Alice Hanken, "Health Information: Management of a Strategic Resource" ,5th Edition, Saunders,2015 3. Karen A. Wager, Frances W. Lee, John P. Glaser, "Health Care Information Systems: A Practical Approach for Health Care Management", John Wiley & Sons, 4th edition, 2017 4. Jean A Balgrosky, "Essentials of Health Information Systems and Technology" , Jones & Bartlett Publishers,2014
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	10%	-	10%	-
Level 2	Understand	20%	-	10%	-	10%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	10%	-	10%	-
Level 6	Create	-	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives	1. Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University	1. Dr. A. Bhargavi Haripriya, SRMIST

Course Code	21BMO123T	Course Name	BASICS OF MEDICAL IMAGING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biomedical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Describe the working principle of X-ray imaging	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Demonstrate the working principle of Computed tomography															
CLR-3:	Narrate the physics behind nuclear radiation and the imaging modalities in nuclear medicine															
CLR-4:	Illustrate the working principle of ultrasound and its different imaging modalities															
CLR-5:	Explain the working principle of magnetic resonance imaging and its application in diagnosis															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe the principle behind the working of X-ray imaging	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-
CO-2:	Explain the working principle of tomographic imaging and reconstruction procedures.	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Compare the difference in working principle of different nuclear imaging modalities	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Analyze the different modes of ultrasound imaging techniques	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Illustrate the physical principle of magnetic resonance imaging and the instrumental components involved in MR imaging	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - X-Ray Imaging	9 Hour
Principles of Imaging with X-rays-Production of X-ray-Interaction of X-ray with Tissue-Coherent, Compton-and photoelectric effect-Attenuation coefficients of X-rays in tissue -collimators-Anti-scatter grids-Intensifying screen- Electronic Intensifier-X-ray Film-Image characteristics-Digital radiography-Flat panel detectors-Mammography – Basic block diagram-X-ray tube design	
Unit-2 - Computed Tomography	9 Hour
Computed Tomography-Historical development-Instrumentation-Hounsfield unit-Detectors and Detector arrays-Tomographic reconstruction-Back projection algorithm-Digital image display-Radiation dose-Image quality- Artifacts-Helical CT-Multi slice spiral CT-Multi slice CT - Detector configurations -CT Applications	
Unit-3 - Nuclear Imaging	9 Hour
General principles of Nuclear Medicine-Radioactivity basics-Production of radionuclides-Types of radioactivity-Instrumentation-Gamma camera-Collimators, scintillation crystal-Photomultiplier tubes-Pulse height analyzer- Single photon emission computed tomography-Instrumentation- -Clinical Application-Photon Emission Tomography-General Principles-Radionuclides used for PET-Instrumentation for PET-Clinical applications of PET	
Unit-4 - Ultrasound Scanners	9 Hour
General Principles -Wave Propagation-Ultrasound Characteristics-Wave reflection and refraction-Absorption, Scattering, Attenuation-Instrumentation-Transducers-Transducer arrays-Scanning modes-A-Mode-B-Mode scan-M-Mode-Duplex scanner- -Spatial resolution, Contrast -to-noise ratio-Doppler effect, Continuous wave Doppler-Color Doppler imaging -Clinical applications-obstetrics and gynecology	
Unit-5 - Magnetic Resonance Imaging	9 Hour
Nuclear Magnetism-Quantum mechanical description-Radiofrequency pulse and rotating frame-Spin-Spin and Spin-Lattice relaxation-Measurement of T1 and T2-Inversion recovery-Spin echo sequences-Slice Selection-Phase and frequency encoding-MRI Instrumentation- Block Diagram-Magnets-Magnetic field gradient coil-Radiofrequency coil-Image characteristics-MRI contrast agents-Clinical application-Brain	

Learning Resources	<ol style="list-style-type: none"> 1. R.S.Khandpur., 'Handbook of Biomedical instrumentation', Tata McGrawHill Publishing Co Ltd., 3rd edition, 2014. 2. Jerrold T. Bushberg, John M. Boone., "The essential physics of medical imaging", Lippincott Williams & Wilkins, 3rd edition, 2011. 3. M. A. Flower (Editor), "Webb's Physics of medical imaging, Second Edition", CRC Press, Taylor & Francis Group, ISBN: 978-0-7503- 0573-0, 2nd edition, 2016. Nadine Barrie Smith, Andrew Webb, "Introduction to medical imaging: Physics, Engineering and clinical applications", Cambridge University Press, 1st edition, 2010. 4. K. Kirk Shung, Michael Smith, Benjamin M.W. Tsui., "Principles of medical imaging", Academic Press, 1st edition, 2012.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	10%	-	10%	-
Level 2	Understand	20%	-	10%	-	10%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	10%	-	10%	-
Level 6	Create	-	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives	1. Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University	1. Dr.S.P.Angeline kirubha SRMIST

Course Code	21BMO124T	Course Name	REHABILITATION ENGINEERING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biomedical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the biomechanics of mobility and universal design	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Learn about personal transportation, manual and powered wheelchairs															
CLR-3:	Appreciate the working of prosthetics, orthotics															
CLR-4:	Understand sensorial prostheses															
CLR-5:	Apprehend the advanced technologies in rehabilitation engineering															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Explain gait cycle and basic rehabilitation terminologies	1	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Differentiate the types and technologies with wheelchairs	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Design basic orthotics and prosthetics	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Summarize the sensorial prosthetics	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Appraise the various advanced topics and challenges in rehabilitation engineering	2	-	-	1	1	2	-	-	-	-	-	-	-	-	-

Unit-1 - Rehabilitation Engineering Introduction	9 Hour
Introduction to rehabilitation Engineering-Scope-Assistive Technology-Terminologies involved-Design considerations-Scope of this field-Rehabilitation approaches-Concepts in rehabilitation engineering-Universal design- Concept of universal design-Barrier free design-Disability assessment-Legal aspects-Provision available-Mobility-Biomechanics of mobility-Introduction to Gait cycle-Its applications	
Unit-2 - Wheelchair Technologies	9 Hour
Personal transportation-Associated disabilities-Lift Mechanisms-Application areas-Wheelchairs-Types-Wheelchair standards-Safety testing-Manual wheelchair-Components-Powered wheelchair-Design considerations- Wheels and casters-Motor selection-Batteries and microprocessors used-Smart wheelchair-Other wheelchair technologies-Human factor, Fault tolerance	
Unit-3 - Orthotics and Prosthetics	9 Hour
Upper and-Lower extremity-anatomy overview-Amputation Classification-Prosthesis prescription-Components of upper limb prosthetics-Fabrication techniques-Components of lower limb prosthetics-Fabrication techniques-Latest technologies-Latest trends in prosthetics-Orthotics-Needs and types-Lower extremity orthotics-Types and consideration-Upper extremity orthotics-Types and consideration-Latest technologies-Latest trends in Orthotics- Improvement in orientation and mobility	
Unit-4 - Sensorial Prosthetics	9 Hour
Sensorial Prosthetics- Introduction-Types of sensorial prosthetics-Categories of visual impairment-Cortical implants-Retinal implants-Mobility aids for blind-Aids for reading and writing-Graphic access-Orientation and navigation aids-Intelligent mobility aids-Hearing functional assessments-Surgical hearing aids-Non surgical hearing aids- Computer aided lip reading -Telecommunication, computers and web accessibility -Latest technologies-Tactile prosthetics Tongue prosthetics-Olfactory prosthetics-Future of sensorial rehabilitation	

Unit-5 - Rehabilitation Applications	9 Hour
Functional electrical stimulation-FES application-Robots in rehabilitation-Therapeutic robots-Rehabilitation in sports-Areas of sports application-Daily living aids-Assistive technology for dyslexia-Assistive technology for speech disorders-Assistive technology for dysphagia-Available types-Neurological rehabilitation-Cognitive rehabilitation-Neuromotor rehabilitation-HAS Hybrid assistive system for walking-Future trends	

Learning Resources	1. Rory.A.Cooper, "Rehabilitation Engineering Applied to Mobility and Manipulation", First Edition, CRC Press, 2010 2. Horia-Nicolai.L.Teodorescu, Lakhmi C. Jain, "Intelligent Systems and Technologies in Rehabilitation Engineering", First Edition, CRC press, 2010. 4. Glenn Hedman, "Rehabilitation Technology", First Edition, Haworth Press Inc, 1990. 5. Michael P. Barnes, Anthony B. Ward, "Oxford Handbook of Rehabilitation Medicine", First Edition, Oxford University Press, 2005
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	10%	-	10%	-
Level 2	Understand	20%	-	10%	-	10%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	10%	-	10%	-
Level 6	Create	-	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Srilanka & Maldives	1. Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University	1. Dr.Varshini Karthik, SRMIST

Course Code	21BMO125T	Course Name	QUALITY CONTROL FOR BIOMEDICAL DEVICES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biomedical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Ensure various quality measures in an organization	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Introduce management principles and management practices to enhance the performance characteristics															
CLR-3:	Implement various quality control strategies to ensure quality															
CLR-4:	Apply innovative ideas at all levels of management															
CLR-5:	Comply with protocols applicable to healthcare globally and nationally															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe Quality, Quality control measures essential for an organization	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-
CO-2:	Implement the quality management principles and good management practices	-	2	-	-	-	-	-	-	-	-	3	-	-	-	-
CO-3:	Apply the various quality control tools	-	-		2	-	-	-	-	-	-	2	-	-	-	-
CO-4:	Adopt the various quality management tools	-	1	-	-	-	-	-	-	-	-	3	-	-	-	-
CO-5:	Accomplish global and national protocols applicable to healthcare	-	1		1	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Quality	9 Hour
Quality: Terminologies-Dimensions of Quality-Quality Planning- Total Quality Management-Basic concepts -Principles of TQM-Leadership – Concepts-Role of Senior Management-Quality Council-Quality Statements- Strategic Planning- Barriers to TQM Implementation	
Unit-2 - TQM Principles	9 Hour
Customer satisfaction – Customer Perception of Quality-Customer Complaints-Service Quality-Customer Retention-Employee Involvement-Motivation-Empowerment-Teams- Team Work-Recognition and Reward-Performance Appraisal-	
Unit-3 - Statistical Process Control	9 Hour
The seven tools of quality-Cause-and-effect diagram-Check sheet-Control chart-Histogram -Pareto chart-Scatter diagram- -Stratification- Six sigma	
Unit-4 – TQM Tools	9 Hour
Benchmarking-Reasons to Benchmark-Benchmarking Process-Quality Function Deployment (QFD-House of Quality- QFD Process –Total Productive Maintenance (TPM) --FMEA-Stages of FMEA	
Unit-5 - Standards for Medical Devices	9 Hour
Standards-Need Types-Medical device safety-medical device quality management systems requirements-ISO 9000:2000 Quality System-Clauses-FDA-Functions-ASTM International-CE marking-IEC-Specifications	

Learning Resources	1. Rose J.E, Total Quality Management, Kogan Page Ltd., 1993	4. Joseph J.Carr, Elements of Electronics Instrumentation and Measurement, 2nd ed., Pearson Education, 2003
	2. Cesar A. Cacere, Albert Zana, The Practise of clinical Engineering, Academic Press, 1997	5. Jerrold T. Bushberg, John M. Boone, The essential physics of medical imaging, 3rd ed., Lippincott Williams & Wilkins, 2011
	3. Greg Bounds, Beyond Total Quality Management-Toward the emerging paradigm, McGraw Hill, 2013	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	10%	-	10%	-
Level 2	Understand	20%	-	10%	-	10%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	10%	-	10%	-
Level 6	Create	-	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., TamilNadu, Sri Lanka & Maldives	1. Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University	1. Dr.D.Kathirvelu SRMIST

Course Code	21BMO126T	Course Name	BIOMECHANICS OF HUMAN MOVEMENTS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biomedical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Identify essential anatomical components of the musculoskeletal system.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Illustrate about the movements using standard anatomical terminology															
CLR-3:	Explain the key contributors to the various events in a gait cycle.															
CLR-4:	Describe measurements used in analysis of human movement.															
CLR-5:	Discuss the causes and compensation mechanisms for pathological gait															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the common concept of movement and study the force balance of change in motion	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Analyze the muscle force and its velocity relationship	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Identify the joint constraints in an intact systems	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Outline the importance of kinematics in human movement	-	-	3	-	-	-	-	-	-	-	-	2	-	-	-
CO-5:	Describe the motor function and balance theory	2	-	-	-	-	-	-	-	1	-	-	2	-	-	-

Unit-1 - Introduction to Biomechanics	9 Hour
Understanding movement for rehabilitation-Force measurement-Vector, scalar general introduction-Drawing vectors, point of application-The force of muscles working principle-Magnitude and direction of moments-Gravity- Moments and posture-Moments and posture-Standing balance-Force magnitude and change in motion-Local and general stability	
Unit-2 - Biomechanics of Human Movements	9 Hour
Structure of Protein filaments-The sarcomere anatomical details-The difference between muscle force and muscle strength-Muscle work- Muscle fiber types-Gradation of muscle force-Length-Tension relationship-Active and passive tension measurement technique-Force –Velocity relationship-Angle of pull -Stability and sequencing-Measuring muscle strength, endurance-Increased vascularization-Increased strength-Increased endurance	
Unit-3 - Joint Mobility	9 Hour
Introduction to joint mobility-Factors involved in assisting and restricting range of movements-Normal range definition-Normal range-Abnormal limitations-Effects of decreased range of movements-Types of therapeutic- movement of joints-Types of therapeutic movement of joints-Passive movements-Active movements-Normal joint constraint in an intact systems	
Unit-4 - Measurement of Human Movement	9 Hour
Linear Kinematics-Angular Kinematics-Forces and movements-Newton's First law of motion-Newton's second law of motion-Newton's third law of motion-Full three dimensional motion capture- Movement assessment systems-Visual movement evaluation-Linear Displacement-Angular Displacement-Body functions and structures-Case study 1:treadmill training-Promoting physical activity to improve health	
Unit-5 - Restoring and Optimizing Human Movements	9 Hour
Basic Principles of motor learning-Theories of skill learning-The balance theory model-The task environment-The task design-Gait of the child with cerebral palsy before and after surgery-The sit to stand movement-Upper limb impairment after stroke-Medical history and evaluation-Motor impairment-Functional limitations	

Learning Resources	1. <i>Basic Biomechanics of the Musculoskeletal System</i> , Margareta Nordin and Victor Frankel Lippincott Williams & Wilkins, 2001	3. <i>Biomechanics and Motor Control of Human Movement</i> , David Winter 17 September 2009, 2009 John Wiley & Sons, Inc.
	2. <i>Biomechanical Analysis of Fundamental Human Movements</i> , Arthur Chapman First Edition 2013	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	10%	-	10%	-
Level 2	Understand	20%	-	10%	-	10%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	10%	-	10%	-
Level 6	Create	-	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., TamilNadu, Srilanka & Maldives	1. Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, AnnaUniversity	1. Dr. G.Anitha, SRMIST

Course Code	21BMO127T	Course Name	DIGITAL HEALTHCARE TECHNOLOGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Biomedical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Illustrate the need and challenges of personalized healthcare	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Explore the basic aspects of telehealth and telemedicine															
CLR-3:	Enumerate mHealth evolution, regulation and applications															
CLR-4:	Demonstrate the use of virtual reality and games in healthcare															
CLR-5:	Explain the importance of IoT in healthcare through its applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Explain the need and challenges of personalized healthcare	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Recognize basic aspects of telehealth and telemedicine	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Demonstrate mHealth evolution, regulation and applications	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Interpret the use of virtual reality and games in healthcare	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Discuss the importance of IoT in healthcare through its applications	3	-	1	-	-	-	-	-	-	-	1	-	-	-	-

Unit-1 - Personalised Healthcare	9 Hour
Personalization of healthcare: the relationship between data, Digital technologies and advanced analytics – Digital health measures – Examples in digital health technologies in clinical research - Examples in digital health technologies in care delivery pathway – Challenges in bringing digital health technologies to market – Challenges in adoption of digital health technologies	
Unit-2 - Telehealth and Telemedicine	9 Hour
Telemedicine versus telehealth – Definitions - Technology vs services – Telemedicine technological requirements – Telehealth technological requirements – Distant health examples – Smart medical shirts – Haptic platform – Overgrown cities – Rural health – Satellite telehealth – Telemedicine critical technologies – Present challenges and benefits – Groundwork for a good telehealth application – Enabling telehealth for existing medical application – Case study – Panic disorder – Case study – Diabetes telehealth framework – Case study – telehealth support for unit care – Medicolegal, ethical and regulatory guidelines pertaining to telehealth	
Unit-3 - M-Health	9 Hour
Evolution from telemedicine to m-Health – Initial and recent applications – Mobile apps for mHealth - Overview of mHealth apps – Regulation of mHealth apps - Cloud computing definition and selected applications – closed loop solutions for personalized health interventions – Challenges in sensor design and fabrication – Challenges in mining and managing Big health data – Common mHealth and ICT applications – Evidence for mHealth impact – New frontiers in mHealth - Case study – Sleep problems and their implications	
Unit-4 - Virtual Reality and Games for Healthcare	9 Hour
Augmenting mental healthcare – Mobilizing services with virtual reality – Pain – Anxiety and phobias – Stress management – Rehabilitation – Games for improving healthcare – Homo Ludens – Learning through challenges and fun – Physical and functional fidelity – Games for health – Rehabilitation – Crowdsourcing science – Gaming doctor – Games in official Medical programs – Games in skills training outing operating room – Financial and Ethical aspects	

Unit-5 - IoT for Healthcare	9 Hour
Concept of IoT-Based Healthcare Technology – Ambient intelligence in Healthcare Technologies – Benefits – Challenges – Data handling and resource management – Security and Privacy – Interoperability – Stakeholder collaboration and implementation – Technologies that enable IoT – Healthcare – Internet of Medical things – Applications of IoT in Healthcare – Benefits - Challenges	

Learning Resources	<ol style="list-style-type: none"> 1. Halit Eren and John G Webster, "Telemedicine and Electronic Medicine", CRC Press, Taylor and Francis Group, New York, 2nd edition, 2016. 2. Shabbir Syed-Abdul, Xinxin Zhu, Luis Fernandez-Luque, "Digital Health: Mobile and Wearable Devices for participatory Health Applications", Elsevier, Cambridge, USA, 2021. 3. Shashi Gogia, "Fundamentals of Telemedicine and Telehealth", Elsevier, Cambridge, USA, 1st Edition, 2020 4. Homero Rivas and Katarzyna Wac, "Digital Health: Scaling Healthcare to the World", Health Informatics, Springer, Switzerland, 2018. 5. Nishu Gupta and Sara Paiva, "IoT and ICT for Healthcare Applications", Springer Innovations in Communication and Computing, Switzerland, 2020.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	10%	-	10%	-
Level 2	Understand	20%	-	10%	-	10%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	10%	-	10%	-
Level 6	Create	-	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anbuselvan T, General Manager – Sales, Wipro GE Healthcare Pvt. Ltd., Tamil Nadu, Sri Lanka & Maldives	1. Dr. S. Poonguzhali, Professor, Centre for Medical Electronics, Anna University	1. Dr. Vani Damodaran, SRMIST

Course Code	21CHO101T	Course Name	SUSTAINABLE ENERGY ENGINEERING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemical Engineering		Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Familiarize various ways of collecting solar energy and its applications	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Familiarize various ways of utilizing wind energy	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Familiarize various aspects of Biomass energy and utilization																	
CLR-4:	Understand the current status and future trends in energy																	
CLR-5:	Appreciate the need for efficient energy storage																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Learn the different industrial solar equipments for heat and electricity	3	2	-	-	-	-	2	-	-	-	-	-	-	-	-		
CO-2:	Know the types of wind mills and their design	2	3	1	-	-	-	-	-	-	-	-	-	-	-	-		
CO-3:	Comprehend the uses of energy from biomass and reactor design	2	-	2	-	-	-	2	-	-	-	-	-	-	-	-		
CO-4:	Apply the concept of energy transfer to modern processes	3	2	-	-	2	-	-	-	-	-	-	-	-	-	-		
CO-5:	Comprehend the various means of energy storage	3	-	2	-	-	-	1	-	-	-	-	-	-	-	-		

Unit-1 - Solar energy	9 Hour
Solar angles, solar collectors, types of collectors, flat type and dish type, solar concentrators, types of concentrators, solar pumping, solar refrigerators, solar air cooling, solar furnaces, solar power generation, solar drying, solar stills, solar cooking, Photovoltaic cells.	
Unit-2 - Wind energy	9 Hour
Availability of wind, Special features of wind energy, Types of wind mills, Power from the wind, Performance of wind mills, Modern wind energy generators, Horizontal wind mills, Vertical wind mills, Wind turbines, Design parameters, Design principles of wind turbine, Wind power farms, and Modern wind farms.	
Unit-3 - Biomass energy	9 Hour
Biomass resources, Composition, fuel properties, Biomass conversion technologies, Anaerobic digestion, Direction combustion, Pyrolysis, Gasification, Biogas technology, Bioethanol and Biodiesel production, Community and institutional biogas plants, Family biogas plants, Recent developments in biomass technology, Energy farming, Design consideration, Digestors and reactors.	
Unit-4 - Energy calculations and modern energy transfer processes	9 Hour
Basic thermodynamic functions and applications, Calculation of heat of reaction, Application of Hess law, Other chemical processes for energy transfer, Microwave-assisted reactions, Sonochemistry, Electrochemistry, Photochemistry.	
Unit-5 - Energy storage	9 Hour
Introduction, Energy storage systems, Mechanical energy storage, Electrical storage, Electrical storage: the lead acid battery, Chemical storage, Electromagnetic energy storage, Thermal energy storage (Sensible heat), Thermal energy storage (Latent heat), Biological storage.	

Learning Resources	1 Rai G.D., "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 1999.	3 Bansal N.K, Manfred Kleen Man and Michael Meliss, "Renewable energy sources of conversion technology" TMH Publication.
	2 Anne E. Marteel-Parrish and Martin A. Abraham, "Green Chemistry and Engineering - A pathway to sustainability", John Wiley & Sons, 2014.	4 Kothari. P., Singal, K. C. and Rakesh, "Renewable Energy Sources and Emerging Technologies", Ranjan PHI Pvt. Ltd., New Delhi, 2008

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd	1. Dr. Lima Rose Miranda, Anna University	1. Dr. K. Deepa, SRMIST
2. Mr. S. Stalin, Course Director, Chem Skill Development Centre	2. Dr. N. Anantharaman, Former Professor, NIT Trichy	2. Dr. K. Selvam, SRMIST

Course Code	21CHO102T	Course Name	PETROLEUM ENGINEERING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):			The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes						
CLR-1:	Describe the formation of crude oil, overview of petroleum exploration and Oil and Gas Well Drilling Technology															1	2	3	4	5	6	7	8	9	10	11	12						
CLR-2:	Explain the Reservoir Engineering and Petroleum Production Operations																																
CLR-3:	Express the properties and analysis of Crude Oil																																
CLR-4:	Define the Petroleum refining processes																																
CLR-5:	Explain the Health Safety and Environment in Petroleum Industry, Enhanced Oil Recovery Techniques and Safety System																																
Course Outcomes (CO):			At the end of this course, learners will be able to:												Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3				
CO-1:	Define formation of crude oil, overview of petroleum exploration															2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Define the Petroleum Production Operations															2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Apply the properties and analysis of Crude Oil															3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-4:	Construct the Petroleum refining processes															3	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-5:	Incorporate the flow sheets of important petrochemicals															2	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	

Unit-4 - Petroleum Refining Processes	9 Hour
Petroleum refining processes, refining flow diagram, petroleum products, feedstock selection for petrochemical, application of C1 to C4 petrochemical, plastics and its classification, process flow for manufacture of synthetic rubber, feed stock for polyesters synthesis, process flow diagram for BTX.	
Unit-5 - Health Safety and Environment	9 Hour
Health safety and environment in petroleum industry: health hazards in petroleum industry, toxicity, physiological, asphyxiation, respiratory and skin effect of petroleum hydrocarbons, sour gases. Safety system: manual automatic shutdown system, blow down systems, gas detection system, fire detection and suppression systems, personal protection system measures, disaster crisis management in petroleum industry. Environment: environment concepts, impact on eco-system, the impact of drilling production operations on environment, environmental transport of petroleum wastes, offshore environmental studies, offshore oil spill and oil spill control, waste treatment methods, enhanced oil recovery techniques, thermal recoveries. Latest trends in petroleum engineering: coal bed methane, shale gas, oil shale, gas hydrate, and heavy oil.	

Learning Resources	<ol style="list-style-type: none"> 1. W. L. Nelson , Petroleum Refinery Engineering, , 4th Edition, McGraw Hill, New York, 1958. 2. B. K. Bhaskara Rao, Modern Petroleum Refining processes, 5th Edition, Oxford and IBH Publishing Co. Pvt. Ltd., 2008. 3. Gopala Rao M. and Marshall Sittig. "Dryden's Outlines of Chemical Technology", 3rd Edn, East-West Press, New Delhi, 1997. 4. J.H. Gary and G. E. Handwerk , Petroleum Refining: Technology and Economics, 4th Edition, Marcel Dekker, Inc., New York, 2001. 5. John C. Reis, Environmental Control in Petroleum Engineering, Gulf Publishing Company, 1996.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	20%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd	1. Dr. Lima Rose Miranda, Anna University	1. Dr.K.Anbalagan, SRMIST
2. Mr. S. Stalin, Course Director, Chem Skill Development Centre	2. Dr. N. Anantharaman, Former Professor, NIT Trichy	2. Dr. S. Kiruthika, SRMIST

Course Code	21CHO103T	Course Name	FUNDAMENTALS OF CHEMICAL ENGINEERING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes			
CLR-1:	Understand the basics of stoichiometry.	1	2	3	4	5	6	7	8	9	10	11	12																
CLR-2:	Describe the fundamentals of size reduction.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3													
CLR-3:	Understand the fundamentals of fluid flow phenomena.																												
CLR-4:	Understand the modes of heat transfer and rate of heat transfer.																												
CLR-5:	Acquire the knowledge on the basics of mass transfer.																												
Course Outcomes (CO):		At the end of this course, learners will be able to:												3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-1:	Comprehend the basics of stoichiometry and mass balance for processes.	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-													
CO-2:	Analyze the mechanical operations involved in material handling.	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-													
CO-3:	Analyze the concept of fluid and its flow characteristics.	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-													
CO-4:	Evaluate the rate of heat transfer for different modes.	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-													
CO-5:	Comprehend the basics of mass transfer.	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-													

Unit-1 - Material Balance	9 Hour
Units and dimensions (mole unit), Analysis of a mixtures, (mole, mass and partial pressure fraction (or percent)), Concentrations, Basis of calculations, Predicting P-V-T properties of gases using ideal gas law & Van der Waals equation, Calculation of density, Basics of chemical equation and stoichiometry (limiting reactant, excess reactant, conversion, selectivity and yield), Basic concepts involved in material balance calculations, Problem solving on Material Balance - Mixing, Drying, Evaporation	
Unit-2 - Particulate Technology	9 Hour
Size reduction, Size analysis, Screen efficiency, Filtration and its types – pressure and vacuum filtration, Filters and its classification, Basics of Settling and sedimentation, Principles of agitation, Types of agitators, Flow patterns: prevention of swirling- draft tubes, Blending and Mixing- Mixers: types	
Unit-3 - Fluid Flow	9 Hour
Nature of fluids: Type of fluids and flow, Fluid flow and their characteristics (Incompressible and compressible, potential flow, Laminar and turbulent flow), Hydrostatic equilibrium and manometers, Newtonian and Non-Newtonian fluids: Newton's law of viscosity, Reynolds number and transition from laminar to turbulent flow, Boundary layer concept, Pipe flow and friction factors, Drag & Lift forces, Terminal settling velocity, Introduction to various types of flow metering devices	
Unit-4 - Heat Transfer	9 Hour
Introduction to Heat Transfer, modes of Heat transfer, Fourier's law of heat conduction and Thermal conductivity, Steady-state conduction, resistances in series - slab and cylinder, Newton's law of cooling, Natural and forced convection, Heat transfer coefficient and Overall heat transfer coefficient, Heat transfer to fluids without phase change: Boiling and Condensation, Basic concepts of radiation, examples and application	

Unit-5 - Mass Transfer	9 Hour
Introduction to Mass Transfer operations, Diffusion, Types, Fick's I law of Diffusion, Steady – state molecular diffusion in fluids at rest and in laminar flow: molecular diffusion in gases, Principles of drying - driers and freeze drying, Methods of distillation, Basic concept of extraction and leaching, Adsorption, Membrane separation processes,	

Learning Resources	1. David M. Himmelblau, Basic Principles and Calculations in Chemical Engineering, 7 th ed., Prentice-Hall of India 2. Warren L. McCabe, Julian C. Smith, Peter Harriott, Unit Operations of Chemical Engineering, 7 th ed., McGraw Hill Education, 2014 3. S.K. Ghosal, S.K., Sanyal and S. Datta, Introduction to Chemical Engineering, TMH Book Company, 1998.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	10%	-	20%	-
Level 2	Understand	20%	-	10%	-	20%	-
Level 3	Apply	30%	-	20%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	30%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd	1. Dr. Lima Rose Miranda, Anna University	1. Mr. V. Ganesh, SRMIST
2. Mr. S. Stalin, Course Director, Chem Skill Development Centre	2. Dr. N. Anantharaman, Former Professor, NIT Trichy	2. Dr. S. Sam David, SRMIST

Course Code	21CHO104T	Course Name	PROCESS PLANT SAFETY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	Familiarize the basics of Industrial safety management												
CLR-2:	Acquire knowledge on chemical plant safety												
CLR-3:	Impart knowledge on Industrial accidents, prevention and fire protection systems												
CLR-4:	Acquire knowledge on Hazard identification techniques												
CLR-5:	Expose industrial hygiene and Occupational health hazards, Safety legislation in chemical industries												
Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	Identify the importance and basic principles of safety management												
CO-2:	Describe the safety aspects of chemical process industries												
CO-3:	Apply the methods of prevention of industrial accidents and learn the fire safety												
CO-4:	Familiarize with various types of Hazard Identification techniques												
CO-5:	Identify the components needed to provide a safe and healthful work environment and to gain insight into the laws relating to industries												

Program Outcomes (PO)														Program Specific outcomes		
1	2	3	4	5	6	7	8	9	10	11	12					
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
2	-	-	-	-	1	-	-	-	-	-	3	-	-	-		
1	2	3	-	-	-	-	-	-	-	-	-	-	-	-		
-	1	-	-	-	2	-	-	-	-	-	3	-	-	-		
2	3	-	-	-	1	-	-	-	-	-	-	-	-	-		
-	-	2	-	-	-	-	-	1	-	-	3	-	-	-		

Hazard and risk, Types of hazards - fire, explosion and toxic gas release, Structure of hazard identification and risk assessment. Process Hazard Analysis Identification of hazards : Fire and explosion hazard rating of process plants - The Dow Fire and Explosion Hazard Index, Preliminary hazard analysis, Hazard and Operability study (HAZOP), Failure mode and Effect Analysis (FMEA), Fault Tree Analysis, Cause and Effect Analysis in process industries.

Unit-5 - Industrial Hygiene and Occupational Safety

9 Hour

Industrial and Occupational health hazards- Electrical, Mechanical safety- Industrial Housekeeping, Personal protective equipment – Head protection – Eye and face protection- Hand protection – Foot and leg protection -Body protection – Respirators – Safety unions, government and voluntary agencies – OSHA, ILO, NEPA in safety. Health and safety executive (HSE)- Safety legislation in India, Factories act, Trade Union act, Worker's compensation act -Indian boilers act, Indian explosives act and rules, Mines act, Environmental protection act

Learning Resources	1. Sharma. A M., "Safety and Health in Industry" -A Hand book, BS Publications, 2019.	5. William Handley, "Industrial safety hand book", McGraw- Hill, 1969.
	2. Fulekar. M.H, "Industrial Hygiene and Chemical Safety", Dreamtech Press, 2020.	6. Daniel. A. Crowl and Joseph. F. Louvar, "Chemical Process safety: fundamentals with applications", Prentice Hall international series, 2020.
	3. Fawcett .H.H, and Wood W.S, "Safety and Accident Prevention in Chemical Operations", John Wiley & sons, U.S.A., 1965.	7. Geoff Wells, "Hazard Identification and Risk Assessment", 1997.
	4. Willie Hammer, Dennis Price, "Occupational safety management and Engineering", Prentice Hall, 2001.	8. Francis, R.L. and White, J.A, "Facilities layout and Location", Prentice Hall of India, 2002.
		9. James A. Klein, Bruce K. Vaughn, "Process Safety Key Concepts and Practical approaches", CRC press, 2017.

Learning Assessment

		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
Total		100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd	1. Dr. Lima Rose Miranda, Anna University	1. Dr. D. Nanditha, SRMIST
2. Mr. S. Ravichandran, Assistant General Manager, SPIC	2. Dr. N. Anantharaman, Former Professor, NIT Trichy	2. Dr. K.Selvam, SRMIST

Course Code	21CHO105T	Course Name	POLLUTION ABATEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Chemical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Familiarize the sustainability concepts, environmental regulations and global issues	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the solid waste generation and disposal methods															
CLR-3:	Demonstrate the concepts of water treatment principles and methods															
CLR-4:	Analyze the air pollution and noise pollution control methods															
CLR-5:	Familiarize the government initiatives, application of software															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Identify the effects of global environmental issues on earth	-	-	-	-	-	-	3	2	-	-	-	1	-	-	-
CO-2:	Discuss the sources and processing methods of solid wastes	1	-	2	-	-	-	3	-	-	-	-	-	-	-	-
CO-3:	Analyze the different water treatment methods and its implementation	2	-	3	-	-	-	3	-	-	-	-	-	-	-	-
CO-4:	Examine the sources of air pollution and the way to control it	1	2	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-5:	Summarize the role of government and application of software in pollution prevention	-	-	-	-	2	-	3	-	-	-	-	1	-	-	-

Unit-1 - Sustainability and Pollution Prevention Methods	9 Hour
Industrial activity and environment, indicators of sustainability-sustainability strategies. Barriers to sustainability, Global issues: Greenhouse effect, Ozone depletion, Global warming, Acid rain. Environment policies and regulations to encourage pollution prevention. Environment friendly chemical processes. Improved process methods to reduce pollution.	
Unit-2 - Solid Waste Management	9 Hour
Sources, types and general disposal methods of solid waste, Waste disposal and management laws and guidelines, Value-extraction from the solid wastes, energy from solid waste. Processing methods: Municipal waste, Biomedical waste, E-waste, plastic waste and nuclear waste.	
Unit-3 - Wastewater Treatment	9 Hour
Wastewater characteristics, Need of water treatment. Principle, removal mechanism, processing methods of Primary, secondary and tertiary treatments, Need of advanced water treatment, recovery of valuables from effluent. Case studies on water pollution control: pharmaceutical, pulp and paper industries.	
Unit-4 - Air Pollution and Noise Pollution Control	9 Hour
Sources and types of air pollution, Classification of air pollutants. Air pollution control equipments: Gravity Settlers, Centrifugal Separators, Electrostatic Precipitators (ESP), Bag filters, wet Scrubbers. Dust management, Odor Control Systems. Control methods of emissions: SO _x , NO _x , Hydrocarbons, VOC, CO. Noise pollution: Sources, causes, effects and control methods	
Unit-5 - Integrated Approach and Circular Economy	9 Hour
Integrated waste management policies, Challenges and opportunities associated with waste management in India, Indian waste management market size, Government initiatives towards environmental protection, Application of artificial intelligence, machine learning in pollution prevention. Circular economy strategies in waste management. Case studies on Indore model, National mission for clean Ganga.	

Learning Resources	1. Bishop.P, "Pollution Prevention: Fundamentals and Practice", McGraw Hill International Edn., McGraw Hill Book Co., Singapore, 2000	4. Rumana Riffat, "Fundamentals of Wastewater Treatment and Engineering", CRC Press, 2012.
	2. Pandey.G.N and Carney.G.C, "Environmental Engineering", Tata McGraw Hill, New Delhi, 2017.	5. Noel de Nevers, "Air Pollution Control Engineering", 3 rd Edition, Kindle Edition, 2016.
	3. Rajaram, V., Siddiqui, F.Z., Agrawal, S., Khan, M.E., "Solid And Liquid Waste Management Waste To Wealth", PHI Learning Pvt Ltd, 2016.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. A. Subramaniam, PESCO Beam Environmental Solutions Pvt. Ltd	1. Dr. Lima Rose Miranda, Anna University	1. Dr. Paromita Chakraborty, SRMIST
2. Mr. S. Stalin, Course Director, Chem Skill Development Centre	2. Dr. N. Anantharaman, Former Professor, NIT Trichy	2. Dr. S.Vishali, SRMIST

Course Code	21CE0301T	Course Name	MAINTENANCE AND REHABILITATION OF STRUCTURES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Assess the diagnosis of distress	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Provide an overview of performance of concrete															
CLR-3:	Identify the sources of dampness and its prevention remedies															
CLR-4:	Choose the appropriate material and its application for buildings															
CLR-5:	Study strengthening and demolition of structural component															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Diagnosis the distresses	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-2:	Demonstrate the performance of the concrete	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-3:	Identify the sources of dampness and its remedies	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-4:	Interpret various types of materials and its selection for building	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-5:	Strengthen and demolish the structural components	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-

Unit-1 - General Aspects	9 Hour
General consideration – distresses monitoring, causes of distresses - Defects due to climate, wear and erosion- Quality assurance & Inspection- Structural & economic appraisal- Life expectancy of different types of buildings- Influence of environmental elements on buildings- Design and construction errors-Corrosion mechanism-Effects of biological agents- Termite control and prevention- Chemical attack on building- Aspects of fire on buildings- Building cracks causes diagnosis-Remedial measures-Thermal cracks-shrinkage cracks- Vegetation and trees growth- Foundation movements	
Unit-2 - Damages and Their Remedies	9 Hour
Sources of dampness - Moisture movement from ground - DPC - Reasons for ineffective DPC - Roof leakage - pitched roofs - Madras terrace roofs - Leakage of concrete slabs Protective seal coatings - Ferro cement overlay - Resin or polymer slurry injection - Thin polymer overlay- Thin epoxy overlay- Dampness in solid walls- Condensation – hygroscopic salts- Remedial treatments- Dry pack & epoxy bonded dry pack- Chemical coating- Flexible and rigid coatings	
Unit-3 - Materials and Techniques of Repair	9 Hour
Materials: types – Essential parameters for materials - Special mortar and concretes, concrete chemicals - Special cements - High grade concrete- Expansive cement –polymer concrete- Epoxies, resins-surface coatings- parameters and type of coatings- Sulphur infiltrated concrete(SIFCON) - Properties and application of SIFCON- Ferrocement- Application of ferrocement- Fiber reinforced concrete- Types and applications- Admixtures-chemical and mineral admixtures - Case Studies SIFCON, Fibre reinforced concrete	

Unit-4 - Maintenance and Diagnosis of Failure	9 Hour
Distresses: concrete structures: Introduction, causes of deterioration Diagnosis of causes, flow charts for diagnosis – Methods of repair – repairing, spalling and disintegration - Preparing of concrete floor and pavements - Steel Structures: types and causes for deterioration – Types and causes for deterioration– preventive measures - Repair procedure - brittle fracture - Lamellar tearing – Defects in welded joints - Mechanism of corrosion - Design to protect against corrosion.– Design and fabrication errors - Distress during erection - Biotical treatments- Preservation – chemical preservatives- Brick masonry structures- Distresses and remedial measures	
Unit-5 - Strengthening and Demolition Aspect	9 Hour
General principle for strengthening - Relieving loads plan – Strengthening super structures -Plating- Conservation of composite construction - Post stressing - Jacketing –Bonded overlays- Reinforcement addition- Fiber wrap techniques- Pre placed aggregate concrete- Shotcrete- Strengthening concrete by surface impregnations- Vacuum methods- Strengthening the substructures: Shoring- Underpinning- Increasing the load capacity of footing- Design for rehabilitation - conservation of heritage structures	

Learning Resources	<ol style="list-style-type: none"> Handbook on “repair and rehabilitation of RCC buildings”, CPWD, Government of India, Government of India Press, India, 2011 Allen R.T and Edwards S.C, “Repair of Concrete Structures”, Blakie and Sons, UK, 1987 Dayaratnam.P and Rao.R, “Maintenance and Durability of Concrete Structures”, University Press, India, 1997 Denison Campbell, Allen and Harold Roper, “Concrete Structures, Materials, Maintenance and Repair”, Longman Scientific and Technical, UK, 1991. Dodge Woodson.R, “Concrete Structures – protection, repair and rehabilitation”, Elsevier Butterworth – Heinmann, UK, 2009. Peter H.Emmons, “Concrete Repair and Maintenance Illustrated”, Galgotia Publications Pvt. Ltd., 2001. Raika, R.N., “Learning from failures - Deficiencies in Design, Construction and Service” – Rand D Centre (SDCPL), Raika Bhavan, Bombay, 1987. https://onlinecourses-archive.nptel.ac.in/noc19_mm06/preview
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	25%	-	25%	-	25%	-
Level 4	Analyze	25%	-	25%	-	25%	-
Level 5	Evaluate	10%	-	10%	-	10%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Lavina D'souza, Head, RMC, Ultratech, lavina.dsouza@adityabirla.com	1. Dr. J. Karthikeyan, Associate Professor, NITT, jk@nitt.edu	1. Dr.K.S.Satyanarayanan, SRMIST
2. Mr. R. Eswaran, Chief Engineering Manager, L&T, eswaran@intecc.com	2. Dr. Manu Santhanam, Professor, IITM, manus@iitm.ac.in	2. Dr.M.Prakash, SRMIST

Course Code	21CE0302T	Course Name	DISASTER RESISTANT STRUCTURES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Know the basic concepts and design philosophy for disaster resistant structures	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Learn the various materials used and design for disaster resistant structures															
CLR-3:	Get an exposure about damage assessment and retrofitting															
CLR-4:	Learn the design and detailing for lifeline structures															
CLR-5:	Explore the modern techniques of damage assessment															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	understand the design philosophy for loads, earthquake and wind	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	study the materials to be used, and design to be made for disaster resistant structures	3	3	3	-	3	-	-	-	-	-	-	-	-	-	-
CO-3:	study damage assessment and retrofitting	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	understand materials design and detailing for lifeline structures	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	know techniques of damage assessment	3	2	2	-	3	-	-	-	-	-	-	-	-	-	-

Unit-1 - Behaviour of Lifeline Structures	9 Hour
Design philosophy to resist flood, cyclone, and earthquake and fire disasters National and International Codes of practice - By-laws of urban and semiurban areas – Past history and lessons from disasters - Approach to traditional and Modern Structures - Concept of life period based Design - case studies.	
Unit-2 - Community Structures	9 Hour
Safety analysis and rating - Reliability assessment repairs and Retrofitting techniques of Community Structures - Protection of Nuclear Structures - Dams, bridges and buildings.	
Unit-3 - Rehabilitation and Retrofitting	9 Hour
Testing and evaluation - Classification according to safety level - methods and materials for strengthening for different disasters - qualification test.	
Unit-4 - Materials, Design and Detailing	9 Hour
Modern Materials for disasters reduction - Detailing aspects of structures subject to probable disasters - Construction techniques - Analysis methodology – Techniques for optimal performance - Provisions for artificial disasters - blast and impact.	
Unit-5 - Techniques of Damage Assessment	9 Hour
Damage surveys - Maintenance and modification to improve hazard resistance - application GIS in disaster management - foundation improvement techniques.	

Learning Resources	1. Raiker, R.N. "Learning from failures, Deficiencies in Design, Construction and Service", R&D Center, Raiker Bhavan, 1987	3. Moskvina V "Concrete and Reinforced Concrete" - Deterioration and protection - MIR Publishers - Moscow 1983
	2. Allen.R.T., and Edwards.S.C., "Repairs of Concrete Structure", U.K.1987	4. Lecture notes on the course "Disasters Management" - conducted by Anna University, 2000

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Er. G.Hariharanath, GA Consultants, Chennai, gac1996ze@hotmail.com	1. Dr. G. Appa Rao, Professor, IIT Madras, garao@iitm.ac.in	1. Dr. R. Ravi, SRMIST
2. Er. AGV. Desigan, Design Group Engineering Consultancy Pvt Ltd. Chennai, desigan.agv@gmail.com	2. Dr. C. Uma Rani, Professor, Anna University, umarani@annauniv.edu	2. Dr. C. Arunkumar, SRMIST

Course Code	21CE0303T	Course Name	SMART CITY AND INFRASTRUCTURE	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the fundamental requirements for a smart city	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Recognize the challenges experienced during the transition to smart cities															
CLR-3:	Know the role of renewable energy in smart energy systems.															
CLR-4:	Comprehend the different technologies used to create smart cities															
CLR-5:	Recognize the various technologies involved in intelligent transportation systems															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Identify the core needs for a smart city.	3	2	-	2	-	3	3	-	-	-	-	-	-	-	-
CO-2:	Realize the difficulties encountered when moving to smart cities	3	2	-	2	-	3	3	-	-	-	-	-	-	-	-
CO-3:	Realize the function of renewable energy in modern energy systems	3	2	2	2	-	3	3	-	-	-	-	-	-	-	-
CO-4:	Identify the various technologies employed to develop smart cities	3	2	2	2	-	3	3	-	-	-	-	-	-	-	-
CO-5:	Learn about the various technologies used in intelligent transportation systems	3	2	2	2	-	3	3	-	-	-	-	-	-	-	-

Unit-1 - Fundamentals of Smart Cities	9 Hour
Introduction to Smart cities, Smart city indicators: Smart governance, Smart economy, Smart environment, Smart people, Smart living, Smart mobility, Smart City Mission, 2015, India "100 Smart Cities" Policy and Mission, Criteria for selection of 'Smart Cities', Case study on smart city projects in India	
Unit-2 - Transition Challenges	9 Hour
Legacy to smart infrastructure systems - Challenges faced in infrastructure layer, service layer and digital/data layer, Decision making constrains - Technological, Financial, Political, Social, environmental, Transition in Socio-Technical systems – role of feedback loop and data layer, Case study on Citizen's perspective on need for smart cities	
Unit-3 - Smart Energy System (SES)	9 Hour
SES Conceptualization and its types, Applications of renewable energy in SES, Smart energy devices, SES in different sectors: buildings, water management, transport, waste management, Case study on SES used in various sectors	
Unit-4 - Smart Buildings	9 Hour
Smart Services in buildings, IoT and Smart Building, Technologies involved in smart building, Energy conservation concepts in building, Green building concepts, GRIHA, LEED and IGBC rating system, Case study on a Platinum rated green building in India	
Unit-5 - Intelligent Transportation Systems (ITS)	9 Hour
Technologies involved in ITS, Smart traffic monitoring systems, Sensors used in ITS, Floating car data, Methods to obtain Floating car data, Navigation systems, Applications of ITS	

Learning Resources	1. Smart City on Future Life - Scientific Planning and Construction by Xianyi Li	3. Smart city government of India. http://smartcities.gov.in
	2. Jo Beall (1997); "A city for all: valuing differences and working with diversity"; Zed books limited, London (ISBN: 1-85649-477-2)	4. Giffinger, Rudolf; Christian Fertner; Hans Kramar; Robert Kalasek; Nataša Pichler-Milanovic; Evert Meijers (2007). "Smart cities – Ranking of European medium-sized cities". Smart Cities. Vienna: Centre of Regional Science

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%		20%		20%	
Level 2	Understand	20%		20%		20%	
Level 3	Apply	30%		30%		30%	
Level 4	Analyze	30%		30%		30%	
Level 5	Evaluate	-		-		-	
Level 6	Create	-		-		-	
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.V.Boobalan, Assistant Engineering Manager Larsen & Toubro, Chennai	1. Dr.K.Yogeswari, Professor, BSACIST	1. Dr.B.Indhu, SRMIST
2. Mr.K.Prithviraj Kannan, Manager at Larsen & Toubro, Bangalore	2. Dr.Vennila.G, Director, K.S.Rangasamy College of Technology, Tiruchengode	2. Mr.M.B.Sridhar, SRMIST

Course Code	21CE0304T	Course Name	REAL ESTATE MANAGEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the scenario of different sectors of real estate	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the relationship between economy and real estate															
CLR-3:	Interpret the norms and regulation of real estate sector															
CLR-4:	Develop the layout of the land for approval															
CLR-5:	Know the housing situation and measures taken in India															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the status of real estate sector in India	-	-	-	-	-	3	-	-	-	-	2	-	-	-	-
CO-2:	Apply the real estate investment decision making concepts	2	2	-	-	-	2	-	-	-	-	3	-	-	-	-
CO-3:	Understand the norms and regulation of real estate project appraisal	2	-	-	-	-	3	2	-	-	-	-	-	-	-	-
CO-4:	Create a layout of land for approval process	-	2	3	2	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Recognize the housing situation and reforms taken for housing in India	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Real Estate	9 Hour
Introduction to real estate, Real estate sector in India – land, Housing, office spaces, ware housing. Characteristics of land, Types of property, Ownership rights, Forms of ownership. Real estate contracts.	
Unit-2 - Real Estate Economics and Investment	9 Hour
Real estate and economy - Relationship between Real estate and macroeconomy, Real estate investment cycle, Real estate project development considerations, Real estate financing, Real estate investment decision making, Tax implications, Risk management, and Property valuation.	
Unit-3 - Real Estate Laws and Regulations	9Hour
Survey of land, Recording, Land divisions and subdivisions, land documents and registration process, Power agent, Land use and development control regulation – Master plan, zoning, Special economic zone, RERA 2016, Real estate investment trust, Transfer of property act 1882, Indian succession acts.	
Unit-4 - Real Estate Development	9 Hour
Land development approval authorities, DTCP's approval procedure, NOC certificates, Criteria for layout development, building byelaws, Building permissions, FSI/FAR, TDR, OSR Calculation, Market price and guideline value, Case study of land layout approval process	
Unit-5 - Real Estate Housing	9 Hour
Introduction to housing, Housing classification, Calculation of UDS, Housing situation in India – urban and rural, Housing policy schemes - Role of government in housing delivery, reforms to improve housing situation, Housing finance, PMAY 2015 – Types and features, Property tax calculation.	

Learning Resources	1. Steve Berges (2015), <i>The Complete Guide to Real Estate Finance for Investment Properties</i> , John Wiley & Sons 2. Arlyne Geschwender (2010), <i>Real Estate Principles and Practices</i> , Real Estate Education Company (REECO) 3. Michael Weir (2001), <i>Concepts of Property</i> , Blackwell Publishers	4. Charles Jacobus (2010), <i>Real Estate Principles</i> , Dearborn Real Estate Education 5. N.G. Miller and D.M. Geltner (2010), <i>Real Estate Principles for the New Economy</i> , Cengage Learning 6. https://nptel.ac.in/courses/124/107/124107001/
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%		20%		20%	
Level 2	Understand	20%		20%		20%	
Level 3	Apply	30%		30%		30%	
Level 4	Analyze	30%		30%		30%	
Level 5	Evaluate	-		-		-	
Level 6	Create	-		-		-	
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. G. Murali, Manager, Srivari Foundation, gmuralioffice@gmail.com	1. Dr. K.Yogeswari, Associate Professor, B.S. Abdur Rahman Crescent Institute of Science and technology, yogeswari@crescent.education	1. Mr. M.B. Sridhar, SRMIST
2. Mr. K. M. Nanthan, Planning Manager south Factories, L&T, rkmmnn@Intecc.com	2. Dr. M. Harikrishna, Associate Professor, National Institute of Technology, Calicut, harikrishna@nit.ac.in	2. Dr. B. Indhu, SRMIST

Course Code	21CE0305T	Course Name	PROJECT MANAGEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Appreciate the project objectives and prepare a project schedule for time, cost and resources	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Prepare an estimate of the project cost and managing projects.															
CLR-3:	Update Project Progress and prepare reports for review and to control the project															
CLR-4:	Plan for the project organisation and directing															
CLR-5:	Prepare a final project closure report and international projects															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Comprehend and identify the elements of project management	3	-	-	-	-	-	-	-	3	-	3	-	-	-	-
CO-2:	Ability to select alternative courses of action to attain project objectives	3	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-3:	Manage the phases of projects	3	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-4:	Ability to Estimate, plan, calculate, and adjust project variable	3	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO-5:	Can manage project risk, including identifying, analyzing and responding to risk	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Project Perspectives	9 Hour
Project Life Cycle - Types of Projects- Selection of Professional Services - Stake-holders in Project - Structure of Project Organization - Role of Project Managers - Financing of Constructed Facilities – Project success Factors.	
Unit-2 - Project Estimation & Management	9 Hour
Project scope- Work breakdown structure and its process - Multidisciplinary team and its role - Factors of Project estimates, types of costs, methods, refining estimates- Case study in WBS and project estimates - Value Engineering - Developing project network- CPM & PERT - Risk Management process - Contingency planning - Opportunity Management and Change control management - Resources allocation classifications methods - Case study in Risk management and resources allocation	
Unit-3 - Construction Planning, Monitoring and Control	9 Hour
Types of Project Plans - Work Breakdown Structure - Resource Levelling - Resource Allocation -Project Scheduling - Types of Project Scheduling - Project Progress Control - Measuring and Updating of Project Progress using Bar Chart, Progress Reports to aid Progress Review - Stage-wise Completion Cost - Earned Value Analysis.	
Unit-4 - Project Organising and Directing	9 Hour
Introduction, Organizational Design, Hierarchical Systems, Organization Structure, Types of Organization Structure, Formal and Informal Organization, Factors Determining Span of Management, Centralization and Decentralization, Span of control, Understanding authority and responsibility.	
Unit-5 - Project Closure and International Projects	9 Hour
Project Closure - Financial Closure - Contract Closure - Project Managers' Closure - Lessons Learnt from the Project - Profit/Loss at Completion - Disputes and Claims - Settlement of Disputes and Claims - Final Project Closure Reports -International projects – environmental factors and cross-culture - Agile Traditional Vs. agile methods - Case studies in project audits.	

Learning Resources	1. Clifford Gray, Erik Larson and Gautam V Desai, <i>Project Management</i> , Tata McGraw Hill Edition, 7th Edition, 2018. 2. A Guide to the Project Management Body of knowledge PMBOK Guide PMBOK® Guide – Sixth Edition, 2017. 3. Adrienne Watt, <i>Project Management</i> , BC Campus Victoria, 2 nd edition, 2014.	4. Choudhury, S, <i>Project Management</i> , Tata McGraw-Hill Publishing Company, New Delhi, 1988. 5. George J. Ritz, <i>Total Construction Project Management</i> - McGraw-Hill Inc, 1994. 6. Kumar Neeraj ha, <i>Construction Project Management - Theory and Practice</i> , Pearson Publications - Dorling Kindersley (India) Pvt. Ltd., 2012.
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%		20%		20%	
Level 2	Understand	20%		20%		20%	
Level 3	Apply	30%		30%		30%	
Level 4	Analyze	30%		30%		30%	
Level 5	Evaluate	-		-		-	
Level 6	Create	-		-		-	
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. G. Muneeswaran, Senior Engineering Manager, Larsen & Toubro, Chennai	1. Dr. S. Shanmugapriya, Associate Professor, CIT, Coimbatore	1. Dr. K. S. Anandh, SRMIST
2. Er. P. Jahanathan, CRO & VP - Contracts, Utracon Private Limited, Chennai	2. Dr. S. Kamal, Associate Professor, Annamalai University, Chidambaram	2. Dr. A. Celina, SRMIST

Course Code	21CE0306T	Course Name	ENVIRONMENTAL IMPACT ASSESSMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand Importance of EIA and its evolution	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Learn principles and methods of environmental analysis	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	Know the interrelationship between various activities and their impact on environment																											
CLR-4:	Understand the Application of EIA in various sectors																											
CLR-5:	Explain the concept of environmental management																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Understand the importance of various rules & regulation in EIA and role of stake holders in EIA	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-												
CO-2:	Apply various techniques in Impact Assessment studies	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-												
CO-3:	Identify the Impact on Water, land and soil environments	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-												
CO-4:	Identify the Impact on Air, Noise, Biota and Socio-Economic environments	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-												
CO-5:	Evaluate the Impact using management plan and make suggestions	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-												

Unit-1 - Introduction	9 Hour
Basic concepts of EIA- Overview of Environmental Laws- EPA 1986, Water Act, Forest Act- Evolution: EIA Notification 1994; 2006 and EIA Draft 2020- Types of EIA; Screening; Scoping- Role of Governmental and NGOs.	
Unit-2 - EIA Methodologies	9 Hour
Baseline Description- Environmental Examination- Screening; Scoping- Methods: Checklist; Matrix; Network; Overlay; Cost Benefit Analysis- Public participation- Analysis of Alternatives- Expert systems	
Unit-3 - Components of the Environment – Water, Land, Soil	9 Hour
Setting Baseline- Impact Prediction and Assessment of- Water: Surface Water, groundwater; Land; Soil- Case Studies.	
Unit-4 - Components of the Environment – Air, Noise, Biota, Socio-Economic	9 Hour
Setting Baseline- Impact Prediction and Assessment of- Noise, Air Environment; Biota; Socio-Economic; Cultural and Aesthetics- Case Studies.	
Unit-5 - Environmental Management Plan	9 Hour
Environmental Management Strategies- Environmental Management Systems- ISO14001; Environmental Mitigation; Risk Analysis; Environmental Audit- TOR preparation- Documentation and Report Preparation	

Learning Resources	1. L. W. Canter, <i>Environmental Impact Assessment</i> , 2nd Ed., McGraw-Hill, 1997.	3. R. Therivel, John Glasson, Andrew Chadwick, <i>Introduction to Environmental Impact Assessment (Natural and Built Environment)</i> , Routledge, 2005.
	2. G. Burke, B. R. Singh and L. Theodore, <i>Handbook of Environmental Management and Technology</i> , 2nd Ed., John Wiley & Sons, 2000	4. K. Whitelaw and Butterworth, <i>ISO 14001: Environmental System Handbook</i> , 1997

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%		20%		20%	
Level 2	Understand	20%		20%		20%	
Level 3	Apply	30%		30%		30%	
Level 4	Analyze	30%		30%		30%	
Level 5	Evaluate	-		-		-	
Level 6	Create	-		-		-	
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. SuyashMisra, Arcadis Consulting India Private Limited, Bangalore.	1. Dr. Vivekanand, Assistant Professor, MNIT, Jaipur	1. Dr. P. Purushothaman. SRMIST
2. Dr.Rajkumar, Director, Hubert Enviro care Systems, Chennai.	2. Dr. Harish Gupta, Assistant Professor, Osmania University, Hyderabad	2. Mr. S. Ramesh, SRMIST

Course Code	21CE0307T	Course Name	MUNICIPAL SOLID WASTE MANAGEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Study the various sources and classification of solid and hazardous waste	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Know the concepts related to waste characteristics and source reduction															
CLR-3:	Realize insights to the storage, collection and transport of waste															
CLR-4:	Explore the concepts related to waste processing technologies															
CLR-5:	Understand concepts related to waste disposal															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the acquired knowledge on building materials and products for construction.	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-2:	Identify various building finishing materials and ferro cement applications for the building construction.	3	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-3:	Apply the knowledge on the masonry, building transport and the termite treatment.	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Disseminate the knowledge on various eco-friendly building materials	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-5:	Recognize the energy efficient buildings and cost-effective construction techniques	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-

Unit-1 - Sources and Types of Municipal Solid Waste	9 Hour
Introduction and Objective of Solid waste management, Sources of solid wastes, Classification of Solid Wastes-Sources & Types based, quantity – factors affecting generation of solid wastes, Salient features of Indian Legislations on management and handling of municipal solid wastes, Public health effect - Environmental effect, Case studies in hazards due to solid waste management	
Unit-2 - Characteristics of Solid Waste and Source Reduction	9 Hour
Characteristics – Physical, chemical and biological methods of sampling and characterization, Waste Stream Assessment (WSA), Source reduction (Basics), Monitoring and Evaluation, Storage and collection of recyclables.	
Unit-3 - Waste Collection, Storage and Transportation	9 Hour
Methods of Collection- Hauled container, Stationary container and other collection methods, types of vehicles, collection routes, Transfer station, types and requirements, selection of location, operation and maintenance.	
Unit-4 - Waste Processing Techniques	9Hour
Mechanical Volume and Size Reduction and Equipment's, Volume reduction or compaction, Size reduction or shredding, Processing techniques- Composting, Incineration, Pyrolysis, Gasification, Anaerobic degradation	
Unit-5 - Disposal	9 Hour
Dumping of solid waste, Methods of dumping of solid waste, Landfill- types, essential components, monitoring of landfill, Leachate collection & treatment, Environmental monitoring system. .	

Learning Resources	1. George Tchobanoglous, Hilary Theisen, Samuel Vigil, <i>Integrated Solid Waste Management</i> , McGraw Hill, 1993 2. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. Evans and <i>Environmental Resources Management, Hazardous waste Management</i> , Mc-Graw Hill International edition, New York, 2001.	4. CPHEEO, "Manual on Municipal Solid waste management, Central Public Health and Environmental Engineering Organization , Government of India, New Delhi, 2000. 5. NPTEL Course-Municipal solid waste management. https://nptel.ac.in/courses/120108005/
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in	1. Dr. E. S. M Suresh, NITTT Taramani, Chennai esmsuresh@gmail.com	1. Dr. K. Prasanna, , SRMIST
2. Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com	2. Dr. G. Dhinakaran, Asst. Professor, CES, Anna University, twinsdina@gmail.com	2. Mr. S. Dhanasekar, SRMIST

Course Code	21CE0308T	Course Name	DISASTER MITIGATION AND MANAGEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Introduce various types of disasters and role of various stakeholders in disaster management	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Understand various hazards, and health issues on disaster management	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Understand various phases of disaster management and risk reduction measures																
CLR-4:	Acquire knowledge on hazard management systems																
CLR-5:	Manage the pre and post disaster scenario																
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	Understand the role of various stakeholders in risk reduction measures	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-	
CO-2:	Acquire knowledge on various modes of hazards and their occurrence	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-	
CO-3:	Illustrate key concepts of vulnerability and risk assessment techniques	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-	
CO-4:	Evaluate various processes employed in pre-disaster scenarios for risk preparedness	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-	
CO-5:	Integrate the management principles in disaster management during post disaster scenario	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-	

Unit-1 - Introduction	9 Hour
Disaster Management- History; Global issues- Strategies- Phases- Global & Indian scenario- Major Disasters in India- Disaster Management in India- NDRF; Disaster Management Act (2005); Disaster Management Policy (2009)	
Unit-2 - Hazards	9 Hour
Natural- Geological; Hydrological; Meteorological; Biological- Man Made- Industrial; Health related; Infrastructural; Intentional	
Unit-3 - Vulnerability and Risk Assessment	9 Hour
Risk Evaluation- Quantitative & Qualitative; Risk Perception; Vulnerability- Mitigation Measures- Need; Agencies involved; Types; Obstacles involved- Role of Insurance	
Unit-4 - Pre-Disaster Management	9 Hour
Integrated Developmental Planning for Disaster Management; Role of Government agencies and NGO's in Mitigation & Management- Vulnerable Groups in Disasters Management; Essential Supplies; Site Management- Role of Technology in Disaster Management; Emergency Management Systems; Role of Remote sensing, GIS and GPS in Disaster Management	
Unit-5 - Post Disaster Management	9 Hour
Medical Trauma and Stress Management- Physical and Socio-economic Impacts of Disasters; Emotional Impacts of Disasters- Rehabilitation and Reconstruction; Education and Public awareness; Capacity building	

Learning Resources	1. D. Alexander, <i>Natural Disasters</i> , ULC Press, 1999	3. Damon P. Coppola, <i>Introduction to International Disaster Management</i> , 3rd edition, Elsevier, 2015
	2. W.N. Carter, <i>Disaster Management: A Disaster Management Handbook</i> , Asian Development Bank, 2008	4. C.J. Barrow, <i>Developing the Environment: Problems and Management</i> , Harlow: Longman, 1995 5. <i>Disaster Management Act "2005"</i> , Ministry of Home Affairs, Govt. of India, 2005

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%		20%		20%	
Level 2	Understand	20%		20%		20%	
Level 3	Apply	30%		30%		30%	
Level 4	Analyze	30%		30%		30%	
Level 5	Evaluate	-		-		-	
Level 6	Create	-		-		-	
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Suyash Misra, Arcadis Consulting India Private Limited, Bangalore.	1. Dr. Vivekanand, Assistant Professor, MNIT, Jaipur	1. Dr. R. Sivakumar, SRMIST
2. Dr. Rajkumar, Director, Hubert Envirocare Systems, Chennai.	2. Dr. Harish Gupta, Assistant Professor, Osmania University, Hyderabad	2. Dr. P. Purushothaman, SRMIST

Course Code	21CE0309T	Course Name	WATER POLLUTION AND ITS MANAGEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Create insights to the source and type of water pollution	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Analyze the characteristics of domestic and industrial water pollution															
CLR-3:	Utilize resource recovered from the waste water															
CLR-4:	Identify the various methods to control the water pollution and regulatory bodies															
CLR-5:	Sustainable practice for effective water management.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the various sources of water pollution	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-
CO-2:	Knowledge of various characteristics presented in polluted water	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-
CO-3:	Apply the concept of resource recovered from the polluted water	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-
CO-4:	Knowledge of Water Act 1974 and regulatory bodies to control of Water Pollution	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-
CO-5:	Analyze the environmental impact of water pollution	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Water Pollution	9 Hour
Sources and types of water pollution - Point source pollution and Non-point source pollution - Types of pollutants - Adverse effects of pollutants - Principles of pollution assessment - Terms and definitions in wastewater - Transport of pollutants - Causes of Water pollution - Hydraulic flow of water pollution - Sampling procedure - Methods of sampling and storage - Effects of water pollution - Eutrophication and their process - Public awareness and practices in water pollution.	
Unit-2 - Characteristics and Effects of Polluted Water	9 Hour
Physical characteristics-Colour, odour, Turbidity, Temperature, Specific conductivity - Chemical characteristics- Organic and Inorganic - Biological characteristics and its significance - Analysis of water pollution and their testing procedures - Water Quality standards-BIS - Discharge of Effluent and their standards - Water borne diseases - Impact of water related issues on animals - Ground water quality - Impact on Effluent in ground water quality - Effects of ground water pollution - Sampling methods of ground water pollution - Legal regulatory aspects of groundwater contamination - Industrial Participation with regulatory boards - Water used in different industries.	
Unit-3 - Mitigation and Control Measures	9 Hour
Mitigation Measures for Water pollution Contamination due to industries - Treatment of Industrial wastewater guidelines and protocol for treating Industrial wastewater - Pollution characteristics of certain typical industries - Thermal pollution and its adverse effects - Role of regulatory bodies in Protection of Water bodies-Control Measures - Discharge Standards for Rivers and Streams - Self-purification of streams - Role of stakeholders - Water quality monitoring and its purpose - Monitoring activities and its strategy - Types of monitoring - Steps involved in water quality monitoring - Parameters and frequency of monitoring - Graphical representation of water quality.	

Unit-4 - Rules and Regulations	9 Hour
Administrative regulation under recent legislations in water pollution control - Water (Prevention & control of pollution) Act 1974 - Water (Prevention & control of pollution) Rules 1975 - Water (Prevention & control of pollution) Cess Act 1977 - Role of pollution control board - Powers given to boards - Irrigational approach in waste conservation - Legal action against defaulters - Management strategy used for water conservation - Industrial approach in water conservation - Awareness of domestic usage for conservation of water - Groundwater management - Public participation in water management - Environmental indices and its types - Water quality index and its types - Assessment of water quality index.	

Unit-5 - Effective Water Management	9 Hour
Rain water Harvesting - Classification of rainwater harvesting - Micro level harvesting, macro level harvesting and other methods - Roof top harvesting and their benefits - Role of Regulatory bodies - Role of local bodies- TWAD Board – CMWSSB - Case Studies related to Effective Water Management - Water crisis and their effects - Water crisis and their effects - Problems faced in water crisis - Zero water day – Awareness programme for water management and its sustainable development - Importance of World water day and World Environment day - Vulnerability of improper water management - Case study on adverse effects of water crisis - Sustainable development.	

Learning Resources	<ol style="list-style-type: none"> 1. Fair.G.M, "Water and Waste water engineering Vol. I& II". John Wiley and sons, Newyork. 2010. 2. Metcalf & Eddy, "Wastewater engineering, Treatment and Reuse", Tata McGraw hill publications, 2008. 3. CPHEEO, "Manual on Sewerage & Sewage Treatment", Ministry of Housing and Urban Affairs, Government of India, New Delhi, 2009. 4. P. K. Goel, Water Pollution: Causes, effects and Control. New Age International, 2006. 5. NPTEL Course: Water, Society and Sustainability. -https://onlinecourses-archive.nptel.ac.in/noc18_hs36 6. NPTEL Course: Wastewater Treatment & Recycling. https://onlinecourses-archive.nptel.ac.in/noc18_ce26
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai	1. Dr. E. S. M Suresh, NITTTR, Taramani, Chennai.	1. Dr. K. Prasanna, SRMIST
2. Mr. A. Abdul Rasheed, CMWSS Board	2. Dr. G. Dhinakaran, Asst. Professor, CES, Anna University	2. Mr. S. Ramesh, SRMIST

Course Code	21CE0310T	Course Name	GLOBAL WARMING AND CLIMATE CHANGE	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Gain knowledge about the earth system	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Study the basics of climate parameters and climate change causing elements															
CLR-3:	Understand importance of global warming															
CLR-4:	Understand different mitigation measures against global warming and their protocol															
CLR-5:	Explore renewable resource usage to reduce global warming															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the acquired knowledge on earth system	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-
CO-2:	Identify the climate parameters and their impact due to human activities	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-
CO-3:	Identify the climate change impact in various sector	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-
CO-4:	Interpret different protocols related to climate change	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-
CO-5:	Implement and analyze reason behind global warming, mitigation measures of climate change	3	-	-	-	-	2	3	-	-	-	-	-	-	-	-

Unit-1 - Earth's Climate System	9 Hour
Introduction to earth system-hydrosphere, lithosphere, cryosphere, atmosphere and biosphere. Hydrological cycle and Carbon cycle. Atmosphere and its composition, Atmospheric stability and lapse rate, Ozone layer and its functions, Ozone depletion and ozone hole, Global warming and its impacts, Greenhouse gases and greenhouse effect, El Nino and La Nina	
Unit-2 - Climate Indices and Extreme Events	9 Hour
Climatology, Paleoclimatology, Indian climate system and their classification, Role of land and ocean to regulate climate, Role of ice and wind to regulate climate, causes of climate change Milankovitch theory (natural cause), Human induced climate variations, Climate Extremes-Cyclones, thunderstorms, Tornadoes, Heat waves, Sea level rising-Ice melting, temperature rising, Floods and droughts. Energy balance of the earth	
Unit-3 - Physical Evidences of Climate Change	9 Hour
Climate change impact in different sectors- Agriculture, Forestry, Fishery, Socio economic impact – tourism, Evidences of warming and change in atmosphere/ ocean circulations. Sea level changes and Shore line changes. Polar ice, Isotopes, Ice melting and Ice core analysis, glaciers loss. Energy supply: Role of energy in development of human civilization, Emissions from energy generation. Role of energy in current climate change.	
Unit-4 - International Responses to Climate Change	9 Hour
Climate change organization and programs, History of IPCC and UNFCCC, IPCC- Assessment report highlights, UNEP, Need for international protocols of climate change, Kyoto protocol, Montreal protocol, UNDP - United nations development program, Carbon credit and Clean development mechanism.	
Unit-5 - Climate Change Adaptation and Mitigation Measures	9 Hour
Renewable and alternative energy technologies- Biomass, Solar, Hydro, Geothermal and Wind. Clean technology, biodiesel, compost, biodegradable plastics. Concept of sustainable development, Concept of carbon sequestration. Adaptation measures- Green building technology. Public awareness - Methods and ecology, economics and ethics: the missing links. Life cycle analysis, Role environmentalist.	

Learning Resources	1. Dash Sushil Kumar, "Climate Change –An Indian Perspective", Cambridge University Press India Private limited 2007. 2. Adaptation and mitigation of climate change-Scientific Technical Analysis. Cambridge University Press, Cambridge, 2006.	3. Atmospheric Science, J.M. Wallace and P.V. Hobbs, Elsevier / Academic Press 2006. 4. Jan C. van Dam, Impacts of "Climate Change and Climate Variability on hydrological Regimes", Cambridge university press, 2003.
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai	1. Dr. E. S. M Suresh, NITTTR, Taramani, Chennai.	1. Mr. K.C.Vinu Prakash, SRMIST
2. Mr. A. Abdul Rasheed, CMWSS Board	2. Dr. G. Dhinakaran, Asst. Professor, CES, Anna University	2. Dr. K.Prasanna, SRMIST

Course Code	21CE0311T	Course Name	INDOOR AND AMBIENT AIR QUALITY MANAGEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	take up the basic concepts of air pollution.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	introduce the knowledge of health related to air pollution															
CLR-3:	Acquire knowledge on various causes, effects and control measures of environmental air pollution															
CLR-4:	Acquire knowledge about design criteria related to IAQ															
CLR-5:	Identify better ventilation system to improve good IAQ															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Analyze the sources, effects and control measures of environmental air pollution	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-2:	Analyze air quality parameters and its impact	3	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-3:	Recognize air pollution measurement methodology	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Apply the concept of Exhaust system for better IAQ	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-5:	Identify the Control devices related to air pollution	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-

Unit-1 - Introduction	9 Hour
Hazard vs. risk; Concentrations of air pollutants; Fundamentals of contaminant mixture the respiratory system: Anatomy of the lungs, modeling gas exchange, diseases; Body burden; 1 st order system	
Unit-2 - Design Criteria	9 Hour
Contaminant concentration limits; Fire and explosion; Hearing and sound; Heat stress; Odor Pollutant emission rates: Physical measurements, flux chambers, mass balances, emission factors. Diffusion Evaporation: Evaporation from liquid surfaces, evaporation in confined spaces, thermodynamics of evaporation	
Unit-3 - Ventilation	9 Hour
General ventilation: Dilution vs. displacement ventilation; The well-mixed model: sources, wall losses, recirculation, air cleaners, infiltration and exfiltration, various room configurations; Clean rooms; Effectiveness of ventilation systems; Heating and cooling costs; Ventilation in tunnels Local ventilation: Hood design, bulk materials, proper selection and design of hoods, buoyant plumes, canopy hoods, air curtains. Air cleaners in series and parallel	
Unit-4 - Exhaust Duct System Design	9 Hour
Energy equation, major and minor losses, fan performance curves, fan selection (matching fan to duct system requirements) 13 Particulate air pollution: Particle sizes/classifications/terminology; Aerodynamic drag and drag coefficient, particles settling in quiescent air (gravimetric settling - terminal settling speed); Equations of particle motion and particle trajectory calculations in an air flow, using Runge-Kutta to predict 2-D particle trajectories; Non-spherical particles - equivalent diameters; Gravimetric settling in rooms and ducts; Inertial separation in curved ducts	
Unit-5 - Air Pollution Control Devices	9 Hour
(APCSs): Lapple cyclones and other APCSSs; Performance and efficiency of APCSSs; Series and parallel APCSSs for particle removal; Filters Control of particulates. Cyclones. Scrubbers. Electrostatic precipitators. Baghouse filters. Control of gases. Absorption. Wet scrubbers and packed scrubbers. Flue gas desulfurization. Adsorption. Incineration. Carbon sequestration.	

Learning Resources	1. Mukherjee, "Environmental Pollution and Health Hazards", causes and effects, 1986 2. Kenneth wark, Cecil F.Warner, "Air Pollution its Origin and Control", Harper and Row Publishers	3. Noel De Nevers, "Air pollution control Engineering", McGraw Hill International Edition 4. M. N. Rao, H. V. N. Rao, Air pollution, Tata McGraw Hill Pvt Ltd, New Delhi, 1993
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai	1. Dr. E. S. M Suresh, NITTTR, Taramani, Chennai.	1. Mr. S. Ramesh, SRMIST
2. Mr. A. Abdul Rasheed, CMWSS Board	2. Dr. G. Dhinakaran, Asst. Professor, CES, Anna University	2. Mr. S. Dhanasekar, SRMIST

Course Code	21CE0312T	Course Name	INTELLIGENT TRANSPORTATION SYSTEMS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Know the fundamentals of road traffic and its features	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the importance of telecommunication and data collection of ITS															
CLR-3:	Learn the various functional areas of ITS															
CLR-4:	Know the user specific ITS implementation															
CLR-5:	Explore the ITS applications globally															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Define the fundamentals of road traffic and features	3	3	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-2:	Assess the telecommunication requirements and data collection of ITS	3	3	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-3:	Demonstrate the functional areas of ITS	3	3	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-4:	Disseminate the implementations of ITS for various user needs and services	3	3	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-5:	Interpret the global applications of ITS	3	2	-	-	-	3	-	-	-	-	-	-	-	-	-

Unit-1 - Fundamentals of Road Traffic Flow	9 Hour
Road user and vehicle characteristics, Basic road geometric elements, Fundamental parameters and relations, Measurement at a Point (Volume data collection and analysis, PCU, PHF etc.), Measurement over a Short Section (Speed data collection and analysis), Measurement along a Length of Road (Density and travel time measurement and analysis), Moving Observer Method, Traffic forecasting and growth studies, Parking and Accident data analysis methods	
Unit-2 - ITS Basics and Telecommunication and Data Requirements	9 Hour
Introduction to Intelligent Transportation Systems (ITS) – Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Application of sensors to Traffic management; Traffic flow sensor technologies, ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection. Vehicle – Road side communication – Vehicle Positioning System	
Unit-3 - ITS Functional Areas	9 Hour
Advanced Traffic Management Systems (ATMS), Advanced Traveller Information Systems(ATIS) - Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS) - Advanced Public Transportation Systems (APTS) - Advanced Rural Transportation Systems (ARTS)	
Unit-4 - ITS User Needs and Services	9 Hour
Travel and Traffic management - Public Transportation Management - Electronic Payment - Commercial Vehicle Operations - Emergency management - Advanced Vehicle Safety systems, Information management	
Unit-5 - ITS Applications	9 Hour
Automated Highway Systems, vehicles in platoons - Integration of Automated Highway Systems, a case study - ITS programs globally - Overview of ITS implementations in developed countries, ITS in developed countries - Case studies	

Learning Resources	1. Kadiyali, L. R. (1987), "Traffic Engineering and Transportation Planning", Khanna Publishers, India. 2. Intelligent Transport Systems, Intelligent Transportation Primer, Washington, US, 2001 3. Choudury M A and Sadek A, "Fundamentals of Intelligent Transportation Systems Planning" Artech House.	4. Sussman, J. M., "Perspective on ITS", Artech House Publishers, 2005. 5. US Department of Transportation, "National IT'S Architecture Documentation", 2007 (CDROM). 6. Cycle W.Halsapple and Andrew B.Winston, "Decision Support Systems – Theory and Application", Springer Verlag, New York, 1987
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Asif Ahmed, Business manager, Ingevity, ahmed.asif@ingevity.com	1. Dr. Venkaiah Chowdary, Professor, NITW, vc@nitw.ac.in	1. Dr. A. Padma Rekha, SRM IST
2. Mr. Ankit Pachouri, Transport Planner, IUT, New Delhi, ankit.pachouri@iutundia.org	2. Dr. V Sunita, Associate Professor, NITT, sunitha@nitt.edu	2. Mr. G. Sivaprakash, SRM IST

Course Code	21CE0313T	Course Name	TRAFFIC MANAGEMENT SYSTEMS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes					
CLR-1:	Study the traffic flow parameters													1	2	3	4	5	6	7	8	9	10	11	12						
CLR-2:	Explore the traffic flow management techniques													Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3			
CLR-3:	Know the intersection control measures																														
CLR-4:	Learn the parking systems and management																														
CLR-5:	Understand the public transportation systems																														
Course Outcomes (CO):		At the end of this course, learners will be able to:																													
CO-1:	Determine the traffic flow parameters for traffic management													3	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Apply the various measures of managing the traffic													3	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-3:	Adopt the control measure at the intersections													3	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-		
CO-4:	Determine the parking characteristics and apply the management techniques													3	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-		
CO-5:	Design the public transportation management system													3	2	3	3	-	-	-	-	-	-	-	-	-	-	-	-		

Unit-1 - Traffic Flow Studies	9 Hour
Urban Road Systems - Highway System Classification, Types of Transportation Facilities - Traffic Flow Theory - Time Space diagram, Variables of Interest - Primary Elements of Traffic Flow, Flow Speed Density, Fundamental Diagram of Traffic Flow, Mathematical Relationships Describing Traffic Flow - Volume Studies, Traffic Counts, travel Time and Delay Studies, Spot Speed Studies, Capacity and Level of Service for Highway Segments.	
Unit-2 - Traffic Flow Management	9 Hour
Introduction, Travel demand management - Traffic management measures, Restrictions to turning movements, one way streets, tidal flow operations, Traffic segregation, Traffic calming, conflict point diagram for various types of streets	
Unit-3 - Intersection Control and Management	9 Hour
Objectives, Demand management, Engineering measures, Junction types(Uncontrolled non-priority junctions, Priority junctions, Channelization, Roundabouts, Traffic signals, Grade separation), Road markings, Traffic Signs	
Unit-4 - Parking Systems and Management	9 Hour
Traffic and parking problems, Types of Parking Facilities, Ill effects of parking, Definitions of Parking Terms, Methodology of Parking Studies, Analysis of Parking Data, Zoning and parking space requirement standards, Design standards for on street parking, Off street parking facilities, Peripheral parking system, Parking control systems.	
Unit-5 - Public Transport Management	9 Hour
Design objectives, Bus priority measures, Bus lanes and busways, and parking management measures, Bus stop improvements, Exclusive bus lanes systems, Bus Preemption at signals, encouraging car pooling	

Learning Resources	1. Dr. Kadiyali L. R., <i>Traffic Engineering and Transport Planning</i> , Khanna Publishers	5. IRC-SP-12 2015 <i>Parking facilities in Urban Roads</i>
	2. Khanna S.K., Justo C.E.G., <i>Highway Engineering</i> , Nem Chand & Bros., Roorkee.	6. IRC 65 - 1976 <i>Traffic Rotaries</i>
	3. Bindra S.P., <i>A course in Highway Engineering</i> , Dhanpat Rai Publications	7. IRC 93 - 1985 <i>Design & Installation of Road Traffic Signals</i>
	4. Martin Whol, Brian V Martin , <i>Traffic system Analysis for Engineers and Planners</i> , McGraw Hill, NY, 1967	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Asif Ahmed, Business manager, Ingevity, ahmed.asif@ingevity.com	1. Dr. Venkaiah Chowdary, Professor, NITW, vc@nitw.ac.in	1. Dr. A. Padma Rekha, SRM IST
2. Mr. Ankit Pachouri, Transport Planner, IUT, New Delhi, ankit.pachouri@iutundia.org	2. Dr. V Sunitha, Associate Professor, NITT, sunitha@nitt.edu	2. Mr. G. Sivaprakash, SRM IST

Course Code	21CE0314T	Course Name	TRAFFIC FLOW MODELING AND SIMULATION TECHNIQUES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand various traffic stream parameters and data collection methods	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Study the traffic control measures and LOS analysis															
CLR-3:	Explore the traffic stream modeling															
CLR-4:	Know the various methods and techniques of simulation															
CLR-5:	Learn the validation of simulation models with case studies															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Evaluate the traffic stream characteristics	3	3	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Analyse the traffic control measures	3	3	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Develop the traffic stream models	3	2	3	3	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Simulate traffic at mid blocks and intersections	3	2	3	3	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply the techniques of calibration and validation of models	3	2	3	3	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Traffic Stream Characteristics	9 Hour
Road user and vehicle characteristics, Fundamental parameters and relations, Measurement at a Point (Volume data collection and analysis, PCU, PHF etc.), Measurement over a Short Section (Speed data collection and analysis), Measurement along a Length of Road (Density and travel time measurement and analysis), Moving Observer Method, Traffic forecasting and growth studies.	
Unit-2 - Traffic Analysis and Management	9 Hour
Basics of traffic management, Principles of Traffic Control and Traffic Signs, Road Markings and Channelization, Uncontrolled Intersection: Gap acceptance and capacity concepts, Uncontrolled Intersection, Traffic Rotaries and Grade Separated Intersection. Capacity and Level of Service concepts, Queuing models and applications. Traffic Signal, Evaluation of a Traffic Signal: Delay Models, Capacity and LOS Analysis of a Signalized, Coordinated Traffic Signal, Vehicle Actuated Signals and Area Traffic Control.	
Unit-3 - Traffic Stream Modelling	9 Hour
Traffic Stream Models, Modelling vehicle arrivals: Continuous distributions to model Headways and speed, Modelling vehicle arrivals: Discrete distributions to model flow and evaluation of distributions, Car Following Models: Linear models, Car Following Models: Non-linear models, Lane Changing Models, Microscopic Traffic Simulation (Vehicle generation, model frame work, calibration and validations, statistical error analysis, applications)	
Unit-4 - Simulation Methodologies	9 Hour
Monte Carlo method, Generation of Pseudorandom Numbers, Discrete Random deviates - Simulation methods, Fundamentals of simulation, Introduction to factorial experimental designs, Fractional factorial design - Components of traffic simulations models, vehicle arrival and movement models, mixed traffic flow simulation, Simulation model development strategies - Study of large scale simulation models; Scanning Technique; Time based and Even-based methods - Examples of Macro, Meso, and Microscopic based simulation models.	

Unit-5 - Calibration and Validation of Simulation of Models **9 Hour**

Simulation scenario evaluation, Number of runs and factors influencing simulation output, Calibration and validation definitions, methodology for calibrating and validating a microscopic traffic simulation model. Calibration and validation guidelines, data requirements, Goodness-of-fit measures - Case studies of application of simulation for various transportation engineering problems.

Learning Resources	<ol style="list-style-type: none"> 1. Kadiyali, L. R. (1987), "Traffic Engineering and Transportation Planning", Khanna Publishers, India. 2. Banks, J; Carson, JS; Nelson, B.L. Discrete-event system simulation. 5th ed. Upper Saddle Drew, DR., Traffic flow theory and control, McGraw Hill Book Company, 1976. 3. May, A.D. Traffic Flow Fundamentals, Prentice Hall, 1st Edition, 1990. 	<ol style="list-style-type: none"> 4. Fred L. Mannering, Scott S. Washburn, Kilareski Walter P., Principles Of Highway Engineering And Traffic Analysis, Wiley India Pvt Ltd., 4th edition, 2011. 5. Highway Capacity Manual, Transportation Research Board, Washington, D.C., 2010. 6. Kadiyali, L.R, "Traffic Engineering and Transport Planning", Khanna Publishers, Delhi, 2006
---------------------------	--	--

Learning Assessment

	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Asif Ahmed, Business manager, Ingevity, ahmed.asif@ingevity.com	1. Dr. Venkaiah Chowdary, Professor, NITW, vc@nitw.ac.in	1. Dr. A. Padma Rekha, SRM IST
2. Mr. Ankit Pachouri, Transport Planner, IUT, New Delhi, ankit.pachouri@iutundia.org	2. Dr. V Sunitha, Associate Professor, NITT, sunitha@nitt.edu	2. Mr. G. Sivaprakash, SRM IST

Course Code	21CE0315T	Course Name	VISCOELASTICITY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the concepts of linear viscoelasticity	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Explore different models to model the behavior of linear viscoelastic materials															
CLR-3:	Comprehend the relation between linear viscoelastic material functions															
CLR-4:	Explore different experimental approaches to characterize the behavior of viscoelastic material															
CLR-5:	Know the correspondence principle and its application towards studying the behavior of viscoelastic material															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Discriminate the viscoelastic material based on its response to different loading conditions	3	3	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Apply different models to the material that exhibits linear viscoelastic behavior	3	3	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Analyze the relation between viscoelastic characteristic functions	3	3	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Characterize the mechanical properties of the viscoelastic material	3	3	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply basic principles to models the behavior of viscoelastic material	3	3	-	3	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Linear Viscoelastic Behavior	9 Hour
Introduction to Viscoelasticity - Review of the structure of viscoelastic materials - Linear viscoelastic behavior, Creep, recovery, relaxation and oscillatory shearing	
Unit-2 - Constitutive Equations	9 Hour
Constitutive equations using mechanical analogs - Maxwell model, Kelvin model, standard linear solid and Burgers' model, generalized models, Integral models,	
Unit-3 - Relation Between Viscoelastic Functions	9 Hour
Boltzmann Superposition Principle - Creep compliance, relaxation modulus, complex modulus, phase lag – Relation between different functions.	
Unit-4 - Mechanical Characterization of Viscoelastic Material	9 Hour
Time-temperature superposition, WLF and Arrhenius equation - Mechanical characterization of viscoelastic materials and experimental Investigation	
Unit-5 - Correspondence Principle	9 Hour
Viscoelastic beam problems - elastic-viscoelastic correspondence principle - Effect of pressure and temperature	

Learning Resources	1. A.S. Wineman and K. R. Rajagopal, <i>Mechanical Response of Polymers: An Introduction</i> , Cambridge University Press, 2000.	4. W. N. Findley, J. S. Lai and K. Onaran, <i>Creep and Relaxation of Nonlinear Viscoelastic Materials</i> , Dover, 1989.
	2. M. T. Shaw and W. J. MacKnight, <i>Introduction to Polymer Viscoelasticity</i> , 3rd Ed., Wiley-Interscience, 2005.	5. A.C. Pipkin, <i>Lectures on Viscoelasticity Theory</i> , 2nd Ed., Springer, 1986
	3. E. Riande, R. Diaz-Calleja, M. G. Prolongo, R. M. Masegosa, C. Salom, <i>Polymer viscoelasticity</i> , CRC Press, 1999	6. R. M. Christensen, <i>Theory of Viscoelasticity</i> , Dover, 2nd Ed., 1982
		7. J. D. Ferry, <i>Viscoelastic Properties of Polymers</i> , 3rd Ed., Wiley, 1980.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers			
Experts from Industry		Experts from Higher Technical Institutions	Internal Experts
1. Dr. Asif Ahmed, Business manager, Ingevity, ahmed.asif@ingevity.com		1. Dr. Venkaiah Chowdary, Professor, NITW, vc@nitw.ac.in	1. Dr. A. Padma Rekha, SRM IST,
2. Mr. Ankit Pachouri, Transport Planner, IUT, New Delhi, ankit.pachouri@iutundia.org		2. Dr. V Sunitha, Associate Professor, NITT, sunitha@nitt.edu	2. Mr. G. Sivaprakash, SRM IST

Course Code	21CE0316T	Course Name	SOIL SCIENCES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the consistency dispersion and workability of soils	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Know the chemical composition of soils															
CLR-3:	Realize the conceptual and practical understanding of soil mineralogy															
CLR-4:	Familiarize with soil conservation and watershed management															
CLR-5:	Explore the mechanism and concept related to soil microbial interactions and genetic landforms															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Gain a thorough knowledge on the characterization and management of soil structure	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Recommend the concept of ion exchange process in the soil chemistry	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Apply the soil classification, mineralogy and soil maps for the Indian scenario	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Demonstrate efficient soil conservation techniques	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-5:	Illustrate the geomorphology of soil condition in India	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-

Unit-1 - Soil Physics	9 Hour
Scope of soil physics and its relation with other branches of soil science; soil as a three phase system - Soil texture, textural classes, mechanical analysis, specific surface - Soil consistence; dispersion and workability of soils; soil compaction and consolidation; soil strength; swelling and shrinkage - Basic concepts - Soil structure - Genesis, types, characterization and management soil structure; Soil aggregation, aggregate stability	
Unit-2 - Soil Chemistry	9 Hour
Chemical (elemental) composition of the earth's crust and soils - Soil colloids: inorganic and organic colloids - Origin of charge, concept of point of zero-charge (PZC) and its dependence on variable - Charge soil components, surface charge characteristics of soils; diffuse double layer theories of soil colloids, zeta potential, stability, coagulation/flocculation of soil colloids - Ion exchange processes in soil; cation exchange-theories based on law of mass action - Chemistry of acid soils - Chemistry of salt-affected soils .	
Unit-3 - Soil Mineralogy, Genesis, Classification	9 Hour
Classification, structure, chemical composition and properties of clay minerals; genesis and transformation of crystalline and non-crystalline clay minerals; identification techniques; amorphous soil constituents and other non-crystalline silicate minerals and their identification; clay minerals in Indian soils - Soil classification, soil mineralogy and soil maps - Usefulness.	
Unit-4 - Soil Conservation	9 Hour
Soil conservation planning; land capability classification; soil conservation in special problem areas such as hilly, arid and semi-arid regions, waterlogged and wet lands - Watershed management - concept, objectives and approach; water harvesting and recycling; flood control in watershed management; socio- economic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds.	

Unit-5 - Soil Biology, Geomorphology and Geochemistry **9 Hour**

Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial biomass; microbial interactions; unculturable soil biota - General introduction to geology and geochemistry, major and minor morphogenic and genetic landforms, study of schematic landforms and their elements with special reference to India.

Learning Resources	1. Baver LD, Gardner WH & Gardner WR. 1972. Soil Physics. John Wiley & Sons.	5. Hudson N. 1995. Soil Conservation. Iowa State Univ. Press.
	2. Bolt GH & Bruggenwert MGM. 1978. Soil Chemistry. Elsevier.	6. Alexander M. 1977. Introduction to Soil Microbiology. John Wiley & Sons.
	3. McBride MB. 1994. Environmental Chemistry of Soils. Oxford Univ. Press.	7. Brikland PW. 1999. Soils and Geomorphology. 3rd edition. Oxford Univ. Press
	4. Indian Society of Soil Science 2002. Fundamentals of Soil Science. ISSS, New Delhi.	

Learning Assessment

Learning Assessment	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. P.Selvanambi, Divisional Engineer (Highways), sundariselvam@yahoo.com	1. Dr.M.Muttharam, Anna University, muttharam@annauniv.edu	1. Dr. P.T.Ravichandran, SRMIST
2. Mr.Lenin K.R., Head –GEOTECH, SECON Private Limited, Bangalore, lenin.kr@secon.in	2. Dr.V.Murugaiyan, Pondichery Engineering College, vmurugaiyan@pec.edu	2. Ms. S. Mary Rebekah Sharmila, SRMIST

Course Code	21CE0317J	Course Name	RURAL DEVELOPMENT AND TECHNOLOGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Gain knowledge about Indian rural development concepts.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Explore the fundamental energy sources available in rural areas, and the biogas production technology.															
CLR-3:	Provide familiarity about developments in rural water supply and sanitation															
CLR-4:	Enhance the knowledge of India's rural development policies and programs															
CLR-5:	Understand the evolution of entrepreneurship in Rural India															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe the various dimensions of rural developments	2	-	-	1	-	1	-	-	-	-	-	-	-	-	-
CO-2:	Develop a solutions for reducing waste and make waste product into useful resources	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-3:	Apply multidisciplinary approaches in Public Health practice	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
CO-4:	Acquire knowledge on policies, schemes and programs for the development of rural community	-	-	-	-	-	3	1	-	-	-	-	-	-	-	-
CO-5:	Implement practical solutions for managing unemployment issues through entrepreneurship	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-

Unit-1 - Introduction	9 Hour
Basic introduction about rural development- History of Rural development- Rural Settlement of UBA Villages Analysis (Practically in the field) * - concept for Rural Settlements- Types of Rural Settlements and its significance- Land use pattern Analysis of UBA Villages (Practically in the field) * - The function and pattern of rural settlements - Rural Settlement analysis- Technological Intervention in Rural Settlement Practically in Lab	
Unit-2 - Rural Energy and Technology	9 Hour
Different energy sources in rural areas- Biomass based energy systems - Assessment of Waste in the University Campus (Practically in the field) * - concepts of pyrolysis and its types - concepts of pyrolysis and its types - Pyrolysis technology and waste management technique- Biomass methodologies (Practically in the field) * - Bio gas and its uses- Biogas production using various substrates including MSW and industrial wastes - Various Digesters and Its Materials (Practically in the field) *	
Unit-3 - Rural Water supply and Sanitation	9 Hour
Rural Water Supply and Sanitation current status - National and State level programme of RWS- Sanitation practices and strategies of Rural UBA Villages (Practically in the field) *. The Basic principles of rural water supply and sanitation - sewage collection and treatment - Hygiene practices at Workplace (Practically in the field) * - Identification of shortcomings for potential improvement - The Latest developments in rural water supply and sanitation practices - Campaign and Concept of 3 R (Practically in the field) *	
Unit-4 - Rural Development policies	9 Hour
Rural Development Legislations and Policies in India - CSR Policy - Policy Framework for rural community and development (Practically in the field) * - Implementation program or plan in Rural development - National Rural Livelihood Mission - Analysis of various Govt. Schemes and Policies (Practically in the field) * - Community Based Natural Resources Management (CBNRM) - Integrated Natural Resources Management (INRM), PMGSY, PMAY - Implementing Rural Employment Schemes in UBA Villages (Practically in the field) *	

Unit-5 - Rural Entrepreneurship	9 Hour
<i>Entrepreneurship Evolution of Entrepreneurship in Rural India - Types of Rural Entrepreneurship - Practicing Business environment in the rural villages (Practically in the field) * - Challenges for Rural Entrepreneurs - Social and Political Aspects of Rural Development - Networking with all Rural Support Systems(Practically in the field) * - Entrepreneurial Opportunities-Potential and Limitations Active - Rural infrastructure development - Development of Cultural Integrity in Rural Entrepreneurship (Practically in the field) *</i>	
*Practical exposure will be given to the students on the specified topics	

Learning Resources	1. U. C. Sharma, <i>Non-Conventional Sources of Energy</i> , Studium Press LLC, USA, 2014. 2. S. Gupta, <i>Rural Water Supply and Sanitation</i> , Vayu Education of India, New Delhi, 2013. 3. M.C. Dash, <i>Concepts of Environmental Management for Sustainable Development</i> Publisher: I K International Publishing House Pvt. Ltd., 2013.	4. G.Shivakoti, U. Pradhan, H. Helmi (editors), <i>Redefining Diversity and Dynamics of Natural Resources Management in Asia</i> , Volume 1st Edition, Sustainable Natural Resources Management in Dynamic Asia, Editors: ISBN: 9780128054543, Elsevier, 2016. 5. P.Rogers, K. F. Jalal, J. A. Boyd, <i>An Introduction to Sustainable Development</i> . Publisher: Routledge; 1 edition, ISBN-10: 1844075206, 2007
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.Chetan Chittalkar, MGNCRE, Govt. of India chetanmgncre@gmail.com	1. Dr. Ramesh, Professor, NIRD, Hyderabad, rramesh.nird@gmail.com	1. Dr. Vignesh K.S, SRM IST
2. Mr. Suresh Mariaselvam, Independent Consultant, suresh.masel@gmail.com	2. Dr. Samuel Inbadurai, Director, SIRD, Tamil Nadu, sird@tn.nic.in	2. Dr. Deepa, SRM IST

Course Code	21CE0318T	Course Name	FLOODS AND FLOOD MANAGEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn floods and flood estimation	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Know flood forecasting and flood routing techniques															
CLR-3:	Understand about flood control structures															
CLR-4:	Study earthen embankments and their design															
CLR-5:	Understand stability analysis of slopes and foundation															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Estimate design floods and flood flows	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Appraise flood routing and flood control	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Design various flood control structures	3	3	3	3	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Analyze and design earthen embankments	3	3	3	3	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Analyze stability of slopes and foundation	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Floods and Flood Estimation	9 Hour
Definition and causes of floods, design flood, SPF, PMF and its importance - Estimating design flood and flood flows - Envelop curves - Methods of flood frequency - Flood frequency studies - Unit hydrograph method - DAD analysis	
Unit-2 - Flood Forecasting and Flood Routing	9 Hour
Flood forecasting, need, problems and limitations - River forecasting procedure - Flood forecasting methods - Flood routing - Reservoir routing - Channel routing, Muskingham method - Flood control, structural and non-structural measures for flood control	
Unit-3 - Flood Control Structures	9 Hour
Gully control structures, temporary check dams - Permanent structures for gully control - Design of chute spillway, design of drop inlets - Ravine reclamation - Control and training of rivers - Objectives, classification, methods of river training - Marginal embankments - Guide banks - Groynes	
Unit-4 - Earthen Embankments	9 Hour
Types and methods of construction - Foundation design – Grouting - Seepage through embankments- Flownet and its properties - Seepage line in composite earth embankments - Drainage filters, piping and its causes - Design of earth dams	
Unit-5 - Stability Analysis	9 Hour
Stability analysis of slopes, stability of foundation against shear - Small earthen embankments - Subsurface dams, site selection and constructional features - Planning of flood control projects and their economics	

Learning Resources	1. Mutreja K. N. 1986, <i>Applied Hydrology</i> , Tata McGraw-Hill Publishing Co, Delhi.	3. Garg S.K., 2009, <i>Irrigation Engineering and Hydraulic Structures</i> , Khanna Publishers Pvt. Ltd, New Delhi.
	2. Subramanya K., 2008, <i>Engineering Hydrology</i> , 3 rd Edi., Tata McGraw-Hill Publishing Co., Delhi	4. Murthy, V.V.N. 2002, <i>Land and Water Management Engineering</i> , 4 th Edi., Kalyani Publishers, New Delhi

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Abdul Hakeem, National Remote Sensing Center, Hyderabad, abdulhakeem_k@nrsc.gov.in	1. Dr. Rehana Shaik, IIIT, Hyderabad, rehana.s@iiit.ac.in	1. Dr. Shaik Niyazuddin Guntakal, SRMIST
2. Dr. Sat Kumar Tomer, Satyukt Analytics Pvt Ltd., Bengaluru, sat@satyukt.com	2. Dr. S. Saravanan, NIT Trichy, saravanans@nitt.edu	2. Dr. R. Sathyanathan, SRMIST

Course Code	21CE0319T	Course Name	CLIMATE CHANGE AND WATER RESOURCES MANAGEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand climate and climate system	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Know the impacts of climate change on water resources															
CLR-3:	Explore the tools available for vulnerability assessment															
CLR-4:	Learn to adapt to climate change and bio diversity															
CLR-5:	Study case studies on water resources management															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Identify the components of climate system and greenhouse effect	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-2:	Disseminate the impacts of climate change in Indian and Global scenarios	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-3:	Recognize the usage of tools to prepare different models	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-4:	Illustrate bio energy crops, hydro power and crop land management	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-5:	Solve the real time issues by adapting different strategies	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-

Unit-1 - The Climate System	9 Hour
Definitions- Climate, climate system, climate change - Drivers of climate change - Characteristics of climate system – Greenhouse effect - Carbon cycle - Wind systems – Ozone hole in the atmosphere – El Nino, La Nina - ENSO, Teleconnections	
Unit-2 - Impacts of Climate Change	9 Hour
Global scenario - Indian scenario - Observed changes and projected changes of IPCC - Impacts on water resources – NATCOM report - Impacts on sectoral vulnerabilities – Special Report on Emissions Scenarios (SRES) - Different scenarios	
Unit-3 - Tools for Vulnerability Assessment	9 Hour
Need for vulnerability assessment – Steps for assessment - Approaches – Models – Quantitative and Economic models - Impact matrix approach - Box models - Zero dimensional models - Higher dimension models - Global climate models – Regional models - Sectoral models	
Unit-4 - Adaptation and Mitigation	9 Hour
Water related adaptation to climate change in the fields of Eco systems and biodiversity – Agriculture and food security, land use, human health, water supply and sanitation - Adaptation and vulnerability and sustainable development – Carbon dioxide capture and storage (CCS), Bio energy crops, Biomass electricity, Hydropower – Energy use in buildings, Land use change and management, cropland management - Implications for policy and sustainable development	
Unit-5 - Case Studies	9 Hour
Water resources assessment case studies - Ganga Damodar project – Ganga valley project – Adaptation strategies in assessment of water resources – Hydrological design practices- Dam safety - Flood management strategies - Drought management strategies - Temporal and spatial assessment of water for irrigation	

Learning Resources	1. Shukla P.R, Subobh K Sarma Climate change and India: Vulnerability assessment and adaptation , University press (India) Pvt ., Ltd., Hyderabad	3. UNFCCC Technologies for adaptation to climate change , 2006
	2. IPCC Report technical paper IV – Climate change and water, 2008	4. Preliminary consolidated report on effect of climate change on water resources, GOI, CWC, MOWR, 2008

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Abdul Hakeem, National Remote Sensing Center, Hyderabad, abdulhakeem_k@nrsc.gov.in	1. Dr. Rehana Shaik, IIIT, Hyderabad, rehana.s@iiit.ac.in	1. Dr. Shaik Niyazuddin Guntakal, SRMIST
2. Dr. Sat Kumar Tomer, Satyukt Analytics Pvt Ltd., Bengaluru, sat@satyukt.com	2. Dr. S. Saravanan, NIT Trichy, saravanans@nitt.edu	2. Dr. R. Sathyanathan, SRMIST

Course Code	21CE0320T	Course Name	PRINCIPLES OF SATELLITE REMOTE SENSING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
Disseminate basic concepts and applications of Electromagnetic Spectrum in Remote Sensing, Energy Balance		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:																
Enlighten the methods and methodologies for Data acquisition, platforms, sensors and their characteristics																
CLR-3:																
Introduce the digital image processing tools and techniques																
CLR-4:																
Upskill the knowledge about optical, thermal and microwave Remote Sensing for solving real life problems																
CLR-5:																
Instill the importance of satellite remote sensing in various real-world applications																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:		3	-	-	-	-	-	-	-	-	3	-	3	-	-	-
Understand the physical principles and sensing process in remote sensing																
CO-2:		3	-	-	-	3	-	-	-	-	-	-	3	-	-	-
Study different type of sensors and their characteristics																
CO-3:		3	-	-	-	3	-	-	-	-	-	-	3	-	-	-
Analyze preprocessing techniques and discuss various Digital Image Processing techniques																
CO-4:		3	-	3	-	-	-	-	-	-	-	-	3	-	-	-
Explain statistical outlook of satellite images and different classification approaches with respect to diverse applications																
CO-5:		3	-	-	3	-	-	-	-	-	-	-	3	-	-	-
Apply the knowledge of satellite remote sensing in various thematic studies																

Unit-1 - Introduction to Remote Sensing	9 Hour
Remote Sensing: History, Development, Definition, Concept & Principles - Electromagnetic Radiation (EMR) and Its Characteristics - Wavelength Regions and their Significance - Interaction of EMR with Atmosphere and Earth's Surface: Absorption - Reflectance and Scattering - Atmospheric Windows - Energy Balance Equation - Spectral Response and Spectral Signature - Spectral, Spatial, Temporal and Radiometric resolutions.	
Unit-2 - Data Acquisition Methods	9 Hour
Platform and their Specifications: Balloon, Rocket, Helicopter, Aircraft and Spacecraft - Sensors and their Specifications: MSS, TM, LISS (I, II, III, IV), PAN, WiFS, AWiFS, MODIS, Weather & Communication Satellites - Scanning mechanisms - Optical and thermal scanners - Satellites and their Specifications: IRS, SPOT, LANDSAT, SENTINEL, RADARSAT.	
Unit-3 - Types of Satellite Remote Sensing	9 Hour
Imaging and Non-Imaging - Active and Passive - Multispectral and Hyperspectral Sensors - Electro-Optical Systems - Microwave Remote sensing concepts: Backscattering - Range and Azimuth Direction, Polarization - Dielectric Properties - Surface Roughness and Interpretation - Applications of optical, thermal and microwave remote sensing.	
Unit-4 - Image Processing Techniques	9 Hour
Concepts about digital image and its characteristics - Radiometric and Geometric correction technique - Types of image displays and FCC - Radiometric enhancement techniques - Spatial enhancement techniques - Contrast stretching: Linear and non-linear methods - Low Pass Filtering: Image smoothing - High Pass Filtering: Edge enhancement and Edge detection - Gradient filters, Directional and non-directional filtering - Unsupervised and Supervised classification techniques.	

Unit-5 - Satellite Remote Sensing – Applications **9 Hour**

Applications of Artificial Intelligence and Remote Sensing – Environmental studies – Smart city planning – Disaster management – Smart Transport planning – Health applications – Water resource management – Agricultural studies – Forest mapping – Soil studies.

Learning Resources	<ol style="list-style-type: none"> 1. Joseph, George and Jeganathan, C, <i>Fundamentals of Remote Sensing</i>, 3rd Edition, Universities press (India) Pvt. Ltd., Hyderabad, 2017 2. John A. Richards, <i>Remote Sensing Digital Image Analysis</i>, Springer-Verlag Berlin and Heidelberg GmbH & Co. KG, ISBN: 9783642441011, 2022 3. Jensen, J.R, <i>Introductory Digital Image Processing: A remote sensing perspective</i>, Prentice Hall Series in GIS, USA, 1996 	<ol style="list-style-type: none"> 4. Lillesand, Thomas M. and Kiefer, Ralph, W, <i>Remote Sensing and Image Interpretation</i>, 4th Edition, John Wiley and Sons, New York, 2007 5. D. Jude Hemanth, <i>Artificial Intelligence Techniques for Satellite Image Analysis</i>, Springer Nature Switzerland, Indian Edition, https://doi.org/10.1007/978-3-030-24178-0, 2020
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Sainarayanan Gopalakrishnan, HCL Technologies, sai.jgk@gmail.com	1. Dr. R. Kumar, NIT Nagaland, rajagopal.kumar@nitnagaland.ac.in	1. Dr. R. Annadurai, SRMIST
2. Dr. Sricharan Srinivasan, Wipro Technologies, sricharanms@gmail.com	2. Dr. B. Surendiran, NIT Puducherry, surendiran@nitpy.ac.in	2. Dr. M. Kamalanandhini, SRMIST

Course Code	21CE0321T	Course Name	SPATIAL INFORMATION SYSTEM	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn the basic concepts of GIS	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the data models and structures in GIS															
CLR-3:	Learn the vector and raster analysis in GIS															
CLR-4:	Study the geospatial analysis in GIS															
CLR-5:	Understand modeling techniques in GIS															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand concepts and data representation of geospatial data	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Learn how geospatial data are stores in GIS	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-3:	Understand the operation with vector and raster data	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Analyze the various interpolation techniques in GIS	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Evaluate the functions of various GIS modeling	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-

Unit-1 - Fundamentals of Cartography	9 Hour
Definition of Map – Mapping Organisation in India- Classification based on Function, Scale, Characteristics – Ellipsoid and Geoid – Co-ordinate Systems – Rectangular and Geographic Coordinates – UTM and UPS – Projection – Function – Types of Map Projections – Transformations – Function - Affine transformation – Choice of Map Projection – Evolution of cartography – Geo-Spatial, Spatial and Non-spatial data – Definition of GIS – Evolution GIS – Components of GIS	
Unit-2 - GIS Data Models and Data Input	9 Hour
Point, Line Polygon / Area, elevation and surface – Tessellations – Attributes and Levels of Measurement – Data Sources – Ground and Remote Sensing survey – Collateral data collection – Input: Map scanning and digitisation, Registration and Georeferencing – Concepts of RDBMS – Raster Data Model – Grid – Data Encoding - Data Compression – Vector Data Model – Topological properties – Arc Node Data Structure – Raster Vs. Vector Comparison – File Formats for Raster and Vector – Data conversion between Raster and vector.	
Unit-3 - Raster and Vector Data Analysis	9 Hour
Raster Data analysis: Local, Neighborhood and Regional Operations – Map Algebra – Vector Data Analysis: Topological Analysis, point-in-polygon, Line-in-polygon, Polygon-in-Polygon – Proximity Analysis: buffering, Thiessen Polygon – Non-topological analysis: Attribute data Analysis- concepts of SQL– ODBC	
Unit-4 - Network Analysis and Surface Analysis	9 Hour
Network – Creating Network Data - Origin, Destination, Stops, Barriers – Closest Facility Analysis, Service Area Analysis, OD Cost matrix analysis, Shortest Path Analysis – Address Geocoding – Surface Analysis – DEM, DTM - Point data to Surface interpolation – DEM Representation – Applications.	

Unit-5 - Data Output and Web Based GIS **9 Hour**

Map Compilation – Cartographic functionalities for Map Design – Symbolization – Conventional signs and symbols – Spatial Data Quality – Lineage, Positional Accuracy, Attribute Accuracy, Completeness, Logical Consistency – Meta Data – Web based GIS: Definition, Merits – Architecture – Map Server – Spatial Data Infrastructure – Spatial Data Standards.

Learning Resources	<ol style="list-style-type: none"> 1. C.P. Lo, Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, 2nd Edition, Prentice Hall, 2006, ISBN-13: 9780131495029 2. John Jensen, Ryan Jensen, Introductory Geographic Information Systems, International Edition, Pearson Publishers, 2012, ISBN-10: 0136147763, ISBN-13: 9780136147763 3. Kang-tsung Chang, Introduction to Geographic Information Systems with Data Set CD-ROM, 6th Edition, Mc Graw Hill, 2013, ISBN-10: 0077805402, 	<ol style="list-style-type: none"> 4. Anji Reddy .M, "Textbook of Remote Sensing and Geographical Information Systems", BS Publications, Hyderabad. 2011. ISBN: 81-7800-112-8. 5. Michael N. DeMers, "Fundamentals of Geographic Information Systems", 2008. 6. Rolf A. de "Principles of Geographic Information Systems An introductory textbook" The International Institute for Aerospace Survey and Earth Sciences (ITC), The Netherlands, 2001.1 7. https://nptel.ac.in/courses/105107155/
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Tune Usha, Scientist, NCCR, Chennai, usha@nccr.gov.in	1. Dr. S. Sanjeevi, Professor, Anna University, Chennai ssanjeevi@annauniv.edu	1. Dr. R. Sivakumar, SRMIST
2. Dr. Sarunjith K J, Scientist, NCSCM, Chennai, sarunjith@gmail.com	2. Dr. C. Lakshumanan, Bharathidasan University, drlaks@gmail.com	2. Dr. Karuppasamy Sudalaimuthu, SRMIST

Course Code	21CE0322T	Course Name	REMOTE SENSING AND GIS APPLICATION IN ENGINEERING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Study the forest and water applications mapping used in engineering techniques.	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Understand the applications mapping potentialities of remote sensing data for Rock and Soil engineering	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Understand the concepts of urban regional planning and Environmental Impact Assessment applications mapping in engineering.																	
CLR-4:	Understand the concepts of GIS data analysis tools and software's.																	
CLR-5:	Apply the Knowledge of GIS in identification of the data and interpretation and perform various GIS spatial analysis and modelling.																	
Course Outcomes (CO):		At the end of this course, learners will be able to:		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	Apply the acquired knowledge on remote sensing application data separately and in combination with GIS techniques for forest and Water potentialities.	3	-	-	3	-	-	-	-	-	-	-	-	-	3	-	-	-
CO-2:	Identify various types of rock minerals and soil moisture estimation in combination with remote sensing and GIS application techniques.	3	-	-	3	-	-	-	-	-	-	-	-	-	3	-	-	-
CO-3:	Apply the acquired knowledge on urban and environmental mapping with remote sensing and GIS techniques	3	-	-	3	-	-	-	-	-	-	-	-	-	3	-	-	-
CO-4:	Disseminate the knowledge on various data analysis tools in GIS software's	3	-	-	3	-	-	-	-	-	-	-	-	-	3	-	-	-
CO-5:	Recognize the GIS techniques for various GIS earth sciences applications	3	-	-	3	-	-	-	-	-	-	-	-	-	3	-	-	-

Unit-1 - Remote Sensing in Forest and Water Applications **9 Hour**
Forests – Forest type classification using multispectral data and density mapping. Forest stock mapping. Forest change detection. Forest fire detection and burned area mapping and fire vulnerability assessment. Applications of Laser in vegetation studies – Aerial and terrestrial. Water –Surface water resources assessment and management, Reservoir sedimentation. Performance evaluation of command areas. Integrated watershed development, water quality monitoring and mapping. Wetland mapping. Snow and Glaciers: Snow Cover Mapping, Glacier Mapping, Forecasting snow melt runoff.

Unit-2 - Remote Sensing in Rock and Soil Applications **9 Hour**
Significance of Geological structures – Role of satellite Image interpretation characters – structural mapping – Fold, fault, Lineaments, Direction circular features. Intrusive rocks, rock exposure, Fractures and Joints – Rose diagram – Significance of landform – Geomorphological guide – Tectonic landforms – Fluvial landforms – Denudational landforms – Volcanic landforms – Importance of ground truth and geological field data collection – Geophysical survey – surface investigation – subsurface investigation. Soils– Soil mapping including generation of derivative maps like land capability, land irrigation and suitability for specific purpose. Land degradation mapping and monitoring, Soil erosion assessment and modeling, Soil moisture estimation using thermal and microwave data.

Unit-3 - Urban and Environmental Studies Applications	9 Hour
Concepts of Urban infrastructure demand analysis – regional planning and its applications – urban renewal land suitability analysis and services, and network planning – Urban landuse plan formulation – Urban growth /Sprawl modeling; Slum detection, monitoring and updating – Expert systems in mapping – Transportation interaction models – Intelligent transportation systems. Remote Sensing satellites for environmental Studies- an Overview; Environmental Policy- Legislation on water, air, noise, environmental protection act with special reference to legislation in India. Environmental Impact Assessment- an overview concepts, strategies, & methodologies – Web GIS.	
Unit-4 - GIS Data Analysis Tools and Software	9 Hour
GIS – Data Input – Storage – Retrieval – Suitability of GIS software for Remote Sensing application in Engineering – Modeling with GIS – Decision support systems – Spatial interpolation, measurement and analysis methods, reclassification techniques, Buffer analysis, overlay analysis, Vector over lay analysis, Topological overlay, raster over lay analysis – measurement of length, perimeter and area – queries –2D to 3 D conversion- DTM and DEM, advantages and disadvantages, Network modeling – The Spatial Analyst Extension and Model Builder – Metadata – Georeferencing – Geocoding – Network Analyst – Interpolation and Surface Modeling – Interpolation Methods – Geodatabase – Building a Geodatabase – Cartographic Design. Overview of Application Software	
Unit-5 - GIS Spatial Analysis and Modelling	9 Hour
GIS modeling, basic elements – classification, model processing, integration, Binary models, index model, regression models – linear regression model, logistic regression model, process model, applications – problem identification– designing data model, project management and evaluation – implementation. Remote sensing Applications in Engineering automated mapping (AM)/ Facility management (FM) Multi criteria evaluation using GIS Techniques – case studies - use of knowledge based tools with GIS - Expert system and DSS. Object oriented GIS, WEB based GIS Applications.	

Learning Resources	<ol style="list-style-type: none"> 1. Anji Reddy .M, "Remote sensing and Geographical information system", B.S Publications, 2011. 2. Chestern, "Geo Informational Systems - Application of GIS and Related Spatial Information Technologies », ASTER Publication Co., 1992. 3. Jeffrey Star and John Estes, "Geographical Information System - An Introduction", Prentice Hall, 1990. 4. Burrough. P.A, "Principles of GIS for Land Resources Assessment", Oxford Publication, 1980 5. SatheeshGopi, "Global Positioning System - Principles and Applications," Tata McGrawHill Publishing Company Limited, New Delhi (India), 2005 6. NPTEL: Course – GIS in Civil Engineering: https://nptel.ac.in/courses/105102015/8
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	10%	-	10%	-	10%	-
Level 6	Create	10%	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. T. Mayamanikandan, Project Scientist, NCCR, Chennai, maya@nccr.gov.in	1. Dr. R. Kanmani Shanmuga Priya, Assistant Professor, Anna University, Chennai.	1. Dr. A. Manimaran, SRMIST
2. Dr. Tune Usha, Scientist, NCCR, Chennai	2. Dr. K. Nagamani Scientist-D/ Head, Centre for Remote Sensing and Geoinformatics, Sathyabama Institute of Science and Technology, Chennai	2. Dr. S. Durgadevagi, SRMIST

Course Code	21CE0323T	Course Name	SPATIAL TECHNOLOGY IN ENGINEERING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Study GNSS satellites	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand various data sources acquiring technologies															
CLR-3:	Learn advance technologies data and processing															
CLR-4:	Explore data processing and analysis															
CLR-5:	Learn applications of spatial technology in various specialization															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Study and understand the basics of spatial data acquisition satellites	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-2:	Learn various data acquisition technology for spatial data generation	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Explore the current technology and its importance in spatial data acquisition	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-4:	Apply the obtained knowledge in data processing and analysis	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Evaluate the role of spatial technology and its applications in various industries	3	-	-	3	3	-	-	-	-	-	-	-	-	-	-

Unit-1 - GNSS and Positioning	9 Hour
Introduction to Global Navigation Satellite System - GNSS Satellites – GPS Satellites – GPS System segments – Signal Structure of GPS – GPS Coordinate System – GPS Errors – Data processing - Applications	
Unit-2 - Spatial Data and Acquisition	9 Hour
Introduction to spatial data – Data acquisition techniques - Satellite systems and Sensors – Remote Sensing Satellites – Indian Satellites – Aerial photos – Aerial Photo types - Data processing Techniques	
Unit-3 - Drone Technology and Laser Scanning	9 Hour
Introduction to Drone and Laser scanning - Drone data acquisition - Drone Data processing software and hardware – Drone application in Engineering Industries – Terrestrial and Aerial Laser Scanner – Components of Laser scanning – Laser scanning data acquisition approaches – Data processing	
Unit-4 - Data Processing and Analysis	9 Hour
Introduction to data processing – Processing Software – Types - Data Format (Satellite, Aerial, Drone, Laser Scanning) – Data Types – Data Analysis – Vector & Raster – Network Analysis – Digital Elevation Models – Surface Analysis.	
Unit-5 - Applications in Engineering Industry	9 Hour
Introduction to applications of spatial technology – Construction Engineering – Transportation Engineering – Urban Planning – Vehicle Tracking – Disaster Management – Health industry	

Learning Resources	1. Alfred Leick, <i>GPS Satellite Surveying</i> , Wiley, Fourt Edition, ISBN 978-1-118-67557-1. 2. David Wheatley and Mark Gillings, <i>Spatial Technology and Archaeology</i> , Taylor and Fancis, ISBN 0-203-30239-7... 3. Michael D., <i>Introducing Geographic Information System with ArcGIS: A workbook Approach to Learning GIS</i> , Jhon Wiley & Sons. Canada, ISBN 987-1-118-15980-4;	4. Otto Huisman and Rolf A. de By, <i>Principles of Geographic Information Systems</i> , The International Institute for Geo-Information Science and Earth Observation (ITC) Netherlands. 5. Kang – Tsung Chang, <i>Introduction to Geographic Information Systems</i> , McGraw Hill Publishing, 2 nd Edition, 2011...
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. D. Vinu, Associate Vice President, DSM Soft Pvt, Ltd, Trichy	1. Dr. S. Kallappan, Chair Professor, Anna University, Chennai	1. Dr. R. Sivakumar, SRMIST
2. Mr. Venkatraman Thennarasu, Director at TetraRays Limited, Krishnagiri.	2. Dr. J. Rajesh banu, Associate Professor, Central University Tamilnadu	2. Dr. Karuppasamy Sudalaimuthu, SRMIST

Course Code	21CE0324T	Course Name	GIS AND SPATIAL ANALYSIS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
CLR-1:	Study the principles of GIS	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Understand about different data used and formats															
CLR-3:	Learn the different models used in GIS data															
CLR-4:	Know the various spatial analysis															
CLR-5:	Aware on more advanced spatial data analysis															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Awareness on GIS concepts and principles	3	-	-	-	2	-	3	-	-	-	-	-	-	-	-
CO-2:	Knowledge on data used in GIS and its standards and accuracy	3	-	-	-	2	-	3	-	-	-	-	-	-	-	-
CO-3:	Apply the knowledge on GIS models and data base management	3	-	-	-	2	-	3	-	-	-	-	-	-	-	-
CO-4:	Analyze the different uses of spatial data analysis	3	-	-	-	2	-	3	-	-	-	-	-	-	-	-
CO-5:	Evaluate the advanced application of spatial data analysis for decision making	3	-	-	-	2	-	3	-	-	-	-	-	-	-	-

Unit-1 - Basics of GIS	9 Hour
Introduction to GIS, Components, GIS Software, GIS Data types – Spatial – Non-spatial, Data Representations, Coordinate System, Geographic coordinate system – Projected coordinate system Projection,	
Unit-2 - GIS Data	9 Hour
Sources of GIS data, Maps – Types, Data Input methods, Output products and methods, Data Conversion - Vectorization- Rasterisation, Meta data, Data Errors, Data Standards	
Unit-3 - Data Models	9 Hour
Topology, Data Accuracy, Vector data model – Georelational Data model – Coverage data structure - Raster data models – Elements - Raster data structure, DEM – Types	
Unit-4 - Spatial Data Analysis	9 Hour
Terrain mapping and Analysis, Viewshed analysis, Least cost path analysis, Query - Types, Buffering, Vector Overlay Operations, Raster Overlay, Measurements	
Unit-5 - Advanced Data Analysis	9 Hour
Reclassification, Interpolation – Local – Global, Spatial Models – Cartographic models – Spatio-temporal models - Cell based Models, Multi-Criteria analysis	

Learning Resources	<ol style="list-style-type: none"> 1. Paul Bolstad, "GIS Fundamentals: A First Text on Geographic Information Systems" 5th Edition, Eider Press, Minnesota 2016. 2. Burrough. P.A, "Principles of Geographical Information System for Land Resources Assessment", Oxford Publications, ISBN-13: 978-0198545927, 1986. 3. . Kang Tsung Chang, "Introduction to Geographical Information System", Tata McGraw Hill, 9th edition, 2019. 	<ol style="list-style-type: none"> 4. Paul A. Longley, Michael F. Goodchild, David J. Maguire, David W. Rhind, "Geographic Information Science & Systems", Fourth Edition, John Wiley & Sons, Inc., 2015. 5. Chandra. A. M. and Ghosh S. K, "Remote Sensing and GIS", Narosa Publishing House, New Delhi, 2000. 6. Michael N. DeMers, "Fundamentals of Geographic Information Systems", 2008.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Sarunjith K J, Scientist, NCSCM	1. Dr. Rajesh Reghunath, Professor, University of Kerala	1. Dr. Aparna S Bhaskar, SRMIST
2. .Dr. Anoop V. Mohandas, GSI, Hyderabad	2. Dr. C. Lakshumanan, Professor, Bharathidasan University	2. Dr. Sachikanta Nanda, SRMIST

Course Code	21CE0325T	Course Name	WEB GIS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn the concepts of Open Web mapping	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Learn the concepts of Open Web mapping.															
CLR-3:	Understand the Web GIS Technical Basics															
CLR-4:	Obtain the concepts of MashUp															
CLR-5:	Gain the knowledge about Geo Portals and Implementation															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand concepts of Open Web Mapping	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-2:	Remember the concepts of Web GIS	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Gain the Technical Basics of Web GIS	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Apply the mashup concepts	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-5:	Obtain the knowledge of Geo portals and Open Source web concepts	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Open Web Mapping	9 Hour
Web Page Basics, Web Mapping, Geospatial Web Services, OGC-framework of open web mapping, importance of open web mapping, international open web standards as published by the Open Geospatial Consortium, explain the importance of international open standards to developers, users and businesses.	
Unit-2 - Internet Concepts & Web GIS	9 Hour
Overview of Internet concepts & features: Internet protocol, Domain Name System, Internet services, www, Web servers, Web clients. CGI, The web and GIS, Web GIS origin and Evolution-concept-Applications.	
Unit-3 - Web GIS Technical Basics	9 Hour
Fundamentals-principles-architecture-components-Thin VS. thick Client architecture- design development. Geospatial web services- Website to web service-geospatial webservice function-service types- interoperability and web service standard	
Unit-4 - Geospatial Mashups	9 Hour
Evolution-Impact-web content-function and interfaces –Mashup design and implementation - challenges and prospects-uses and benefits-supporting technology- solution and production.	
Unit-5 – Geoportals	9 Hour
Concept-uses-functions-architectures-geoportal applications-challenges and prospects. Web page design principles, HTML, XML, data formats, helperapplications, Java, databases and the Web. Application of Internet services to GIS, Internet GIS software, interoperability issues & Open GIS-GSDI and NSDI, Applications-e-business, e-government.	

Learning Resources	1. Burrough P.A., Principles of Geographical Information System for Land Resources Assessment, Oxford Publications, 1980 2. Pindé Fu and Jiulin Sun, Web GIS: Principles and applications, ISBN:9781589482456, ESRI, 2010 3. Randy Connolly & Ricardo Hoar, Fundamentals of Web Development, Pearson	4. Kang-tsung Chang, Introduction to Geographical Information System, Fourth Edition, Tata McGraw Hill, 2008 5. AM Chandra SK GOSH "REMOTE SENSING AND GEOGRAPHICAL INFORMATION SYSTEM, Narosa Publishing House Pvt LTD., India 6. https://swayam.gov.in/nd1_noc20_de04/preview 7. https://nptel.ac.in/courses/105/107/105107155
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Er. Praves hlyer, Hexagon, Chennai, Prevish.lyer@intergragh.com	1. Dr. R. Srinivasa Raju, IRS, Anna University, Chennai raju_irs@yahoo.com	1. Dr. R. Sivakumar, SRMIST
2. Dr. Tune Usha, Scientist, NCCR, Chennai, usha@nccr.gov.in	2. Dr. S. Ramesh, NIOT, sramesh@niot.res.in	2. Dr. Karuppasamy Sudalaimuthu, SRMIST

Course Code	21CE0401T	Course Name	BUILDING MATERIALS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Explore the concepts of Load bearing materials, testing procedure and properties of reinforced concrete	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Learn the non-load bearing materials of construction and its types and application	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	Know the suitable floors and requirement of good truss system in buildings																											
CLR-4:	Get insight into suitable damp proofing, painting and identify the defects in plastering.																											
CLR-5:	Get insight into building services like water supply, electricity and sewage disposal																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	To gain knowledge of building materials such as stones, bricks, aggregates, cements and its properties for better construction	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-												
CO-2:	To gain knowledge on non-Load bearing materials, innovative materials	3	-	-	-	-	2	-	-	-	-	-	-	-	-	-												
CO-3:	Identify the suitable floors, roofs in buildings	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-												
CO-4:	To gain knowledge about doors, windows, plastering, painting, damp proofing, scaffolding, shoring, underpinning and to take suitable engineering measures	3	-	-	-	-	2	-	-	-	-	-	-	-	-	-												
CO-5:	Identify the suitable services in building at various aspects	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-												

Unit-1 - Load Bearing Materials of Construction	9 Hour
Introduction to conventional materials used in construction - stones, bricks, cement, mortar, concrete, steel and timber - manufacturing process, types, applications, properties, testing procedures and availability - methods of improving ductility and fire resistance of concrete (principles only) - reinforced concrete, fibre reinforced concrete, prestressing principles, ferrocement - high strength concrete and high performance concrete - admixtures.	
Unit-2 - Non-Load Bearing Materials of Construction	9 Hour
Wood based products – varnishes – distempers – asbestos – glass – tiles – terracotta – porcelain – stoneware – earthenware – geosynthetics - polymer products - fibre reinforced plastics - types, process of manufacture and application- innovative sustainable green building materials – translucent wood, other planet urbanizing materials etc:	
Unit-3 - Lintel Floor and Roof	9 Hour
Definition - Function and classification of lintels - Balconies - Chajja and canopy – Arches - Elements and Stability of an Arch – Floors - Requirement of good floor - Components of ground floor - Selection of flooring material -Laying of Concrete - Mosaic, Marble – Granite - Tile flooring - Cladding of tiles – Roof - Requirement of good roof - Types of roof - Elements of a pitched roof - Trussed roof, King post Truss, Queen Post Truss, Steel Truss, Different roofing materials, R.C.C. Roof – Introduction to façade materials	
Unit-4 - Plastering, Damp Proofing and Painting	9 Hour
Plastering and Pointing - purpose, materials and methods of plastering and pointing - defects in plastering -Stucco plastering - lathe plastering. Damp proofing- causes, effects and methods - Paints- Purpose – types - ingredients and defects - Preparation and applications of paints to new and old plastered surfaces - wooden and steel surfaces.	

Unit-5 - Building Services **9 Hour**

Integration of services in buildings - water supply & plumbing layout for a residential building - elevators & escalators - planning & installation - basic components of the electrical system for a residence - typical electrical layout diagram. Lay out of external services -water supply- sewage disposal-electrical cabling

Learning Resources	<ol style="list-style-type: none"> 1. Punmia. B.C., Ashok Kumar Jain, Arun Kumar Jain, Building Construction, Laxmi Publishing (P).Ltd. New Delhi-2, 2012. 2. Bhavikatti.S.S, Building Materials, Vikas Publishing House.Pvt. Ltd., New Delhi, 2012. 3. Rangwala .S.C," Engineering Material"s, Charotar Publishing House, Anand, 2012. 4. K.S.Jagadish, B. U. Venkataramareddy and K. S. Nanjundarao. Alternative Building Materials and Technologies. New Age International, 2007. 5. https://www.scientific.net/book/binders-materials-and-technologies-in-modern-construction-iii/978-3-0357-3157-6
---------------------------	--

Learning Assessment

		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice		
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
Total		100 %		100 %		100 %	

Course Designers

Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Er. K. Jayasankar, Senior Vice President, Ultra Tech Cement Limited, Mumbai	1. Dr. R. Senthil, Professor, Anna University, Chennai	1. Dr. K.S.Satyanarayanan, SRMIST
2. Dr. P. Manoharan, Regional Executive Engineer, Madurai, Municipal Administration.	2. Dr. R. Baskar, Professor, Annamalai University, Chidambaram	2. Dr. N.Parthasarathi, SRMIST

Course Code	21CEO402T	Course Name	INTRODUCTION TO ENVIRONMENTAL STUDIES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	gain knowledge of the physical, chemical and biological aspect of the environment	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	an overview of the natural world works															
CLR-3:	understand issues facing the environment from a scientific and social perspective															
CLR-4:	explore how environment issues affect humans from multiple perspective															
CLR-5:	explore solutions to environmental degradation through law, policy and human behaviour															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the acquired knowledge on environmental protection.	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-2:	Identify natural resources and its conservation	3	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-3:	Identify variety of environmental problems, and solutions, in a scientific context	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Gain the knowledge on various social issues	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-5:	Know the environmental laws and ethics	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-

Unit-1 - Environment and Ecosystem	9 Hour
Introduction to Environmental studies - Definition, scope and importance, Ecology-Ecosystem, Types, Structure and Function of Ecosystem - Forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystems- Food chains, food webs and ecological pyramids -Biodiversity and its Conservation, Threats to biodiversity -Need for Public Awareness.	
Unit-2 - Natural Resources	9 Hour
Forest resources, Water resource, Mineral resources, , Food resources : World food problems, changes caused by agriculture and overgrazing, Energy resources : Growing energy needs, renewable and non-renewable energy sources, Land Resources soil erosion and causes for soil erosion, causes and effects of desertification, Role of an individual in conservation of natural resources -Equitable use of resources for sustainable development	
Unit-3 - Pollution Control Technologies and Global Environmental Problem	9 Hour
Environmental Pollution: Definition, causes, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution and nuclear hazards, Role of an individual in prevention of pollution. Case studies.: Floods, earthquake, cyclone and landslides, Climate change, global warming	
Unit-4 - Social Issues and the Environment	9 Hour
From Unsustainable to Sustainable development- Resource for a Growing Population and Political Implications, Solid waste Management: Causes, effects and control measures of urban and industrial wastes. E-waste and plastic waste: recycling and reuse Water conservation: Rain water harvesting, watershed management. Resettlement and rehabilitation of people: its problems and concerns.	

Unit-5 - Environmental Ethics and Environmental Impact Assessment	9 Hour
Environment Ethics, Environmental Laws, Environmental Impact Assessment, RS and GIS in EIA, Environment Management Plan, Disaster management, Green Politics, Earth Hour, Green Option Technologies, ISO standards: ISO 9000 and 14000. Environmental communication and public awareness, Role of National Green Tribunal; EIA Formulations, stages, Merits and demerits: case studies (e.g., CNG vehicles, Bharat IV stage) Role of NGOs in the protection of environment	

Learning Resources	1. Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, 2nd ed., UGC	2. Kamaraj. P, Arthanareeswari. M, Environmental Science–Challenges and Changes, 6th ed., Sudhandhira Publications, 2013
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai	1. Dr. E. S. M Suresh, NITTTR, Taramani, Chennai.	1. Mr. K.C.Vinu Prakash, SRMIST
2. Mr. A. Abdul Rasheed, CMWSS Board	2. Dr. G. Dhinakaran, Asst. Professor, CES, Anna University	2. Mr. D. Justus Reymond, SRMIST

Course Code	21CEO403T	Course Name	INTEGRATED WASTE MANAGEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Study the various sources and classification of solid and hazardous waste	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Know the concepts related to waste characteristics and source reduction															
CLR-3:	Realize insights to the storage, collection and transport of waste															
CLR-4:	Explore the concepts related to waste processing technologies															
CLR-5:	Understand concepts related to waste disposal															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the acquired knowledge on building materials and products for construction.	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-2:	Identify various building finishing materials and ferro cement applications for the building construction.	3	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-3:	Apply the knowledge on the masonry, building transport and the termite treatment.	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Disseminate the knowledge on various eco-friendly building materials	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-5:	Recognize the energy efficient buildings and cost-effective construction techniques	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-

Unit-1 - Sources and Types of Integrated Waste	9 Hour
Introduction and Objective of Solid waste, Sources of solid wastes, Classification of Solid Wastes-Sources & Types based, quantity – factors affecting generation of solid wastes Hazardous waste and its types, Salient features of Indian Legislations on management and handling of Integrated wastes, Public health effect - Environmental effect, Case studies in hazards due to solid waste management	
Unit-2 - Characteristics of Solid Waste and Source Reduction	9 Hour
Functional elements of integrated waste management, Characteristics – Physical, chemical and biological methods of sampling and characterization, Waste Stream Assessment (WSA), Source reduction (Basics), Monitoring and Evaluation, Storage and collection of recyclables	
Unit-3 - Waste Collection, Storage and Transportation	9 Hour
Methods of Collection- Hauled container, Stationary container and other collection methods, types of vehicles, collection routes, Transfer station, types and requirements, selection of location, operation and maintenance.	
Unit-4 - Waste Processing Techniques	9 Hour
Mechanical Volume and Size Reduction and Equipment's, Volume reduction or compaction, Size reduction or shredding, Processing techniques- Composting, Incineration, Pyrolysis, Gasification, Anaerobic degradation.,	
Unit-5 - Disposal	9 Hour
Dumping of solid waste, Methods of dumping of solid waste, Landfill- types, essential components, monitoring of landfill, Leachate collection & treatment, Environmental monitoring system.	

Learning Resources	1. George Tchobanoglous, Hilary Theisen, Samuel Vigil, <i>Municipal Solid Waste Management</i> , McGraw Hill, 1993 2. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. Evans and <i>Environmental Resources Management, Hazardous waste Management</i> , Mc-Graw Hill International edition, New York, 2001.	4. CPHEEO, "Manual on Integrated waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2000. 5. NPTEL Course-Integrated waste management. https://nptel.ac.in/courses/120108005/
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in	1. Dr. E. S. M Suresh, NITTT TaramaniChennai esmsuresh@gmail.com	1. Dr. K. Prasanna, SRMIST
2. Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com	2. Dr. G. Dhinakaran, Asst. Professor, CES, Anna University, twinsdina@gmail.com	2. Mr. S. Dhanasekar, SRMIST

Course Code	21CEO404T	Course Name	PRINCIPLES OF SUSTAINABLE DEVELOPMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Study the importance of Environment, Ecosystem and sustainability	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Know the current issues related to environment															
CLR-3:	Realize the measurement tool for impacts on environment															
CLR-4:	Explore the concepts about sustainability in material resources															
CLR-5:	Understand the sustainable strategies and policies															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the acquired knowledge on values of Environment, Ecosystem and sustainability theory.	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-2:	Understand the various environmental issues and current treatment/ disposal methods	3	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-3:	Learn the impacts caused by humans on environment and their measurement tools	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Know the changes in material resources and sustainable traps	3	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-5:	Explore the sustainable strategies and policies for practical applications	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-

Unit-1 - Sustainability and Development Challenges	9 Hour
Definition of sustainability – Environmental, Economic and Social dimensions of sustainability - Sustainable Development Models – Strong and Weak Sustainability – Defining Development- Millennium Development Goals – Mindsets for Sustainability, Global, Regional and Local environmental issues – Social insecurity - Resource Degradation – Climate Change – Desertification	
Unit-2 - Environmental Concerns – Present and Future	9 Hour
Climate Change – Air Issues (Ozone depletion, smog, other air pollutants) – Water issues (Eutrophication, water quality/access, Pollution) – Land use changes – Waste (quantity generated, Treatment/ disposal methods, E-waste – Human health – Diversity of life on the plant (population stresses and ecology, Failure at large scale.	
Unit-3 - Assessing Progress and Way Forward	9 Hour
Sustainability in global, regional and national context - Change in materials used (history) & critical materials - Energy and fossil fuel consumption -Buildings - Food systems - Transportation - Businesses and service organizations - ISO and other standards - Systems engineering – material flow analysis; lean/6S (certification potential) - Environmental Product Declarations - Carbon Foot printing - Life Cycle Assessment using software– certification potential Handprints - Trade-offs in Impacts and Decision-Making from Data	
Unit-4 - Cross – Discipline Considerations	9 Hour
Issues in developing countries: sanitation and public health, changes in material resources without corresponding changes in treatment options - Ethical issues: links between environmental emissions and poverty - Sustainability traps: failed policies to address consumption (one-child, forced sterilization, etc.)	

Unit-5 - Sustainable Socio-Economic Systems	9 Hour
Corporate / Organizational responsibility (Sustainability strategy development, Management tools, Sustainable/ethical investment accounts, Silos and open access, Product development and design) - Policies for Sustainability (COP commitments, UK and other national directives, US approaches to sustainability policies) - Sustainability in Individual Lives (Behavioral changes, Activism and group networking) - Future of the planet - Careers in sustainability - Course recap	

Learning Resources	1. F. Douglas Muschett, <i>Principles of Sustainable Development</i> , CRC Press, 2019 2. Bhavik R. Bakshi, <i>Sustainable Engineering Principles and Practice</i> , Cambridge University Press, 2019.	3. Catherine Mulligan, <i>Sustainable Engineering: Principles and Implementation</i> , CRC Press, 2019 4. Kauffman, Joanne, LEE, Kun Mo, <i>Handbook of Sustainable Engineering</i> , Springer 2013.
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajkumar Samuel, Hubert Enviro-Care Systems, Chennai, rajkumar@hecs.in	1. Dr. E. S. M Suresh, NITTTR Taramani Chennai, esmsuresh@gmail.com	1. Mr. D. Justus Reymond, SRMIST
2. Mr. A. Abdul Rasheed, CMWSS Board, juruterarasheed@gmail.com.	2. Dr. G. Dhinakaran, Assistant Professor, CES, Anna University, twinsdina@gmail.com	2. Mr. C. Vinuprakash, SRMIST

Course Code	21CE0405T	Course Name	ROAD SAFETY AND AUDIT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn the safe design of road geometric features	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Study the data analysis of road accidents															
CLR-3:	Explore the safety measures in design of new roads and in traffic operations															
CLR-4:	Know the safety aspects while reconstructing															
CLR-5:	Understand the concept of auditing the safety issues															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Design the road geometrics for safety measures	3	3	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-2:	Analyze the accident spots for safety measures	3	3	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-3:	Apply the safety features in design of new roads and operations	3	3	-	-	-	3	-	2	-	-	-	-	-	-	-
CO-4:	Demonstrate the safety aspects in road reconstruction	3	3	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-5:	Organize the audit for road safety measures	3	3	-	-	-	3	-	3	-	-	-	-	-	-	-

Unit-1 - Road Geometric Elements and Its Safety Measures	9 Hour
Cross-sectional elements, Surface characteristics, unevenness, camber, kerb, road margins and width, light reflecting characteristics - Sight distance requirements, stopping, overtaking sight distances - Horizontal curve - Vertical curve - safety and control measures at intersections - access control measures - Level of service analysis - On-road features, parking, lighting, marking, busbays, laning	
Unit-2 - Road Accident Spot Analysis	9 Hour
Analysis of Individual Accidents to Arrive at Real Causes - Statistical Methods of Analysis of Accident Data, Application of Computer Analysis of Accident Data -Traffic Engineering Studies - Statistical Methods In Traffic Safety Analysis, Regression Methods, Poisson Distribution, Chi- Squared Distribution, Statistical Comparisons- Traffic Management Measures And Their Influence On Accident Prevention	
Unit-3 - Traffic Safety in Design of New Roads and Operations	9 Hour
Ways of Ensuring Traffic Safety in Road Design considering the Features of Vehicle Fleet, Psychological Features of Drivers, Natural and Meteorological Conditions, Structure of Traffic Streams, Orientation of a Driver on the Direction of a Road beyond the Limits of Actual Visibility and Roadway Cross Section & Objects on the Right-of-Way. Ensuring Traffic Safety during Repair and Maintenance, Prevention of Slipperiness and Influence of Pavement Smoothness, Restriction speeds on Roads, Safety of Pedestrians, Cycle Paths, Informing Drivers on Road Conditions with Aid of Signs, Traffic Control Lines & Guideposts, Guardrails & Barriers and Road Lighting	
Unit-4 - Traffic Safety in Reconstruction	9 Hour
Road Reconstruction and Traffic Safety, Reconstruction Principles, Plotting of Speed Diagram for Working out Reconstruction Projects, Use of Accident Data in Planning Reconstruction of Roads, Examples of Reconstruction of Selected Road Sections for Improving Traffic Safety, Improving Traffic Conditions on Grades, Sharp Curves, Redesign of Intersections, Channelized At-Grade Intersections, Bus Stops, Parking & Rest Areas and Effectiveness of Minor Road Improvements.	

Unit-5 - Road Safety Audit **9 Hour**

Key elements of a road safety audit, Road Safety Audits & Investigations, Work zone safety audit; Crash investigation and analysis, Methods for identifying hazardous road locations, Case Studies - Procedures and Practice, Code of Good Practice and Checklists. Road Safety Issues and Various Measures through Engineering, education and enforcement measures for improving road safety.

Learning Resources	<ol style="list-style-type: none"> 1. Athelstan Popkess, Traffic Control and Road Accident Prevention, Chapman and Hall, 1997 (Digitized 2008) 2. Ezra Hauer, Observational Before-After Studies in Road Safety, Pergamon Press, 1997 (reprinted 2002) 3. Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna Publications, New Delhi, 2009. 	<ol style="list-style-type: none"> 4. J. Stannard Baker, Traffic Collision Investigation, Northwestern University Center for Public Safety, 2002. 5. BABKOV, V.F. Road conditions and Traffic Safety, MIR, publications, Moscow - 1975. 6. K.W. Ogden, Safer Roads – A Guide to Road Safety Engg. Averbury Technical, Ashgate Publishing Ltd., Aldershot, England, 1996.
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Asif Ahmed, Business manager, Ingevity, ahmed.asif@ingevity.com	1. Dr. Venkaiah Chowdary, Professor, NITW, vc@nitw.ac.in	1. Dr. A. Padma Rekha, SRM IST
2. Mr. Ankit Pachouri, Transport Planner, IUT, New Delhi, ankit.pachouri@iutundia.org	2. Dr. V Sunitha, Associate Professor, NITT, sunitha@nitt.edu	2. Mr. G. Sivaprakash, SRM IST

Course Code	21CE0406T	Course Name	TRANSPORTATION SYSTEMS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Study the characteristics of road transport system	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Explore the components and control measures of railway transport systems															
CLR-3:	Know the facilities in the airway transport systems															
CLR-4:	Learn the facilities of ports and harbour															
CLR-5:	Understand the special modes of transportation systems															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Determine the features of the road transportation system	3	3	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-2:	Derive the components of railway transportation systems and its control measures	3	3	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-3:	Obtain the facilities in airway transportation system	3	3	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-4:	Characterize the facilities of waterway transportation systems	3	3	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-5:	Demonstrate the special transportation systems globally	3	3	-	-	-	3	-	-	-	-	-	-	-	-	-

Unit-1 - Roadway Transportation	9 Hour
History of Road Development plans - Highway planning and alignment, requirements, factors controlling the alignment - Cross-sectional elements - Sight distance requirements, all types of sight distances- Horizontal curve, superelevation, extra-widening, transition curve- Vertical curve, summit and valley curve - Intersections, types and conflicts, control measures - Pavement, types, material characteristics, factors affecting the pavement design	
Unit-2 - Railway Transportation	9 Hour
History of Railway development - Permanent way, Components of permanent way - Rails, Sleepers, Ballast, Subgrade (functions, types) - Coning of wheels - Track laying process - Track Geometrics, superelevation, gradients, transition curve - Turnouts, points and crossing components, types - Signals, types - Interlocking - railways stations and junctions, types - Yards, functions and types - Maintenance operations	
Unit-3 - Airway Transportation	9 Hour
History of Airways development - Master plan and layout - Components of airport, runway, taxiway, hanger, apron, terminal buildings - Aircraft parking systems - Control measures, VFR and IFR - Runway configurations - airport marking and lighting	
Unit-4 - Waterway Transportation	9 Hour
History of Waterway transportation - Ports and Harbour - Classification - Natural Phenomena, waves, tides, littoral drift - ship characteristics - entrance facilities - approach facilities - protection facilities - loading and unloading facilities - dock facilities - mooring facilities - navigational facilities - turning basin - fenders - dredging facilities	
Unit-5 - Special Transportation System	9 Hour
Urban transportation systems - Mass rapid transit system - Light rail transit - Personal rapid transit, guided way systems, cabin taxi, dual mode bus - Para transit systems - Demand responsive system - Intermediate public transport.	

Learning Resources	1. Dr. Kadiyali L. R., <i>Traffic Engineering and Transport Planning</i> , Khanna Publishers 2. Khanna S.K., Justo C.E.G., <i>Highway Engineering</i> , Nem Chand & Bros., Roorkee. 3. SaxenaSubhash C and Satyapal Arora, "A Course in Railway Engineering", Dhanpat Rai and Sons, Delhi, 1998. 4. Khanna S K, Arora M G and Jain S S, "Airport Planning and Design", Nemchand and Brothers, Roorkee, 1994. 5. R. Srinivasan, "Harbour, Docks and Tunnel Engineering", Charotar Publishing home, 27th Edition, 2015 6. Alan Black, <i>Urban Mass Transportation Planning</i> , McGraw-Hill, 1995.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Asif Ahmed, Business manager, Ingevity, ahmed.asif@ingevity.com	1. Dr. Venkaiah Chowdary, Professor, NITW, vc@nitw.ac.in	1. Dr. A. Padma Rekha, SRM IST
2. Mr. Ankit Pachouri, Transport Planner, IUT, New Delhi, ankit.pachouri@iutundia.org	2. Dr. V Sunitha, Associate Professor, NITT, sunitha@nitt.edu	2. Mr. G. Sivaprakash, SRM IST

Course Code	21CEO407T	Course Name	RHEOLOGY OF COMPLEX MATERIALS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basics of continuum mechanics	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Comprehend different linear viscoelastic functions															
CLR-3:	Explore different models to model the behavior of linear viscoelastic materials															
CLR-4:	Know various nonlinear viscoelastic models															
CLR-5:	Explore different experimental approaches to characterize the flow behavior of material															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the basics of continuum mechanics to capture different flow behavior of the material	3	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Characterize the mechanical properties of the viscoelastic material	3	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Model the behavior of linear viscoelastic material	3	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Analyze the nonlinear viscoelastic flow behavior of the material	3	3	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply various experimental techniques to characterize the flow behavior of the material	3	3	-	2	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Continuum Mechanics	9 Hour
Vectors and tensors - Differentiation of tensors - Kinematics of Deformation - Lagrangian and Eulerian derivatives - velocity and acceleration - Balance Laws, conservation of mass, balance of linear and angular momentum, Conservation of energy	
Unit-2 - Linear Viscoelastic Behavior	9 Hour
Elastic response, viscous response and viscoelastic response – Linear viscoelastic properties and its relation - Boltzman principle - time temperature super position	
Unit-3 - Linear Viscoelastic Models	9 Hour
Elastic response Mechanical models - Maxwell element, Voigt kelvin element and generalized models - response to creep, stress relaxation and oscillatory shearing – Integral models	
Unit-4 - Nonlinear Viscoelastic Behavior	9 Hour
Elementary theories of non-linear viscoelastic behavior – Fourier Transformations and nonlinearity - nonlinear models	
Unit-5 - Rheometry	9 Hour
Newtonian and non-Newtonian fluids - shear stress, shear strain and shear rate – flow curve, zero shear viscosity - Flow measurements - capillary viscometer, rotational and cone and plate viscometer	

Learning Resources	1. A.S. Wineman and K. R. Rajagopal, <i>Mechanical Response of Polymers: An Introduction</i> , Cambridge University Press, 2000.	4. W. N. Findley, J. S. Lai and K. Onaran, <i>Creep and Relaxation of Nonlinear Viscoelastic Materials</i> , Dover, 1989.
	2. M. T. Shaw and W. J. MacKnight, <i>Introduction to Polymer Viscoelasticity</i> , 3rd Ed., Wiley-Interscience, 2005.	5. A.C. Pipkin, <i>Lectures on Viscoelasticity Theory</i> , 2nd Ed., Springer, 1986
	3. E. Riande, R. Diaz-Calleja, M. G. Prolongo, R. M. Masegosa, C. Salom, <i>Polymer viscoelasticity</i> , CRC Press, 1999	6. R. M. Christensen, <i>Theory of Viscoelasticity</i> , Dover, 2nd Ed., 1982
		7. J. D. Ferry, <i>Viscoelastic Properties of Polymers</i> , 3rd Ed., Wiley, 1980.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Asif Ahmed, Business manager, Ingevity, ahmed.asif@ingevity.com	1. Dr. Venkaiah Chowdary, Professor, NITW, vc@nitw.ac.in	1. Dr. A. Padma Rekha, SRM IST
2. Mr. Ankit Pachouri, Transport Planner, IUT, New Delhi, ankit.pachouri@iutundia.org	2. Dr. V Sunitha, Associate Professor, NITT, sunitha@nitt.edu	2. Mr. G. Sivaprakash, SRM IST

Course Code	21CEO408T	Course Name	WATER CONSERVATION AND MANAGEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Study management and monitoring of water resources	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand aquifer properties and treatment techniques															
CLR-3:	Know the methods to conserve water															
CLR-4:	Learn the importance of community involvement in water conservation															
CLR-5:	Understand Acts and policies in water management															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply acquired knowledge to manage surface and ground water	3	-	-	-	-	3	3	-	-	-	-	-	-	-	-
CO-2:	Identify different types of pollutants and its effect	3	-	-	-	-	3	3	-	-	-	-	-	-	-	-
CO-3:	Disseminate the knowledge on various irrigation methods to save water	3	-	-	-	-	3	3	-	-	-	-	-	-	-	-
CO-4:	Recognize the roles of Panchayat raj, NGO's and Educational institutions	3	-	-	-	-	3	3	-	-	-	-	-	-	-	-
CO-5:	Apply the Acts and policies at State and National level projects	3	-	-	-	-	3	3	-	-	-	-	-	-	-	-

Unit-1 - Management and Monitoring of Water Resources	9 Hour
Water and its importance – Sources, Geographical distribution, Quality and Water cycle – Influence of human activity on the water cycle - Surface water resources - Elementary knowledge of ground water – Water quality and its impact on human beings	
Unit-2 - Water Pollution and Quality Assessment	9 Hour
Soil and aquifer properties and their effect on ground water - Different types of pollutants - Effects of pollutants on water quality, organisms and human health - Water borne diseases and its control - Treatment techniques of used water, use of recycle water - Water supply in urban and rural areas	
Unit-3 - Conservation of Water	9 Hour
Different methods to conserve water in industries - Water recycling – Methods to conserve water in agriculture - Sprinkler, drip irrigation, root irrigation, use of polymers, dry land farming, agro forestry, orchard development, rotational crop method - Water saving economic crops	
Unit-4 - Community Involvement and Water Analysis	9 Hour
Community involvement in water management - Roles of Panchayat Raj institutions, NGO's, Educational institutions, Media, Political parties and farmers associations – Elementary idea of water analysis and instruments used - Chemical analysis with the help of portable instrument	
Unit-5 - Acts/ Policies	9 Hour
Acts / Policies related to water management and conservation at central and state levels- Administrative machinery for implementation from state to Panchayat levels	

Learning Resources	1. Ahuja, Satinder 2008, Arsenic Contamination of ground water 2. Singhal, B.B.S and Gupta, R.P., 1999, Applied hydrogeology of fractures Rocks 3. Todd D.K., 1980, Ground water hydrology, John Wiley and sons	4. Bennison, E.W. 1947, Ground water its development, uses and conservation 5. Ganoulis 2009, Risk analysis of water pollution, Wiley interscience
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Abdul Hakeem, National Remote Sensing Center, Hyderabad, abdulhakeem_k@nrsc.gov.in	1. Dr. Rehana Shaik, IIIT, Hyderabad, rehana.s@iiit.ac.in	1. Dr. Shaik Niyazuddin Guntakal, SRMIST
2. Dr. Sat Kumar Tomer, Satyukt Analytics Pvt Ltd., Bengaluru, sat@satyukt.com	2. Dr. S. Saravanan, NIT Trichy, saravans@nitt.edu	2. Dr. R. Sathyanathan, SRMIST

Course Code	21CE0409T	Course Name	WATER QUANTITY AND QUALITY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Study the physical and chemical properties of water	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Address the concepts on the stream flow measurement															
CLR-3:	Explore the basic concepts about water pollution and its treatment															
CLR-4:	Know about the recycling and reuse of waste water															
CLR-5:	Interpret the concepts of the water quality and its standards															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Analyze physical and chemical properties of water	3	3	-	-	-	-	3	-	-	-	-	2	-	-	-
CO-2:	Estimate discharge and velocity in streams	3	2	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-3:	Identify water pollution and its treatment	3	-	-	-	-	-	3	-	-	-	-	2	-	-	-
CO-4:	Appraise recycling and reuse of waste water	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-5:	Illustrate the water quality standards and models	3	-	-	-	-	-	3	-	-	-	-	2	-	-	-

Unit-1 - Properties of Water	9 Hour
Properties of water (Physical and Chemical) – Suspended and dissolved solids – Major ions – Water quality investigation – Sampling design - Samplers and automatic samplers - Data collection platforms – Field kits – Water quality data storage, analysis and inference - Water quality for irrigation – Salinity and permeability problem - Irrigation practices for poor quality water	
Unit-2 - Stream Flow Measurement	9 Hour
Measurement of stage and velocity – Area-velocity method – Dilution technique – Electromagnetic method – Ultrasonic method – Stage-Discharge relationships – Hydrometry stations	
Unit-3 - Water Pollution and Treatments	9 Hour
Sources and Types of pollution – Organic and inorganic pollutants – BOD-DO relationships – Impacts on water resources – NPS pollution and its control – Eutrophication control - Water treatment technologies - Constructed wetland.	
Unit-4 - Recycling and Reuse of Waste Water	9 Hour
Multiple uses of water – Reuse of water in agriculture – Low cost waste water treatment technologies - Economic and social dimensions - Packaged treatment units – Reverse osmosis and desalination in water reclamation.	
Unit-5 - Water Quality Management and Its Standards	9 Hour
Principles of water quality – Water quality classification – Water quality standards - Water quality indices – TMDL Concepts – Water quality models.	

Learning Resources	1. George Tchobanoglous, Franklin Louis Burton, Metcalf & Eddy, H. David Stense, and Wastewater Engineering: Treatment and Reuse, McGraw-Hill, 2002.	4. Mackenzie L Davis, David A Cornwell, Introduction to Environmental Engineering, McGraw Hill 2006.
	2. 2 Vladimir Novonty, Water Quality: Diffuse pollution and watershed Management, 2 and edition, John Wiley & Sons, , 2003	5. Stum, M and Morgan, A., Aquatic Chemistry, Plenum Publishing company, USA, 1985.
	3. K. Subramanya; Engineering hydrology; McGraw Hill, fourth edition	6. 5. Lloyd, J.W. and Heathcote, J.A., Natural inorganic chemistry in relation to groundwater resources, Oxford University Press, Oxford, 1988.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Abdul Hakeem, National Remote Sensing Center, Hyderabad, abdulhakeem_k@nrsc.gov.in	1. Dr. R. Saravanan, Anna University, rsaran@annauniv.edu	1. Dr. R. Sathyanathan, SRMIST
2. Dr. Sat Kumar Tomer, Satyukt Analytics Pvt Ltd., Bengaluru, sat@satyukt.com	2. Dr. S. Saravanan, NIT, Tiruchirappalli, ssaravanan@nitt.edu	2. Mrs. D. Jaishree, SRMIST

Course Code	21CE0410T	Course Name	REMOTE SENSING SURVEYING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1: Study the basics principles of remote sensing techniques.		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2: Understand the various platforms and sensors used in remote sensing.																
CLR-3: Understand the concepts and applications behind various remote sensing satellites data.																
CLR-4: Understand the concepts of ground truthing hyper spectral remote sensing analysis.																
CLR-5: Apply the Knowledge of GPS surveying techniques.																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1: Apply the acquired knowledge on remote sensing application with its techniques.		3	-	-	-	3	-	-	-	-	-	-	3	-	-	-
CO-2: Identify various types of platforms and sensors combination used with remote sensing application.		3	-	-	-	3	-	-	-	-	-	-	3	-	-	-
CO-3: Apply the acquired knowledge on different satellite data on remote sensing applications.		3	-	-	-	3	-	-	-	-	-	-	3	-	-	-
CO-4: Disseminate the knowledge on ground truthing analysis technique by hyper spectral remote sensing surveying.		3	-	-	-	3	-	-	-	-	-	-	3	-	-	-
CO-5: Recognize the GPS surveying techniques for different field applications.		3	-	-	-	3	-	-	-	-	-	-	3	-	-	-

Unit-1 - Remote Sensing	9 Hour
Physics of Remote Sensing: Electromagnetic Radiation (EMR), Characteristics – Electromagnetic Spectrum (EMS) – Interactions Between Matter and Electro-Magnetic Radiation – Energy Interaction in The Atmosphere – Energy Interactions with The Earth's Surface. Radiation Laws. Atmospheric Windows – Types of Remote Sensing with Respect to Wavelength Regions. Electro Magnetic Radiation (EMR): Velocity of EM radiation, Polarization, coherent radiation, Propagation of EM waves, from one medium to another, Attenuation, quantum nature of EM radiation, Thermal radiation, Source of EM radiation, for Remote sensing – Fundamentals of Radiometry: Measure Geometry – concept of the solid angle – radiometric quantities – Surface characteristic for Radiometric Measurements – Observation geometry in Remote sensing – Reflectance Measurement – Physical Basis of Signature – Signature in the Reflective OIR region – Thermal Infrared (TIR) and Microwave region.	
Unit-2 - Remote Platforms and Sensor	9 Hour
Platforms: Principles of satellite Missions – Locating satellites in space – Types of Orbits, Airborne platforms – balloons, helicopters, aircrafts – Spaceborne platforms – Orbital Elements of Satellite – Sun synchronous and Geosynchronous satellites – Projectile geometry – Land coverage – Repetitively – On track and Across track stereovision capability. IRs, LANDSAT, SPOT, RUSSIAN, CANADA, JAPAN, EUROPEAN, CAHAINA SATELLITE series. Sensor Technology – Historical Development – Sensor Types Characteristics: Active and Passive Remote Sensing – Imaging Systems – Non-Imaging Sensors – Across Track and Along Track Scanners – Framing and Scanning Systems – Characteristics of Optical Sensors – Resolution. Classification of Remote sensor, selection of sensor parameters, spatial resolution, spectral resolution, Radiometric resolution, Temporal resolution, – Optical and Infrared sensors: Quality of Image in Optical system, Imaging mode, – Photographic camera, Television camera, Optical mechanical scanners operated from satellites, Push broom cameras, Whisk broom cameras. Microwave sensors.	

Unit-3 - Remote Sensing Satellites and Data Products **9 Hour**
 Overview of Different Satellite and Sensors for Earth Observations- Coarse – Medium and High – Resolution Missions (IRS Series – LANDSAT Series – SPOT Series – High resolution satellites, character and applications, CARTOSAT Series – GEOSAT – IKONOS Series – QUICKBIRD Series, Weather/Meteorological satellites, INSAT series, NOAA, GOES, NIMBUS Applications – Marine observation satellites OCEANSAT – ASTER – Sentinel – Aqua and Terra (MODIS) – SLAR / SAR and Future Missions.

Unit-4 - Ground Truthing Hyper Spectral Remote Sensing and Image Analysis **9 Hour**
 Atmospheric correction – Analysis technique of hyper spectral remote sensing – Biophysical modelling – Image transmission & compression – Spectroscopy – Image cube, Hyperian /HYSI, – Spectral matching – Digital Spectral Data – Libraries – Application of Hyper spectral data – MODIS. Importance of Ground truth data collection – Ground Truth Radiometer (GTR), Radiometric Calibration – Digital and Analog Methods – use of radiometers, and spectrophotometers, etc., – Spectral Reflectance – Physical basis of spectral signatures of the objects and Spectral – Signature for Vegetation – Soil – Water and Snow – Thermal Image and Interpretation – Interpretation of SAR data (from Satellite) for Landuse studies.

Unit-5 - GPS Surveying Techniques **9 Hour**
 Modern Surveying Equipment – Introduction to Concept of Global Positioning System and its architecture – Positioning Methods using Satellites – GPS Principles – GPS receivers – More on GPS principles – GPS in Different Engineering Application – Different types of GPS Errors and Accuracy in GPS observations – Satellite geometry and Accuracy measures – Other Satellite navigation Systems and GPS Modernization – GPS Applications in Various Fields – Concept of DGPS and WAAS – GNSS And Types (NAVSTAR – GLONASS – GALELIO) – IRNSS.

Learning Resources	1. George Joseph and Jeganathan. C, Fundamentals of Remote Sensing, Universities Press, 3rd edition, 2018	5. Satheesh Gopi, Global Positioning System: Principles and Applications, Tata Mcgraw-Hill Publishing Company Limited, 2005
	2. Anij Reddy, M. "Textbook of Remote Sensing and Geographical Information systems", B S Publications, Hyderabad, 2008.	6. NPTEL - NOC: Remote Sensing Essentials, IIT Roorkee, https://nptel.ac.in/courses/105107201
	3. Richards, Remote sensing digital Image Analysis–An Introduction Springer – Verlag 1993.	7. NPTEL - NOC: Remote Sensing: Principles and Applications, https://nptel.ac.in/courses/105101206
	4. Lillesand, T.M., Kiefer, R.W & Chipman, J.W. "Remote Sensing & Image Interpretation", John Wiley and Sons, India, 2007.	8. NPTEL - Remote Sensing, IISc Bangalore, https://nptel.ac.in/courses/105108077
		9. NPTEL - NOC: GPS SURVEYING, IIT Roorkee, https://nptel.ac.in/courses/105107157
		10. NPTEL - NOC: Remote Sensing and GIS, IIT Guwahati, https://nptel.ac.in/courses/105103193

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	–	20%	–	20%	–
Level 2	Understand	20%	–	20%	–	20%	–
Level 3	Apply	20%	–	20%	–	20%	–
Level 4	Analyze	20%	–	20%	–	20%	–
Level 5	Evaluate	10%	–	10%	–	10%	–
Level 6	Create	10%	–	10%	–	10%	–
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. T. Mayamanikandan, Project Scientist, NCCR, Chennai, maya@nccr.gov.in	1. Dr. R. Kanmani Shanmuga Priya, Assistant Professor, Anna University, Chennai.	1. Dr. A. Manimaran, SRMIST
2. Dr. Tune Usha, Scientist, NCCR, Chennai	2. Dr. K. Nagamani Scientist-D/ Head, Centre for Remote Sensing and Geoinformatics, Sathyabama Institute of Science and Technology, Chennai	2. Dr. S. Durgadevagi, SRMIST

Course Code	21CE0411T	Course Name	INTRODUCTION TO GIS AND DATA	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Study the basic concepts of GIS	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the real-world data types and representations															
CLR-3:	Know the different data sources and standards															
CLR-4:	Understand the data models															
CLR-5:	Explore the vector and raster analysis															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the concepts of GIS	3	-	-	-	3	-	3	-	-	-	-	-	-	-	-
CO-2:	Recognize the real word data and its representation in GIS	3	-	-	-	3	2	-	-	-	-	-	-	-	-	-
CO-3:	Apply the knowledge of data standards on GIS data	3	-	-	-	3	2	-	-	-	-	-	-	-	-	-
CO-4:	Create the data model to store GIS data	3	-	-	-	3	-	3	-	-	-	-	-	-	-	-
CO-5:	Identify the spatial analysis for real world problem	3	-	-	-	3	-	3	-	-	-	-	-	-	-	-

Unit-1 - GIS Concepts	9 Hour
GIS, History of GIS, Elements of GIS, Cartography - Maps – based on purpose & Scale, Coordinate system – Geographic & projected coordinate system - UTM, Datum, Projections – Based on preserved Property – Surface.	
Unit-2 - Real World and Representations	9 Hour
Geospatial data – Spatial data – Attribute data, Data Representations – Vector format- Raster format -Types of attribute table, GIS Software, Topology – Adjacency, Contiguity-Containment, Errors	
Unit-3 - Data Sources & Standards	9 Hour
Input Data – Primary – Secondary, Data input methods, Data output methods and products, Data Standard, Data Quality, Data Errors – Positional accuracy - Attribute Accuracy – Logical Consistency - Lineage, Meta Data, Layout.	
Unit-4 - GIS Data Models	9 Hour
Vector data model – Geo-relational - Shapefile - TIN, Geodatabase, Raster Data Model - Elements of Raster data, Raster data structure – cell by cell – Run Length Encoding – Quad Tree, Data Conversion, DEM – DTM – DSM- Terrain Parameters – slope- aspect – hill shade	
Unit-5 - Spatial Data Analysis	9 Hour
Data Retrieval – Query – Spatial and Non-Spatial Query, Proximity Analysis - Buffering, Overlay – Vector – Raster, Network Analysis, Terrain Analysis, Spatial Interpolation, Modelling	

Learning Resources	<ol style="list-style-type: none"> 1. Paul Bolstad, "GIS Fundamentals: A First Text on Geographic Information Systems" 5th Edition, Eider Press, Minnesota 2016. 2. Burrough. P.A, "Principles of Geographical Information System for Land Resources Assessment", Oxford Publications, ISBN-13: 978-0198545927, 1986. 3. Kang Tsung Chang, "Introduction to Geographical Information System", Tata McGraw Hill, 9th edition, 2019. 4. Paul A. Longley, Michael F. Goodchild, David J. Maguire, David W. Rhind, "Geographic Information Science & Systems", Fourth Edition, John Wiley & Sons, Inc., 2015. 5. Anji Reddy .M, "Textbook of Remote Sensing and Geographical Information Systems", BS Publications, Hyderabad. 2011. ISBN: 81-7800-112-8. 6. Rolf A. de "Principles of Geographic Information Systems An introductory textbook" The International Institute for Aerospace Survey and Earth Sciences (ITC), The Netherlands, 2001.1 7. Michael N. DeMers, "Fundamentals of Geographic Information Systems", 2008.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. V. S. Jeyakanthan, Scientist, NIH, Kakinada	1. Dr. R. B. Binoj Kumar, Professor, University of Kerala	1. Dr. Aparna S Bhaskar, SRMIST
2. Dr. Sarunjith K. J., Scientist, NCSCM, Chennai	2. Dr. C. Lakshumanan, Professor, Bharathidasan University	2. Dr Satish Kumar J, SRMIST

Course Code	21CEO412T	Course Name	WEB AND MOBILE GIS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Study basics of Geographical Information System	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand WebGIS architecture, services and components															
CLR-3:	Learn advancement and application of WebGIS															
CLR-4:	Know basics of Mobile GIS															
CLR-5:	Explore opportunities and application of Mobile GIS															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the obtained knowledge in spatial analysis and development.	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Know basics of WebGIS and various services	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-3:	Apply knowledge on development of application for various domain.	3	-	2	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Disseminate the importance of Mobile GIS components and Systems	3	-	-	-	-	-	-	-	-	-	-	3	-	-	-
CO-5:	Apply gain knowledge on Mobile GIS for different applications	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to GIS	9 Hour
Introduction to Geographical Information System (GIS) – Types of GIS - Components of GIS --- Data types and Formats – Open Source and Proprietary GIS Softwares- Basic Map elements in GIS - Data Analysis in GIS – ArcGIS API for Python and JavaScript.	
Unit-2 - Basics of Web GIS	9 Hour
Introduction to WEB GIS – WEB GIS Architecture and Components – Web Services (WFS, WMS, WCS) – Web Server (Apache, TOMCAT) - Map Server (Web Server, Geoserver, ArcGIS Server)	
Unit-3 - Advancement and Applications of WebGIS	9 Hour
Internet GIS Application Framework - MapServer utilities – Publishing interactive map – Accessing Map through WebServices- WEBGIS and Location based services - Managing spatial data on Web using open-source tools – Development of a WebGIS application for various domain (Case Study)	
Unit-4 - : Basics of Mobile GIS	9 Hour
Introduction to Mobile GIS – Technology for Mobile GIS (Computer Network, OS, Systems and Softwares) – Mobile GIS components – Mobile GIS Architecture – Development of Mobile Positioning and Mobile Terminal Technology – WebGIS to Mobile GIS	
Unit-5 - Opportunities and Applications of Mobile GIS	9 Hour
Opportunities of Mobile GIS - Market opportunities - Applications of Mobile GIS - Online services and Navigation for traffic information – Public Information Services – Urban disaster management	

Learning Resources	1. Michael D., <i>Introducing Geographic Information System with ArcGIS: A workbook Approach to Learning GIS</i> , Jhon Wiley & Sons. Canada, ISBN 987-1-118-15980-4;	3. Jane Drummond, <i>Dynamic and Mobile GIS Investigating changes in Space and Time</i> , CRC Press, 2007
	2. Otto Huisman and Rolf A. de By, <i>Principles of Geographic Information Systems</i> , The International Institute for Geo-Information Science and Earth Observation (ITC) Netherlands.	4. Eric Pimpler, Mark Lewin, <i>Building Web and Mobile ArcGIS Server Applications with Javascript</i> , Second Edition, Packt Publishing, Birmingham. 5. Tyler Mitchell, <i>Web Mapping Illustrated</i> , First edition, June 2005, ISBN 978-0596-00865-9

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. D. Vinu, Associate Vice President, DSM Soft Pvt, Ltd, Trichy	1. Dr. S. Kaliappan, Chair Professor, Anna University, Chennai	1. Dr. R. Sivakumar, SRMIST
2. Mr. Venkatraman Thennarasu, Director at TetraRays Limited, Krishnagiri.	2. Dr. J. Rajesh banu, Associate Professor, Central University Tamilnadu	2. Dr. Karuppasamy Sudalaimuthu, SRMIST

Course Code	21CEO413T	Course Name	DIGITAL MAPPING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Civil Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Study various preparation of map making Process	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Learn the different data types.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	Understand data representation and Software.																											
CLR-4:	Acquire various digital data analysis techniques.																											
CLR-5:	Intellect different applications of digital mapping.																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Disseminate the knowledge on cartography.	3	3	-	-	-	-	-	-	-	-	-	3	-	-	-												
CO-2:	Identify different data sources	3	-	-	-	3	-	-	-	-	-	-	3	-	-	-												
CO-3:	Explore the different data representation	3	-	-	-	3	-	-	-	-	-	-	3	-	-	-												
CO-4:	Exhibit different digital analysis	3	-	-	3	-	-	-	-	-	-	-	3	-	-	-												
CO-5:	Apply Knowledge of Digital mapping	3	-	-	-	-	-	-	-	-	3	-	3	-	-	-												

Unit-1 - Cartography	9 Hour
History of Cartography - Coordinate systems - Projection systems – Maps – Characteristics - types and uses of Maps – Automated mapping Tools and function - map layout, color and pattern in digital mapping, Human perception of static, multimedia and animated maps.	
Unit-2 - Different Data Sources	9 Hour
GPS: Satellites, Sources and Errors of GPS, Aerial photographs – Types - Correction, Remote sensing: Types of Resolution -Optical and microwave Remote sensing, IRS, Landsat, Sentinel, RISAT- Digital Elevation Model - SRTM, PALSAR, CARTOSAT - LIDAR – Types - LIDAR wave form - UAS – Data formats.	
Unit-3 - Data Representation and Software	9 Hour
Spatial and Non-Spatial data - Data format – Data compression – Data Storage – Data Visualization 2D,3D – Graphical representation – Important tools in application software– LIDAR -Machine Learning, Supervised and Unsupervised	
Unit-4 - Digital Data Analysis	9 Hour
Map Generalization - Spatial and nonspatial - Digital Elevation Model - Terrain analysis - UAS - LIDAR – Filtering – Classification – Hyperspectral - Supervised, Maximum likelihood, Minimum Distance classifier – Unsupervised, ISODATA, K-Means, Hyperspectral – Advantages - Support Vector Machine- Spectral Angle Mapper - Satellites Microwave Remote sensing – SAR – SLAR - Satellites	
Unit-5 - Applications of Digital Mapping	9 Hour
GPS applications in Transport studies, Aerial photographs applications in urban studies- Remote sensing application studies in flood mapping – Soil moisture studies using microwave remote sensing – Forest studies using LIDAR mapping - Agriculture studies using Unmanned aerial vehicle – Resource mapping using hyperspectral studies – Land use and Land cover studies using machine learning Techniques – Drone applications in 3D urban mapping.	

Learning Resources	1. Robinson .A. H, Morrison .J. L, Muehrcke .A. C, Kimerling .A. J and Guptill .S. C, "Elements of Cartography", 6th Edition, John Wiley and Sons, 1995.	4. Kang Tsung Chang, "Introduction to Geographical Information System", Tata McGraw Hill, 9th edition, 2019.
	2. John R. Jensen "Introducing Digital Image Processing" - Prentice Hall, New Jersey 1986	5. Fahlstrom, P. and Gleason, T. 2012. Introduction to UAV Systems. 4th edition. United Kingdom. John Wiley & Sons Ltd
	3. Anji Reddy .M, "Textbook of Remote Sensing and Geographical Information Systems", BS Publications, Hyderabad. 2011. ISBN: 81-7800-112-8.	6. Borden D. Dent, Jeffrey Troguson, Thomas W. Hodler, "Cartography: Thematic map Design", McGraw-Hill Higher Education, 2008

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Sarunjith K J, Scientist, NCSCM, Chennai, sarunjith@gmail.com	1. Dr. K. Palanivel, Professor, Bharathidasan University, Trichy. kkpv/cers@bdu.ac.in	1. Dr. J. Satish Kumar, SRMIST
2. Dr. T. Mayamanikandan, Project Scientist, NCCR, Chennai, maya@nccr.gov.in	2. Dr. R. Kanmani Shanmuga Priya, Assistant Professor, Anna University, Chennai. kanmanirajkumar@gmail.com	2. Dr. M. Kamalanandhini, SRMIST

Course Code	21CSO270T	Course Name	CYBER SECURITY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12			
CLR-1:	Understand the cyber security threat landscape	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Develop a deeper understanding and familiarity with various types of Cyber attacks															
CLR-3:	Analyze and evaluate existing legal framework and laws on cyber security															
CLR-4:	Analyze and evaluate the digital payment system security and remedial measures against digital payment frauds															
CLR-5:	Analyze and evaluate the importance of personal data its privacy and security															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Able to identify security issues and resolve	-	-	-	-	-	-	-	3	-	-	-	2	-	-	-
CO-2:	Able to work with cybersecurity tools	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-3:	Analyze threats and risks within context of the cyber security architecture	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-
CO-4:	Appraise cyber security incidents to apply appropriate response	-	-	-	-	-	-	-	2	-	-	-	2	-	-	-
CO-5:	Evaluate decision making outcomes of cyber security scenarios	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-

Unit-1 - Introduction to Cyber Security	9 Hour
Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Advent of internet, Internet infrastructure for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security	
Unit-2 - Cybercrime and Cyber Law	9 Hour
Classification of cybercrimes, Common cybercrimes- cybercrime targeting computers and mobiles, cybercrime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Cybercriminals modus-operandi, Reporting of cybercrimes, Remedial and mitigation measures, Legal perspective of cybercrime, IT Act 2000 and its amendments, Cybercrime and offences, Organizations dealing with Cybercrime and Cyber security in India, Case studies.	
Unit-3 - Social Media Overview and Security	9 Hour
Introduction to Social networks. Types of Social media, Social media platforms, Social media monitoring, Hashtag, Viral content, Social media marketing, Social media privacy, Challenges, opportunities and pitfalls in online social network, Security issues related to social media, Flagging and reporting of inappropriate content, Laws regarding posting of inappropriate content, Best practices for the use of Social media, Case studies.	
Unit-4 - E - Commerce and Digital Payments	9 Hour
Definition of E- Commerce, Main components of E-Commerce, Elements of E-Commerce security, E-Commerce threats, E-Commerce security best, practices, Introduction to digital payments, Components of digital payment and stake holders, Modes of digital payments- Banking Cards, Unified Payment Interface (UPI), e-Wallets, Unstructured Supplementary Service Data (USSD), Aadhar enabled payments, Digital payments related common frauds and preventive measures. RBI guidelines on digital payments and customer protection in unauthorized banking transactions. Relevant provisions of Payment Settlement Act,2007	

Unit-5 - Digital Devices Security, Tools and Technologies for Cyber Security		9 Hour
End Point device and Mobile phone security, Password policy, Security patch management, Data backup, Downloading, and management of third party software, Device security policy, Cyber Security best practices, Significance of host firewall and Ant-virus, Management of host firewall and Anti-virus, Wi-Fi security, Configuration of basic security policy and permissions		
Tutorial :		
1. Checklist for reporting cybercrime at Cybercrime Police Station.	9. Setting, configuring and managing three password policy in the computer (BIOS, Administrator and Standard User).	
2. Checklist for reporting cybercrime online.	10. Setting and configuring two factor authentication in the Mobile phone.	
3. Reporting phishing emails.	11. Security patch management and updates in Computer and Mobiles.	
4. Demonstration of email phishing attack and preventive measures.	12. Managing Application permissions in Mobile phone.	
5. Basic checklist, privacy and security settings for popular Social media platforms.	13. Installation and configuration of computer Anti-virus.	
6. Reporting and redressal mechanism for violations and misuse of Social media Platforms.	14. Installation and configuration of Computer Host Firewall.	
7. Configuring security settings in Mobile Wallets and UPIs.	15. Wi-Fi security management in computer and mobile.	
8. Checklist for secure net banking.		

Learning Resources	1. Nina Godbole & Sunit Belapure "Cyber Security", Wiley India, 2022 Reprint Evan Wheeler, "Security Risk Management", Syngress ISBN: 97815, 2021	5. Security in the Digital Age: Social Media Security Treats and Vulnerabilities by Henry A. Oliver, Create Space Independent Publishing Platform. (Pearson , 13 th November, 2001)
	2. Bruce Newsome, "A Practical Introduction to Security and Risk Management", 20203. . David L. Cannon, "CISA Certified Information Systems Auditor Study Guide", John Wiley & Sons, ISBN: 978-0-470-23152-4, 2019.	6. Electronic Commerce by Elias M. Awad, Prentice Hall of India Pvt Ltd.
	3. Cyber Crime Impact in the New Millennium, by R. C Mishra ,Auther Press. Edition 2010.	7. Cyber Laws: Intellectual Property & E-Commerce Security by Kumar K, Dominant Publishers.
	4. Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives by Sumit Belapure and Nina Godbole, Wiley India Pvt. Ltd. (First Edition, 2011)	8. Network Security Bible, Eric Cole, Ronald Krutz, James W. Conley, 2nd Edition, Wiley India Pvt. Ltd.
		9. Fundamentals of Network Security by E. Maiwald, McGraw Hill.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts

Course Code	21CS0351T	Course Name	WEB PROGRAMMING	Course Category	0	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing		Data Book / Codes / Standards	Nil	

[illegible]

Unit-1 - Introduction	9 Hour
Introduction to WEB, Basics of WWW, HTTP protocol, Client Server architecture, Introduction to web server installation and configuration, Web Design Concepts of effective web design, Web design issues including Browser, Bandwidth and Cache, Display resolution, Look and Feel of the Website, Page Layout and linking, User centric design, Sitemap, Planning and publishing website, Designing effective navigation	
Unit-2 – HTML and CSS	9 Hour
Basics of HTML and CSS, Structure of HTML page, HTML tags for data formatting, tables, links, images, meta tags, frames, html form tags, media, APIs, HTML5 tags and validation. Need for CSS, Syntax and structure, CSS rules for Backgrounds, Colors and properties, manipulating texts, Fonts, borders and boxes, Margins, Padding Lists, CSS Positioning. Animations, Tool-Tips, Style images, Variables, Media Queries, Wildcard Selectors (*, ^ and \$) in CSS, Working with Gradients, Pseudo Class and Pseudo elements	
Unit-3 – Client Side Scripting	9 Hour
Client Side Scripting using JavaScript Syntax of JavaScript, Execution of JavaScript, Internal, Embedded and External JavaScript, JavaScript : variables, arrays, functions, conditions, loops, Pop up boxes, JavaScript objects and DOM, JavaScript inbuilt functions, JavaScript validations and Regular expressions, Event handling with JavaScript.	
Unit-4 – Server Side Programming	9 Hour
Server Side Programming with PHP Difference between Client side and Server side scripting, Structure of PHP page, PHP Syntax: variables, decision and looping with examples, PHP and HTML, Arrays and Functions, String, Form processing, File uploads, Dates and time zone, Working with Regular Expressions, Exception Handling.	

Unit-5 – Database Connectivity **9 Hour**

Database programming with PHP and MySQL Basic MySQL commands, PHP functions for database connectivity, Implementation of CRUD operations using PHP, Prepared Statement and stored procedure execution in PHP, Advanced Web Programming concepts, Asynchronous Web Programming, Difference between synchronous and asynchronous web programming.

Learning Resources	<ol style="list-style-type: none"> 1. Web Technology, Moseley and Savaliya, Wiley India 2016 2. HTML 5 Black Book 2Ed, Kogent Learning Solutions Inc, dreamtech 2016 3. Web Design, Joel Sklar, Cengage Learning 2015 4. Learning PHP, MySQL, JavaScript, CSS & HTML5, 3rd Edition, Robin Nixon, O'Reilly 2014 	<ol style="list-style-type: none"> 5. A Step-by-Step Guide to Creating Dynamic Websites By Robin Nixon Publisher: O'Reilly Media 2021 6. Internet and World Wide Web How to program, P.J. Deitel & H.M. Deitel, Pearson, 5th edition, 2014 7. JavaScript for impatient programmers, Dr. Axel Rauschmayer 2022 8. PHP: The Complete Reference By Steven Holzner, McGrawhill, 2017
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	30%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. K.Sankar, Chief Data Scientist - AI, ML and Computer Vision.Eagle Software India Pvt Ltd. Greams Road, Chennai - 600006. Mob : 7305926073	1. Dr. K. Venington, Assistant Professor, Department of Computer Science and Engineering, National Institute of Technology Srinagar, Hazratbal - 190006, Jammu and Kashmir. Contact: +91 9790278826	1. Dr.S.Babu, SRMIST,

Course Code	21CSO352T	Course Name	PYTHON PROGRAMMING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basic programming syntax of Python	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand various Looping statements and Functions															
CLR-3:	Acquire the Knowledge of object oriented feature in Python															
CLR-4:	Comprehend the significance of Lists, Sets and Tuples in Program Development															
CLR-5:	Acquire the knowledge of Files and handling Exceptions															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the basic programming knowledge for Program Development	1	3	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-2:	Apply the knowledge of Loops and Functions to build application	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Design of real world application using Object oriented features	1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Apply the concepts of Lists and Tuples for program optimization	1	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Design of Applications for data exchange using Files	1	-	3	-	2	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction	9 Hour
Introduction - History of Python-Getting Started with Python-Programming style and Documentation-Identifiers-Variables-Assignment statements-Expressions- Data Types-Operators-Precedence-Comments-Type Conversions-Common Python Functions-Introduction to Methods and Strings	
Unit-2 - Loops and Functions	9 Hour
Introduction-Scope-IF Statements-Types of IF Statements-Conditional Expressions-Loops -While Loops-For Loop-Nested Loops-Functions-Definitions-Default Arguments-Calling a Function- Functions with or without returning values-Passings arguments to a function-Call by Value - Call by Reference-Recursion	
Unit-3 - Classes and Objects	9 Hour
Introduction to Object oriented Programming-Need of class and objects-Defining classes-Constructing Objects-Abstraction and Encapsulation-Overriding Methods - Inheritance and Polymorphism-Modules and Packages-Introduction to String Class-String Functions-Formatting Strings	
Unit-4 - Lists - Tuples-Sets	9 Hour
Introduction to Lists-Creation of List-Functions for Lists-Passing List to Functions-Operation on Lists-Searching and Sorting-Multidimensional Lists-Advanced List Processing - Sample programs on Lists-Lotto number and Deck of Cards-Introduction to Tuples-Sets - Creation and Accessing Sets-Dictionary Operations and Methods	
Unit-5 - Files and Exception Handling	9 Hour
Introduction - Structure of File - Opening and Writing Data-Accessing Files-File Dialogs-Retrieving data from web-Introduction to Exceptions-Errors and Exceptions-Command line arguments-Need for Exception-Handling Exceptions-Raising Exceptions-Exception Objects-Custom Exception Classes	

Learning Resources	1. Y.Daniel Liang, "Introduction to Programming using Python"1st edition, Pearson,2021, 2. Karl Beecher, "Computational Thinking-A beginners guide to problem solving and programming, 2017	3. Allen Downey, "Think Python - How to Think Like a Computer Scientist, Green Tea Press, 2021
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. D. Surendran, CEO, SKS Skill Fasteners Private limited	1. Dr. Kannimuthu.S, Professor, Karpagam College of Engineering,Coimbatore	1. Dr. P. Madhavan, SRMIST

Course Code	21CSO353T	Course Name	MOBILE APPLICATION DEVELOPMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basics of Android devices and Platform.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Acquire knowledge on basic building blocks of GUI Components in Android programming															
CLR-3:	Analyze Data storage mechanism in different Android App															
CLR-4:	Appraise android services for different applications															
CLR-5:	Design and apply the knowledge to publish Android applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Exhibit the knowledge on Android devices and Platform	1	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-2:	Demonstrate the usage of GUI Components for App development.	1	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Decide on suitable Data storage mechanism for Apps	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Implement Android services using threads	1	-	3	-	3	-	-	-	-	-	-	-	-	-	-
CO-5:	Develop and publish Android applications	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Mobile Application Development	9 Hour
Introduction, Android platform: Features and architecture, versions, ART (Android Runtime), ADB (Android Debug Bridge). Development environment/IDE: Android studio and its working environment, Application anatomy: Application framework basics: resources layout, values, asset XML representation and generated R.Javafile, Android manifest file. Creating a simple application.	
Unit-2 - GUI for Android	9 Hour
Introduction to activities life-cycle, intent filters, adding categories, linking activities, user interface design components, Views and View Groups: Basic views, picker views, adapter views, Menu, App Bar, basics of screen design; different layouts, App widgets. Lollipop Material design: new themes, new widgets, Card layouts. RecyclerView, Fragments: Introduction to Fragments, life-cycle.	
Unit-3 - Memory Management	9 Hour
Introduction to Different Data persistence schemes, Shared preferences, File Handling, Managing data using SQLite database. Content providers: user content provider, Android in-built content providers, Integration of Social media apps.	
Unit-4 - Threads and Android Services	9 Hour
Introduction to services – local service, remote service and binding the service, the communication between service and activity, Intent Service, Multi-Threading: Handlers, Async Task, android network programming: HTTP URL Connection, Connecting to REST-based and SOAP based Web services, Broadcast receivers: Local Broadcast Manager, Dynamic broadcast receiver, System Broadcast. Pending Intent, Notifications, Telephony Manager: Sending SMS and making calls, Interaction with server side apps	
Unit-5 - Building android Applications	9 Hour
Introduction to Location based services, Google maps V2 services using Google API. Animations and Graphics: Property Animation, View Animations, Drawable Animations, Media and Camera API: Working with video and audio inputs, Camera API, Sensor programming: Motion sensors, Position sensors, Environmental sensors, Guide lines, policies and process of uploading Apps to Google play	

Learning Resources	1. Dawn Griffiths, David Griffiths, "Head First: Android Development", O'Reilly 2015, ISBN: 9781449362188.	3. Paul Deitel, Harvey Deitel, Alexander Wald, "Android 6 for Programmers, App Driven approach", 2015, Prentice Hall, ISBN: 9780134289366.
	2. Greg Milette, Adam Stroud, "PROFESSIONAL Android™ Sensor Programming", John Wiley and Sons, Inc 2012, ISBN/978111265055	4. http://developer.android.com/training/index.html

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mrs. C.Saranya, Engineering Manager, embedUR systems Pvt. Ltd, Chennai.	1. Dr. Thiyagarajan, Asst Prof/Dept of IT, Sri Venkateswara College of Engineering, Sriperumbudur.	1. Dr. B. Prakash, SRMIST
		2. Ms. Revathi, SRMIST
		3. Ms. Vathana, SRMIST

Course Code	21CSO354T	Course Name	DATA ANALYTICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basic concepts of Data Analytics	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Share knowledge of Data Analytics techniques															
CLR-3:	Explore the concept of visualization and its tools															
CLR-4:	Explore and apply the machine learning techniques															
CLR-5:	Implement the applications of Data analytics in different domains															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Exhibit knowledge on the fundamental concepts of data analytics	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Suggest suitable data analysis techniques to handle large data	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Create an interactive dashboard to visualize data	-	1	2	-	3	-	-	-	-	-	-	-	-	-	-
CO-4:	Apply appropriate machine learning algorithm to perform data analytics	1	2	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Develop intelligent decision support systems	-	1	2	-	3	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Data Analytics	9 Hour
Types – Phases - Quality and Quantity of data – Measurement - Exploratory data analysis - Analytic Processes and Tools	
Unit-2 - Big Data and Cloud Technologies	9 Hour
Streams Concepts – Stream Data Model and Architecture - Introduction to HADOOP: Big Data, Apache Hadoop, MapReduce - Data Serialization - Data Extraction	
Unit-3 - Data Visualization	9 Hour
Introduction to data visualization – Data visualization options – Filters – Dashboard development tools – Creating an interactive dashboard with dc.js - summary.	
Unit-4 - Machine Learning	9 Hour
Modeling Process – Training model – Validating model – Predicting new observations –Supervised learning algorithms – Unsupervised learning algorithms	
Unit-5 - Case Studies	9 Hour
Case studies and projects, Understanding business scenarios- Scalable and parallel computing with Hadoop and Map-Reduce- Feature engineering and visualization	

Learning Resources	1. Davy Cielen, Arno D. B. Meysman, Mohamed Ali, <i>Introducing Data Science</i> , Manning Publications Co., 1st edition, 2016.	3. <i>Data Analytics Made Accessible</i> : 2023, Kindle Edition
	2. <i>Hadoop: The Definitive Guide</i> , 4th Edition [Book] - O'Reilly	4. https://www.amazon.in/Data-Analytics-Made-Accessible-2018-ebook/dp/B00K2I2JL8

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. C.Giridharan, M.Tech, Software engineer (Data science), Quickplay media Pvt Ltd , Chennai	1. Dr. Bala Vinayaga sundaram, Anna University	1. G.Malarselvi, SRMIST
		2. Dr. T. Ragunthar, SRMIST

Course Code	21CSO355T	Course Name	MACHINE LEARNING FOR ALL	Course Category	O	OPEN ELECTIVE					L	T	P	C						
						2	1	0	3											
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil													
Course Offering Department		School of Computing		Data Book / Codes / Standards		Nil														
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	provide basic concepts of machine learning				1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3			
CLR-2:	provide deeper understanding of various tools and techniques for Machine learning Algorithms and outputs																			
CLR-3:	Understand and Implement the major classification techniques																			
CLR-4:	Understand and Implement the various Clustering Methods																			
CLR-5:	Learn and Understand the Tree based machine Learning Algorithms																			
Course Outcomes (CO):		At the end of this course, learners will be able to:																		
CO-1:	Understand the concepts of machine learning				-	2	-	-	1	-	-	-	-	-	-	-	-			
CO-2:	Learn and understand machine tools and libraries of machine learning				-	2	-	-	-	-	2	-	-	-	-	-	-			
CO-3:	Learn and understand the linear learning models and classification in machine learning				-	2	-	-	2	-	-	-	-	-	-	-	-			
CO-4:	Understand the clustering techniques and their utilization in machine learning				-	2	-	-	1	-	-	-	-	-	-	-	-			
CO-5:	Study the tree based machine learning techniques and to appreciate their capability				-	2	-	-	2	-	-	-	-	-	-	-	-			
Unit-1 - Introduction to Machine Learning																	9 Hour			
Machine Learning: What and Why?-Types of Machine Learning, Supervised Learning- Unsupervised Learning- Reinforcement learning- Platform for machine learning- Machine learning python libraries- Scikit-learn - Over fitting and under fitting- linear regression-Deriving mathematical intuition behind linear regression-Bias and Variance-Testing and Training of data- Regularization- Classification-types- Error and noise																				
Tutorial:																				
1. Implementation of Linear regression with real time data, 2. Implementation of Classification Algorithm																				
Unit-2 - Tools and Techniques for Machine Learning																	9 Hour			
Training data – Testing data – validation data, Performance metrics- MSE, accuracy, confusion matrix, precision, recall, F- score- Logistic Regression- Types of Logical regression- Spam filtering using logistic regression-Naive Bayes with scikit-learn-Naïve Bayes applications																				
Tutorial:																				
3. Logistic Regression Implementation, 4. Naïve Bayes Implementation																				
Unit-3 - Classification Techniques																	9 Hour			
Classification in Machine learning, Binary Classification-Multi label classification- Imbalanced Classification- Support vector machine-Multi class classification- K nearest neighbour classification-Principal Component Analysis-PCA Application																				
Tutorial:																				
5. Support Vector Machine Implementation. 6. PCA Analysis																				

Unit-4 - Clustering Algorithms	9 Hour
Clustering algorithm, Types of clustering algorithm, Choosing the number of clusters- Spectral clustering - Hierarchical clustering - Agglomerative clustering -Clustering data points and features, K-Means clustering, DB Scan Clustering algorithm- Application: image segmentation using K-means clustering	
Tutorial:	
6. K Means Clustering, 7. DB Scan Clustering Implementation	
Unit-5 - Tree based Machine Learning	9 Hour
Decision tree representation- Basic decision tree learning algorithm- Inductive bias in decision tree- Decision tree construction- Issues in decision tree- Random Forest- Random forest with scikit learn- Multivariate adaptive regression trees (MART)- Introduction to Artificial Neural Networks- Perceptron learning	
Tutorial:	
7. Decision Tree Construction, 8. Random Forest Implementation	

Learning Resources	1. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012. 2. Ethem Alpaydin, "Introduction to Machine Learning", Prentice Hall of India, 2005 3. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997. 4. Sebastian Raschka, Vahid Mirjalili, "Python Machine Learning and deep learning", 2 nd edition, kindle book, 2018	5. Carol Quadros, "Machine Learning with python, scikit-learn and Tensorflow", Packet Publishing, 2018. 6. Gavin Hackling, "Machine Learning with scikit-learn", Packet publishing, O'Reilly, 2018.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Sibi Varthan, Senior Test Engineer, Tech Mahindra	1. Dr.Sundaravadivazhagan, Professor, University of Technology and Applied Sciences, AI Mussnah	1. Dr.M.Sangeetha , SRMIST
		2. Dr.G.Vadivu, SRMIST

Course Code	21CSO356T	Course Name	CONVOLUTIONAL NEURAL NETWORKS FOUNDATION	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn the evolution of neural networks	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Utilize the knowledge for model development															
CLR-3:	Fine tune the performance with optimization techniques															
CLR-4:	Utilize class and build domain model for real-time programs															
CLR-5:	Construct CNN model for image based applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand fundamentals of Neural Networks	-	3	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-2:	Understand fundamentals of CNN Architecture	-	3	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-3:	Learn how to apply performance optimization	-	3	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-4:	Understand different CNN Architectures	-	3	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-5:	Understand CNN in image classification	-	3	-	-	3	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to AI & ML	9 Hour
Types of ML-Old versus new ML-Artificial neural networks-Activation functions The XOR problem-Training neural networks-Backpropagation and the chain rule-Batches Loss functions-The optimizer and its hyperparameters- Underfitting versus overfitting Feature scaling-Fully connected layers T1: Implement Simple Programs like vector addition in TensorFlow. T2: Implement a simple problem like regression model in Keras.	
Unit-2 - Fundamental CNN Architecture	9 Hour
Convolution Input padding-Calculating the number of parameters (weights)- Calculating the number of operations-Converting convolution layers into fully connected layers-The pooling layer-1x1 Convolution-Calculating the receptive field-Building a CNN model in TensorFlow. T1: Implement a CNN based classifier of handwritten digits: The Convolution Layer T2: Implement a CNN based classifier of handwritten digits: The Max Pooling Layer T3: Implement a CNN based classifier of handwritten digits: The Fully Connected Layer	
Unit-3 - Performance Optimization	9 Hour
Number of hidden layers -Number of neurons per hidden layer -Batch normalization -Advanced regularization and avoiding overfitting -Applying dropout operations with TensorFlow -Which optimizer to use? -Memory tuning - Appropriate layer placement -Building the second CNN by putting everything together - Dataset description and preprocessing -Creating the CNN model -Training and evaluating the network. T1: Implement a CNN with Adam optimizer T2: Implement a CNN and apply dropout operations with TensorFlow, T3 Implement a CNN with a validation technique	

Unit-4 - Popular CNN Model Architectures	9 Hour
Introduction to ImageNet -LeNet -AlexNet architecture -VGGNet architecture -VGG16 image classification code example -GoogLeNet architecture -Architecture insights -Inception module -ResNet architecture. T1: Implement Image Net model for a Dataset T2: : Traffic sign classifiers using AlexNet T3 : Implement VGGNet model for a Dataset	
Unit-5 - Image Classification	9 Hour
CNN model architecture-Cross-entropy loss (log loss)-Multi-class cross entropy loss-The train/test dataset split-Datasets-ImageNet-CIFAR-Loading CIFAR- -Building the CNN graph-Learning rate scheduling-Introduction to the tf.data API-Main training loop-Model Initialization-Do not initialize all weights with zeros-Initializing with a mean zero distribution-Xavier-Bengio and the Initializer-Improving generalization by regularizing-L2 and L1 regularization. T1: Implement Image classification with TensorFlow T2: Build TensorFlow input pipelines for image T3: Implement a CNN for Image processing L2 regularization	

Learning Resources	<ol style="list-style-type: none"> 1. Iffat Zafar, Giounona Tzanidou, Richard Burton, Nimesh Patel, Leonardo Araujo," Hands-On Convolutional Neural Networks with TensorFlow", ",Packt Publishing., 2018. 2. Mohit Sewak, Pradeep Pujari, Md. Rezaul Karim,"Practical Convolutional Neural Networks: Implement Advanced Deep Learning Models Using Python, ",Packt Publishing ,2018 3. Charu C. Aggarwal. Neural Networks and Deep Learning: A Textbook. Springer. 2019. 4. Stanford University Course http://cs231n.stanford.edu/2018/syllabus.html
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Gowtham Kumar Jyayachandiran, Assistant Vice President Nomura		1. Dr.K.Arthi, SRMIST

Course Code	21CSO357T	Course Name	DATA VISUALIZATION BASICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn the basics of EDA analysis and exploring PyViz, HoloViz for data visualization	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Know to perform D3 for data visualization															
CLR-3:	Utilize the Matplotlib library to visualize data															
CLR-4:	Explore the Tableau to visualize data															
CLR-5:	Explore the Apache Superset to visualize data															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Use EDA techniques to identify insights of data and data visualization using PyViz and HoloViz	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
CO-2:	Create effective visualization using D3 templates	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-3:	Implement the code to visualize data using Matplotlib	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CO-4:	Visualize different kinds of dataset using Tableau	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
CO-5:	Visualize different kinds of dataset using Apache Superset	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-

Unit-1 - Introduction to EDA, PyViz and HoloViz	9 Hour
Fundamentals of EDA-EDA with Personal Email-Descriptive Statistics-EDA on Wine Quality Data Analysis-Exploratory data analysis using seaborn-Using PyViz / HoloViz (Geoviews, Datashader, HvPlot)-creating several types of Leaflet maps using folium. T1: A data-centric approach to visualization using plot, T2: Building interactivity in plots, T3: Building dashboards using Panel	
Unit-2 - Data Driven Documents-D3	9 Hour
Introduction to D3-Getting started with D3-D3 visualization sample templates-Displaying Results Using D3>Create a summary file for visualization-Visualization using HTML document-Data visualization showing the stacked view-Bar chart-Multiple Donuts-Stacked Area-Pie chart T4: Identifying appropriate template for the available dataset, T5: Displaying results using D3, T6: Creating visualization showing bar chart, donuts, pies using D3	
Unit-3 - Visualization with Matplotlib	9 Hour
Simple Line Plots-Simple Scatter Plots-Visualizing Errors-Density and Contour Plots-Histograms, Binnings, and Density-Customizing Plot Legends-Customizing Colorbars-Multiple Subplots-Text and Annotation-Customizing-Ticks-Customizing Matplotlib: Configurations and Stylesheets-Three-Dimensional Plotting in Matplotlib-Geographic Data with Basemap-Visualization with Seaborn T7: Implement simple plotting using Matplotlib, T8: Customizing colorbars, multiple subplots, text and annotation using Matplotlib, T9: Implement geographic data visualization using Seaborn	
Unit-4 - Tableau Your Data	9 Hour
Creating Visual Analytics with Tableau Desktop: shortcomings of traditional information analysis, Workspace-Connecting to Your Data :Connection, Generated values, Data Extract, Joining, Blending, Data Quality- Building Your First Visualization-creating calculations to enhance Your Data: Showme, Trendline, sorting, filters, sets, groups-Creating Calculations to Enhance Your Data: Aggregation, calculated values, Formulas, function reference-Bringing It All Together with Dashboards: understanding, right way, best practices T10: Exploring the workspaces of Tableau, T11: Building simple visualization using Tableau, T12 Building dashboards using Tableau	

Unit-5 - Apache Superset	9 Hour
Getting Started with Data Exploration: Installing, sharing, configuring, add database, uploading, customization -Configuring Superset and Using SQL Lab: setting wen server, creation, migration, securing, caching, mapbox-User Authentication and Permissions: security, google sign in, list users page, views/ menus, list permission, user statistics page-Visualizing Data in a Column-Comparing Feature Values-Drawing Connections between Entity Columns-Mapping Data That Has Location Information-Building Dashboards	
T13: Exploring the workspaces of Superset, T14: Building simple visualization using Superset, T15 Building dashboards using Superset	

Learning Resources	<ol style="list-style-type: none"> 1. Jake VanderPlas (2017). Python Data Science Handbook: Essential Tools for Working with Data. First Edition O'Reilly Media,Inc. ISBN-10: 1491912057, ISBN-13:978-1491912058 2. Suresh Kumar Mukhiya, Usman Ahmed (2020). Hands-On Exploratory Data Analysis with Python: Perform EDA techniques to understand, summarize, and investigate your data. Copyright © Packt Publishing Ltd. 3. Shashank Shekhar (2018). Apache Superset Quick Start Guide-Develop interactive visualizations by creating user-friendly dashboards, -Copyright © Packt Publishing Ltd. 4. Mike Dewar (2012). Getting Started with D3. O'Reilly Media, Inc., ISBN:9781449328795 5. Big Data Visualization, James D. Miller, Copyright © 2017 Packt Publishing Ltd. 6. Tableau Your Data:Fast and Easy Visual Analysis with Tableau Software- Daniel G.Murray, with the InterWorks team, John Wiley & Sons, Inc. ISBN: 978-1-118-61204-0 7. Shai Vaingast, "Beginning Python Visualization Crafting Visual Transformation Scripts", Apress, 2nd edition, 2014. 8. Wes Mc Kinney, "Python for Data Analysis", O'Reilly Media, 2012. 9. Wesley J.Chun,"Core Python Applications Programming,3rd ed,Pearson,2016 10. https://pyviz.org/ 11. https://holoviz.org/
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Vishwa Prasath T S, Technology Analyst, Accenture Pvt Ltd	1. Mr.C.M.T.Karthikeyan, Asst. Professor, Government College of Engineering - Bargur	1. Dr. P.Rajasekar, SRMIST

Course Code	21CSO358T	Course Name	NETWORK SECURITY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:		Gain a complete knowledge on types of security attacks, services and mechanisms.														
CLR-2:		Understand the implementation of Internetwork security model and its standards and vulnerabilities.														
CLR-3:		Demonstrate the Conventional Encryption Principles and the Public key cryptography principles														
CLR-4:		Take up projects on Email privacy system and compare Pretty Good Privacy (PGP) and S/MIME.														
CLR-5:		Build a model of Firewall and test the security issues														
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:		Identify security breaches in a computer network														
CO-2:		discuss major issues concerning computer security.														
CO-3:		use standard security tools to locate and fix security leaks in a computer network.														
CO-4:		understand a variety of cryptographic algorithms and protocols underlying network security applications.														
CO-5:		Understand the system-level security issues.														

Unit-1 - Introduction	9 Hour
Attacks, Services and Mechanisms, Security Attacks, Security - Services, Integrity check, digital Signature, authentication, has algorithms.	
Unit-2 - Secret Key Cryptography	9 Hour
Block Encryption, DES rounds, S-Boxes IDEA: Overview, comparison with DES, Key expansion, IDEA rounds, Uses of Secret key Cryptography; ECB, CBC, OFB, CFB, Multiple encryptions DES	
Unit-3 - Hash Functions and Message Digests	9 Hour
Length of hash, uses, algorithms (MD2, MD4, MD5, And SHA) MD2: Algorithm (Padding, checksum, passes.) MD4 and 5: algorithm (padding, stages, digest computation.) SHA: Overview, padding, stages	
Unit-4 - Public key Cryptography	9 Hour
Algorithms, examples, Modular arithmetic (addition, multiplication, inverse, and exponentiation) RSA: generating keys, encryption and decryption. Other Algorithms: PKCS, Diffie-Hellman, El-Gamal signatures, DSS, Zero-knowledge signatures	
Unit-5 - Authentication	9 Hour
Password Based, Address Based, Cryptographic Authentication. Passwords in distributed systems, on-line vs off- line guessing, storing. Cryptographic Authentication: passwords as keys, protocols, KDC's Certification Revocation, Inter- domain, groups, delegation	

Learning Resources	1. Atul Kahate, Cryptography and Network Security, McGraw Hill.	3. Stallings, W., Cryptography and Network Security: Principles and Practice, 3rd ed., Prentice Hall PTR., 2020.
	2. Kaufman, c., Perlman, R., and Speciner, M., Network Security, Private Communication in a public world, 2nd ed., Prentice Hall PTR., 2021.	4. Stallings, W. Network security Essentials: Applications and standards, Prentice Hall, 2020.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.M.Vivekanandan,Nokia	1. Karthikeyan.C.M.T, Govt College of Engg, Bargur	1. D.Saveetha, SRMIST
2. Mr.Santhosh Kumar,CTS	2. Syedthouheed,Reva University, Bangalore	

Course Code	21CSO359T	Course Name	FUNDAMENTALS OF INFORMATION SYSTEM SECURITY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Gather and document security requirements	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Design and document security plan															
CLR-3:	Develop data/information assurance plans and implementation strategies															
CLR-4:	Identify, analyze, and evaluate infrastructure and network vulnerabilities															
CLR-5:	Identify and assess current and anticipated security risks and vulnerabilities															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand Security Requirements	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Carry out Security Plan	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Identify, analyze, and evaluate infrastructure and network vulnerabilities	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Develop data/information assurance plans and implementation strategies	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-5:	Identify, analyze, and evaluate infrastructure and network vulnerabilities	-	-	2	-	-	-	-	2	-	-	-	-	-	-	-

Unit-1 - The Security Problem in Computing	9 Hour
The meaning of computer Security, Computer Criminals, Methods of Defense	
Unit-2 - Program Security	9 Hour
Secure Programs, no malicious Program Errors, viruses and other - malicious code, Targeted Malicious code, controls Against Program Threats, Protection in - General- Purpose operating system	
Unit-3 - Data base Security	9 Hour
Security requirements, Reliability and integrity, Sensitive data, Inference, multilevel database, proposals for multilevel security.	
Unit-4 - Administering Security	9 Hour
Security Planning, Risk Analysis, Organizational Security policies, Physical Security. Legal Privacy and Ethical Issues in Computer Security	
Unit-5 – Software Ethics	9 Hour
Protecting Programs and data, Information and the law, Rights of Employees and Employers, Software failures, Computer Crime, Praia, Ethical issues in Computer Security, case studies of Ethics.	

Learning Resources	1. Security+ Guide to Network Security Fundamentals, 5th Edition Mark Ciampa Cengage Learning (2019) ISBN: 978-1-305-09391-1	2. Fundamentals of Information Systems Security, 3rd Edition by David Kim, Michael G. Solomon October 2018, Jones & Bartlett Learning ISBN: 9781284116465
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.M.Vivekanandan,Nokia	1. Karthikeyan.C.M.T, Govt College of Engg,Bargur	1. D.Saveetha, SRMIST
2. Mr.Santhosh Kumar,CTS	2. Syedthouheed,Reva University, Bangalore	

Course Code	21CSO360T	Course Name	SECURITY POLICY IMPLEMENTATION	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the common Information Systems Security models	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Review CIA characteristics – confidentiality, integrity and availability															
CLR-3:	Understand security measures from Technology, Policy & Practice and Education/Training/Awareness dimensions.															
CLR-4:	Understand risk management – identification, quantification, response and control.															
CLR-5:	Learn disaster recovery procedures and countermeasures for the business enterprise.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Students implement IT risk management plans	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Identify alternate sites for processing mission-critical applications, and techniques	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Handling information security	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Personnel and facilities; protection of sensitive	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-5:	Identify emerging security risks and implement security policies	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction and Threats to Enterprise Security	9 Hour
Introduction and Threats - Vulnerabilities - Risk Thinking - Security Responses	
Unit-2 - I.T. Enterprise Security Issues	9 Hour
Common Enterprise Security Issues - Ethical Issues - Legal and Regulatory Issues - Asset Security - Security Risk	
Unit-3 - Security Policies, Standards and Procedures	9 Hour
Security Policies - Rationale for Policies, Standards and Procedures - Preparing and Gathering Information - Policy Parameters - Policy Tiers -Enterprise-Tier Policies - Topic-Tier Policies - Application-Tier Policies - Asset Classification	
Unit-4 - I.T. Operational Security Management	9 Hour
Common Operational Security Management - Quality Assurance in Software Development - Security in system development -Specialized Issues in Operational Security Management	
Unit-5 - I. T. Business Continuity	9 Hour
Preparation - An introduction to business continuity and disaster recovery - Reviewing business continuity concepts - Establishing principles of disaster recovery planning -Reviewing steps for disaster recovery planning - Preparing to develop a disaster recovery plan - Preparing for I.T. continuity - Assessing risks - Prioritizing assets for recovery - Developing plans and procedures - Learning organizational relationships	

Learning Resources	1. <i>Information Security Policies and Procedures: A Practitioner's Reference</i> by Thomas R. Peltier, Second edition, Auerbach, ISBN 0-8493-1958-7	3. <i>Security Policies and Procedures: Principles and Practices</i> Sari Greene (2021) Prentice Hall ISBN 0-13-186691-5
	2. <i>Guide to Disaster Recovery</i> Erbschloe, M. (2021) Thomson Course Technology ISBN 9 780619 131227	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. T Ravichandran, Product Manager, Servis2 IT Team, Chennai.		1. Dr. P. Balamurugan, SRMIST
2. Dhanvanth Kesavan, NTT Data, Cyber security analyst, Chennai.		

Course Code	21CSO451T	Course Name	DEEP LEARNING FOUNDATION	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the concepts of Neural Networks and Deep Learning	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the Deep neural network and layered learning approach															
CLR-3:	Study and understand CNN and RNN for deep learning															
CLR-4:	Learn and understand Auto Encoders and its applications															
CLR-5:	Understand the concept of transfer learning and its applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply basic mathematical concepts learning algorithms	-	2	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-2:	Apply the knowledge of gradient descent and regularization techniques in feed forward networks	-	2	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-3:	Deal with Convolution Neural Networks	-	2	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Analyze various types of data encoders	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply Various network models in deep learning	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-

Unit-1 - Deep Learning Basics	9 Hour
Introduction – Basics - Learning Algorithms - Supervised and Unsupervised Training - Hyper parameters Vs Parameters - validation sets - Estimators, Bias, Variance – Regularization - Challenges Motivating Deep Learning - The Curse of Dimensionality – Perceptron Learning Algorithm – Linear Separability – Multilayer perceptron – Backpropagation.	
Tutorial	
1. To implement data classification using simple ML algorithm. 2. To implement Planer data classification with a hidden layer, 3. Neural Network to predict house prices with Keras.	
Unit-2 - Deep Neural Network	9 Hour
Introduction to a simple DNN - Platform for deep learning - requirements to build DNN - Deep learning software libraries - Tensorflow, Keras, PyTorch - Deep – Hyper parameter Tuning, Batch Normalization - Learning XOR - Gradient-Based Learning - Various types of Gradient Descent functions – Early Stopping – Drop out.	
Tutorial	
1. To implement gradient descent and backpropagation in deep neural network, 2. Create a simple deep neural network and tune the hyperparameters. 3. To build a simple feed forward neural network to recognize handwritten character.	
Unit-3 - Convolution Neural Networks	9 Hour
Introduction to convolution neural network – operation – motivation – pooling – Normalization – sequence modeling – VGGNet , LeNet – Recurrent Neural Network – Topologies – Long Short Term Memory – Bidirectional LSTMs – Bidirectional RNNs – LSTM with Keras.	
Tutorial	
1. Build a CNN model to classify Cat and dog image. 2. Develop LSTM Models for Time Series Forecasting. 3. Implementation to predict the prices of stocks using the “Google stock price” data using LSTM.	

Unit-4 - Encoder and Decoder	9 Hour
Encoder – Decoder – Auto Encoder Introduction – Auto Encoders – Under complete Auto Encoder – Regularized Auto Encoder – Stochastic Auto Encoder – Denoising Auto Encoder – Contractive Auto Encoder – Applications – Dimensionality Reduction – classification using Auto encoders	
Tutorial	
1. To Perform compression on mnist dataset using auto encoder, 2. Image Dimensionality reduction using encoders, 3. Anomaly detection using auto encoder	
Unit-5 - Transfer Learning	9 Hour
Deep Architecture in Vision – AlexNet to ResNet – GoogleNet – Transfer Learning – Siamese Networks – Metric Learning – Ranking – Triplet Loss – CNN – RCNN – Applications.	
Tutorial	
To implement a Pre-trained CNN model as a Feature Extractor using Transfer Learning	
1. Image recognition using CNN. 2. Object detection using CNN	

Learning Resources	1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016 (available at http://www.deeplearningbook.org) 2. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012 3. Michael Nielsen, "Neural Networks and Deep Learning", Online book, 2016 (http://neuralnetworksanddeeplearning.com/)	4. Christopher and M. Bishop, "Pattern Recognition and Machine Learning", Springer Science Business Media, 2006. 5. Jason Brownlee, "Deep Learning with Python", ebook, 2016.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Dr. S. Srividhya, SRMIST
		2. Dr.M.Prakash, SRMIST

Course Code	21ECO101T	Course Name	SHORT RANGE WIRELESS COMMUNICATION	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	ECE	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Overview of different modulation scheme and wireless system	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Familiarize the various components that used to implement a short-range radio system.															
CLR-3:	Analysis of the various kinds of transmitters and receivers used for Short range Wireless Communication															
CLR-4:	Know about regulations and standards of ISM band communications															
CLR-5:	Design and analysis of short-range radio like UWB and Visible light															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Familiarize the various forms of signals used for information transmission and modulation, and overall wireless system properties	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Present various component types that can be used to implement a short-range radio system.	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Describe the various kinds of transmitters and receivers.	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Aware the regulations and standards of ISM band communications	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Gain the knowledge of the most important new developments in short-range radio like UWB and Visible light.	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Wireless Systems	9 Hour
Introduction to wireless systems, Reasons for the Spread of Wireless Applications Characteristics of Short-range Radio, Wireless Applications Elements of Wireless Communication Systems, Transmitter Elements of Wireless Communication Systems, Receiver Wireless Local Area Networks (WLAN), WIFI Network Architecture, Bluetooth, Transceiver, Bluetooth Modes Zigbee Architecture, Frame Structure Applications and conflicts, Ultra-wideband Technology, Bit Sequence detection, UWB Block Diagram, Case study: Design and analyze the WLAN hardware module	
Unit-2 - Antennas and Baseband Coding Basics	9 Hour
Types of Antennas-Dipole, ground plane, loop Helical, Patch antennas, Antenna Characteristics, Impedance, directivity and gain, Effective area Polarization, Bandwidth, Antenna factor Baseband Data Format and Protocol - Radio Communication Link Diagram Code Hopping, Baseband Coding- Digital systems Wireless Microphone System RF Frequency and Bandwidth-factors, Propagation characteristics Modulation types Modulation for digital event communication, Continuous Digital Communication, Advanced Digital Modulation Spread Spectrum, DHSS Spread Spectrum, FHSS RFID transceiver, Design issues for RFID	
Unit-3 - RF Transceivers	9 Hour
RF Receivers- Introduction RF Source, Frequency control Modulation types Amplifiers Impedance matching in transmitter and receivers Filtering, SAW band pass filter matching, Tuned Radio Frequency (TRF), ASH Receiver Super regenerative Receiver, Block diagram Super regenerative Receiver, Operation Super heterodyne Receiver, Block diagram Super heterodyne Receiver, Operation Direct Conversion Receiver, Block diagram Direct Conversion Receiver, Operation Digital Receivers-Software radio, Software radio operation Repeaters Case study: Design and analyze the simple real-time AM transceiver	

Unit-4 - Wireless Standards		9 Hour
FCC Regulations, Terms and definitions, Nomenclature for defining Emission, modulation and transmission, Technical Background to the WPAN Concept, Regulation and Standardization Issues European Consortium: Overview Millimeter, Wave Applications and Services , PAN scenarios in the IST Magnet project, Typical LDR services connected to the IST- FP6 MAGNET project, Frequency Regulation and Standardization, Issues, Optional UM4 usage models issued from the EEE802.15.3c TG Flexible antenna gain, 60 GHz regulation status for wireless transmissions, Channel Propagation Characterization and Modeling, 60 GHz Propagation Measurements, Propagation Channel Characterization, Multipath Propagation Modeling		
Unit-5 - Optical Wireless Technologies		9 Hour
Fundamentals of UROOF Technologies, Conversion from RF to Optical Domain, Conversion from Optical to RF Domain, Optical Microwave Mixing Used for UWB Over Systems, Integrated UROOF Transceiver (IUT), Mixed Wireless-wired UROOF Channel, Carrier-to-noise Ratio, Laser and Photodetector Noise Baseline, Clipping Distortion Implication , Latency, Modelling the Propagation through the Fibre, Analysis of UWB Technologies forUROOF, Comparing UWB Technologies for Radio-over- fibre MB-OFDM, Over Multimode Fibre , All-optical Generation of Ultra-wideband Impulse Radio Operation, Principles and Theoretical Approach VLC Link, Transmitter, The VLC Channel Receiver, Modulation, Potential Applications, Challenges		
Learning Resources	1. Alan Bensky, "Short range Wireless Communications- Fundamentals of RF system design and Applications", Elsevier Inc, 2004	
	2. Antti V. Raisenen, Arto Lehto, "Radio engineering for wireless communication and sensor applications", Artech House, 2003	
	3. Rolf Kraemer and Marcos Katz, "Short-range wireless communications emerging technologies and applications", Wiley WWRP series, March 2009	
	4. Shlomi Arnon, John Barry, George Karagiannidis, Robert Schober, Murat Uysal, "Advanced Optical Wireless Communication Systems", Cambridge University Press, 2012	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	20%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.ani@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr. P.Prabhu, SRM IST
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	

Course Code	21EO102J	Course Name	ELECTRONICS CIRCUITS AND SYSTEMS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	18ECO106J	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	ECE	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes							
CLR-1:	Provide a basis for understanding semiconductor material, how a PN junction is formed and its principle of operation	CLR-2:	Describe the basic structure, operation and characteristics of transistors BJTs and FETs, and discuss their use as an amplifier	CLR-3:	Learn the basics of op-amp: the principle, operation, characteristics and fundamentally important circuits	CLR-4:	Describe and analyze the basic operation of sinusoidal oscillators and use a 555 Timer in an oscillator application.	CLR-5:	Learn the fundamentals of analog and digital communication, networking, radio transmission and mobile telephones	1	2	3	4	5	6				7	8	9	10	11
				Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3					
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in amplification	CO-3:	Identify different configurations of op-amp and analyze the parameters of op-amp and observe the frequency response of operational-amplifier.	CO-4:	Understand & demonstrate different applications based on operational-amplifier and special linear ICs	CO-5:	Understand the basic concepts and techniques of telecommunication systems and networks	3	3	-	-	3	-	-	-	-	-	-	-	-	-
CO-1:	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and demonstrate its important applications	CO-2:	Review the transistor (BJT & FET) construction, operation, characteristics and parameters, as well as its application in ampl																				

Unit-1 - Active Discrete Components & Circuits – I	12 Hour
Types of semiconductors, Current mechanism in semiconductors, Basic operation of PN junction diode, VI Characteristics of diode, Applications of diode: HWR & FWR, Clippers & Clampers, Breakdown Mechanism, Zener diode as a voltage regulator, BJTs: Structure & Operation, IV Characteristics, Small Signal Model, BJT as amplifier, CE BJT amplifier operation, Differential amplifier operation Practice: VI characteristics of Normal and Zener diode, Clipper and Clamper, BJT IV characteristics, Differential Amplifier	
Unit-2 - Active Discrete Components & Circuits – II	12 Hour
MOSFETs Structure & Operation, Characteristics & Parameters, IV Characteristics, Early Effect, MOSFET Biasing (Voltage-Divider Biasing), Small signal model, MOSFET as an amplifier, Frequency Response of CS MOSFET, CS-MOSFET amplifier operation, Voltage gain, Input and output resistance, Differential amplifier operation Practice: VI characteristics MOSFET, Biasing, MOS frequency response, CS Amplifier. Differential Amplifier	
Unit-3 - Linear Integrated Circuits	12 Hour
Introduction to Op-amp, Basic op-amp and its characteristics, Op-amp modes, Parameters, Op-amp circuits: Scale changer, Adder, Subtractor, HWR & FWR, Clipper & Clamper Log & Antilog amplifiers, Instrumentation amplifier, Comparator, Comparator applications, Schmitt trigger Practice: Single stage Op-Amp, HWR and FWR, Comparator, Schmitt Trigger	

Unit-4 - Oscillators and Timers	12 Hour
RC Phase-Shift oscillator Operation & Design, Wein bridge Oscillator operation & Design LC oscillators operation: Hartley Oscillator, Colpitts Oscillator, 555 Timer IC: Basic Operation, Astable Operation, Monostable Operation, Applications of 555 Timer, Voltage-Controlled Oscillators	
Practice: Oscillator, VCO	
Unit-5 - Telecommunications	12 Hour
Analog & Digital Communication: Stages in telecommunication systems, Carriers and Modulation, Carriers and Modulation, Pulse Modulation, Pulse Modulation, Digital Transmission, Frequency Division, Multiplexing Time Division Multiplexing, Networks: RS-232, circuit switching, Message switching, TCP/IP, Radio Transmission: Electromagnetic, Spectrum, Ground waves, Sky waves, Antennas, Directional transmissions, Transmitters, Receivers, Mobile telephones	
Practice: Modulation and demodulation	

Learning Resources	1. Owen Bishop, "Electronic Circuits and Systems", 4th edition, Elsevier, 2011. 2. Harry Kybett, Earl Boysen, "All New Electronics", 3rd edition, Wiley, 2008.	3. Paul Scherz, "Practical Electronics for Inventors", McGraw-Hill, 2000. 4. Digital Communication John G. Proakis, 5th edition, McGraw-Hill, 2014
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	-	20%	30%	-
Level 2	Understand	30%	-	-	30%	30%	-
Level 3	Apply	40%	-	-	40%	40%	-
Level 4	Analyze	-	-	-	10%	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr. Saivineeth, ML Accelerator Architect @ Google	1. Dr. Rajesh Agarwal, SRMIST
		2. Dr. Soumya Ranjan, SRMIST

Course Code	21ECO103T	Course Name	MODERN WIRELESS COMMUNICATION SYSTEM	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	ECE	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn to analyze the transmission of various wireless communication systems			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the fundamentals of various networks in wireless communication																	
CLR-3:	Understand the techniques involved in personal communication services.																	
CLR-4:	Introduce various wireless systems for 3G and future communication																	
CLR-5:	Learn to analyze wireless networks for short range communication and understanding the fundamentals																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Discuss the fundamentals of transmission in wireless systems			-	-	-	3	-	-	-	-	-	-	-	-	3	-	-
CO-2:	Provide an overview of various approaches to communication networks			-	-	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Study the numerous different-generation technologies with their individual pros and cons			-	-	-	3	-	-	-	-	-	-	-	-	2	-	3
CO-4:	Discuss about the principles of operation of the different access technologies like FDMA, TDMA, SDMA and CDMA and their pros and cons			-	-	-	3	-	-	-	-	-	-	-	-	2	-	3
CO-5:	Learn about the various mobile data services and short-range networks and gain knowledge on Fundamentals			-	-	-	3	-	-	-	-	-	-	-	-	3	-	3

Unit-1 - Transmission Fundamentals	9 Hour
Cellphone Generations- 1G and 2G- 2.5G- 3G- 4G Transmission Introduction- 4G Transmission Fundamentals- Time domain concepts- Frequency domain concepts- Radio Media- Analog Vs Digital- Channel capacity- Transmission media- Signaling Schemes	
Unit-2 - Network Concepts	9 Hour
Communication Networks, LANs, MANs, WANs, Circuit switching, Packet switching, ATM Cellular Networks Introduction, Cells, Duplexing, Multiplexing, Voice coding, Multiple Access Techniques: FDMA, TDMA, SDMA, CDMA, Spectral efficiency	
Unit-3 - Personal Communication Services	9 Hour
Personal communication Introduction, HSCSD, GPRS, D-AMPS, CDMA One, CDMA Two, Packet Data Systems- GSM-HSCSD- GPRS- D-AMPS- CDMA Introduction-CDMA One- CDMA Two- Packet Data Systems	
Unit-4 - 3G and Beyond	9 Hour
3G Introduction- MT-2000 Introduction- IMT-2000- W-CDMA Introduction- W-CDMA- CDMA 2000 Introduction- EDGE- Wi-Fi Introduction- WiMAX Introduction- WiMAX-OFDM- MIMO	
Unit-5 - Mobile Data Services and Short Range Network	9 Hour
Mobile Data Services Introduction Messaging, wireless web, WAP, site design Short-Range Wireless Networks: Unlicensed spectrum, WLANs, cordless telephony, IrDA, Bluetooth Smart Phones: Future phones , mobile OSs, smart phone applications- Data Services- Messaging- Wireless web-WAP- Site design- Short-Range Wireless Networks- Unlicensed spectrum- WLANs- Cordless telephony- IrDA- Bluetooth Smart Phones- Future phones- Mobile Oss- Smart phone applications	

Learning Resources	1. Simon Haykin, David Koilpillai, Michael Moher, "Modern Wireless Communication", 1/e, Pearson Education, 2011.	5. Ian F.Akyildiz, David M. Gutierrez Estevez, and Elias Chavarria Reyes, "The evolution of 4G cellular systems: LTE advanced", Physical communication, Volume 3, No. 4, pp. 217-298, Dec. 2010\
	2. Rappaport T.S, "Wireless Communications: Principles and Practice", 2nd edition, Pearson education.	6. William Stallings, "Wireless Communication & Networking", Pearson Education Asia, 2004.
	3. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, Aug. 2005.	7. Andrea.F. Molisch, "Wireless communications", 2nd edition, Wiley Publications.
	4. Andy Doman, "The essential guide to wireless communications applications: from cellular systems to Wi-Fi", 2nd Edition, Prentice Hall, 2002	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	1. Dr. Meenakshi, Professor of ECE, CEG, Anna University, meena68@annauniv.edu	1. Dr. Sandeep Kumar P, SRMIST
2. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	2. Dr. Venkatesan, Sr. Scientist, NIOT, Chennai, venkat@niot.res.in	

Course Code	21ECO104J	Course Name	PCB DESIGN AND MANUFACTURING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	ECE	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Explore the terminologies of PCB design and electronic components	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2:	Understand the design and other consideration involved in PCB design	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	Understand the PCB design consideration for special application circuits															
CLR-4:	Design a PCB layout using PCB designing tool															
CLR-5:	Explore various PCB manufacturing techniques															

Course Outcomes (CO):	At the end of this course, learners will be able to:	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CO-1:	Identify the various types of PCB and electronics components packaging	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Select suitable design and consider appropriate parameters involved in PCB design	2	1	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-3:	Apply the appropriate design rules in designing PCB for special application circuits	3	-	2	-	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Design and develop a PCB layout using PCB designing tool	1	-	3	-	-	-	-	-	-	-	-	-	3	-	-
CO-5:	Identify and select the required PCB manufacturing technology	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Basics of PCB and Electronic Components	12 Hour
Need for Printed Circuit Board, Classification of Printed Circuit Boards, Manufacturing of basic PCB - Single and Double-sided Plated Through-holes, Multi-layer Boards, Flexible Boards, Challenges in modern PCB Design and Manufacture, PCB Standards. Types, Symbols, Packaging, shapes and terminal details of Electronic Components, Integrated Circuits (digital & linear), Random Access Memory, Read Only Memory, Microcontrollers, Surface Mount Devices, Heat Sinks, Transformer, Relays, Connectors.	
Practice: Demonstration of electronic components- Passive and active components, analog and digital integrated circuits (IC), Demonstration of testing and measuring Instruments - Logic analyzer, spectrum analyzer, IC tester (Analog and Digital), LCR meter.	
Unit-2 - PCB Design Considerations	12 Hour
PCB Design Considerations – General, Mechanical and Electrical Design Considerations, PCB Design Considerations – Conductor Patterns, Component Placement Rules, Fabrication and Assembly Considerations, Environmental Factors, Cooling Requirements and Packaging Density, Layout Design.	
Practice: Design and analysis of RL and RC circuits - Schematic in EDA tool, Design and analysis of RLC circuits - Schematic in EDA tool, PCB Layout Design - RL, RC and RLC circuits.	
Unit-3 - PCB Design Rules	12 Hour
PCB Design Rules - Analog Circuits, Digital Circuits, High Frequency Circuits, Fast Pulse Circuits, Microwave Circuits, Power electronic circuits. High-density Interconnection Structures, Electromagnetic Interference/Compatibility (EMI/EMC).	
Practice: Schematic and Layout in EDA tool - Regulated power supply, Full wave rectifier circuit with fixed voltage regulator.	

Unit-4 - Schematic and PCB Layout Design	12 Hour
Schematic Capture – Introduction to schematic capture tool, Simulation of simple electronic circuit, Schematic to layout transfer, PCB Layout Design - Conception Level introduction, Specifying Parts, Packages and Pin Names, Libraries, Checking foot prints of the components, Part list, Net list, Making Net list Files, Mounting Holes, Adding Text, DRC, Pattern Transfer, Layout printing. Practice: Schematic and layout design using PCB design tool: Single Digit Pulse Counter, Electronic turn ON/OFF timer using IC555, etc. (Open Choice).	
Unit-5 - PCB Fabrication	12 Hour
Image Transfer Techniques- Screen Printing, Pattern Transferring Techniques, Printing Inks, Photo Printing, Laser Direct Imaging (LDI), Copper Clad Laminates - Properties of Laminates, Types of Laminates, Evaluation of Laminates. Etching Techniques – Wet Chemical Etching, Mechanical Etching, PCB Assembly Process - Through-hole, Surface Mount, Mixed Technologies, Soldering. Practice: Manufacturing and testing the PCB: Single Digit Pulse Counter, electronic turn ON/OFF timer using IC555, etc. (Open Choice)	

Learning Resources	<ol style="list-style-type: none"> 1. Raghbir Singh Khandpur, "Printed Circuit Boards: Design, Fabrication, and Assembly" McGrawHill Electronic Engineering, 2006. 2. Charles A. Harpe, "High Performance Printed Circuit Boards", McGraw Hill Professional, 2000. 3. Bruce R. Archambeault, James Drewniak, "PCB Design for Real-World EMI Control", Volume 696 of The Springer International Series in Engineering and Computer Science, Springer Science & Business Media, 2013 4. Kraig Mitzner, "Complete PCB Design Using OrCAD Capture and PCB Editor", Newnes/Elsevier, 2009. 5. Douglas Brooks "Signal Integrity Issues and Printed Circuit Board Design", Prentice Hall PTR, 2003. 6. Mark I. Montrose "Printed Circuit Board Design Techniques for EMC Compliance: A handbook for designers" Wiley, 2 Edition, 2015. 7. Esim open-source tool: http://esim.fossee.in/ 8. INA/Orcad User manual
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd.	1. Dr. P. Eswaran, SRM IST
		2. Dr. Sanjay Kumar Sahu, SRM IST

Course Code	21ECO105T	Course Name	FIBER OPTICS AND OPTOELECTRONICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	ECE	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
Analyze the basic laws and theorems of light associated with the optical fiber communication and the classification of optical fibers		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:																
Address concepts related to transmission characteristics such as attenuation and dispersion																
CLR-3:																
Explore the fundamentals of optoelectronics Sources and Detectors																
CLR-4:																
Illustrate the integration methods available for optoelectronic circuits and devices																
CLR-5:																
Gain to information on Optical modulators and amplifiers																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:		3	2	-	-	-	-	-	-	-	-	-	1	-	-	1
Apply the basic theorems related to fiber optic communication, and attain knowledge of types of optical fibers																
CO-2:		3	2	-	-	-	-	-	-	-	-	-	1	-	-	1
Define the optical signal distortion factors in optical fiber communication																
CO-3:		3	2	-	-	-	-	-	-	-	-	-	1	-	-	1
Interpret the principle and operation of various, light sources and detectors																
CO-4:		3	-	2	-	-	-	-	-	-	-	-	1	-	-	1
Summarize the various optoelectronic integrated circuits and Optoelectronic Devices																
CO-5:		3	2	-	-	-	-	-	-	-	-	-	1	-	-	1
Gain the knowledge of various optoelectronic modulators and amplifiers																

Unit-1 - Basics of Optical Fiber	9 Hour
Evolution of fiber optic system, Elements of an optical fiber transmission link. Characteristics and behaviour of light. Total internal reflection, Acceptance angle Numerical aperture, Critical angle, Ray optics Types of rays, Optical fiber modes, Optical fiber configurations, Single mode fibers, Multimode Fibers, Step Index Fibers, Graded Index Fibers.	
Unit-2 - Fiber Attenuation and Dispersion Characteristics	9 Hour
Attenuation – Absorption, Attenuation units, Scattering losses, Bending losses, micro-bending and macro bending losses, Core cladding losses, Signal distortion in optical waveguides, Types of dispersion-Intramodal and Intermodal dispersion, Material dispersion, Waveguide dispersion, Signal, distortion in single mode fibers, Polarization mode, dispersion, Intermodal dispersion, Pulse Broadening in Graded Index Waveguides, Mode Coupling and Design Optimization of Single Mode Fibers.	
Unit-3 - Semiconductor Optical Sources and Detectors	9 Hour
Light source materials, Surface emitting LEDs, Edge emitting LEDs, Quantum efficiency and LED power – Internal quantum efficiency derivation, Quantum efficiency and LED power – External quantum efficiency and total LED, Semiconductor laser diode, Modes and threshold condition, Photo detection principle, PIN Photodiode, PIN photodiode - Avalanche Photodiode, Avalanche Photodiode, Noise mechanism in photodetectors	
Unit-4 - Introduction to Optoelectronic Integrated Circuits	9 Hour
Need for Integration - Hybrid and Monolithic Integration, Materials and processing of OEICs, Application of optoelectronic integrated circuits, Slab and Strip Waveguides, Integrated transmitters and receivers – Front end photo receivers. Photo receiver noise and bandwidth considerations, PIN-HBT photo receivers. OEIC transmitters – equivalent circuit for integrated receivers, Complex circuits and arrays Integrated transmitters and receivers -optical control and microwave oscillators, Guided wave devices – Waveguide and couplers	

Unit-5 - OEIC Modulators, Switches and Amplifiers	9 Hour
Electro optic (EO) effect, EO Modulators, Single waveguide EO Modulators, Dual channel waveguide EO Modulators, Mach-Zehnder EO Modulator, Acousto optic modulator, Raman Nath modulator, Bragg modulator, Optical switching and logic devices, Optical switching and logic devices – Bipolar controller modulator Optical switching and logic devices tuneable threshold logic gate, Switching speed and energy, Optical Amplifiers, Semiconductor optical amplifiers, Optical gain – Limitations, Erbium doped fiber amplifiers – energy level diagram and amplification mechanism, Fiber Raman Amplifier configuration, Forward pumping, Backward pumping.	

Learning Resources	1. Gerd Keiser, "Optical Fiber Communications", 5th Edition, McGraw Hill Education (India), 2015. 2. Khare R P, "Fiber Optics and Optoelectronics", Oxford University Press, 014	3. J. Wilson and J. Hawkes, "Optoelectronics – An Introduction", Prentice Hall, 1995. 4. Robert G. Hunsperger, Integrated Optics Theory and Technology, Springer, 2009 5. Pallab Bhattacharya, "Semiconductor Optoelectronic Devices", Prentice Hall of India Pvt. Ltd, 2006
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	40%	-	40%	-	40%	-
Level 4	Analyze	10%	-	10%	-	10%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd.	1. Dr. Bandaru Ramakrishna, SRMIST

Course Code	21ECO106J	Course Name	EMBEDDED SYSTEM DESIGN USING ARDUINO	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	ECE	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Get to know about ARDUINO hardware details and environment	1	2	3	4	5	6	7	8	9	10	11	12	PO-1	PO-2	PO-3
CLR-2:	To understand the core elements of ARDUINO programming language	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	Create insights to the concepts of serial communication															
CLR-4:	To use common input and output devices															
CLR-5:	Apply the ARDUINO programming into real time applications															

Course Outcomes (CO):	At the end of this course, learners will be able to:	1	2	3	4	5	6	7	8	9	10	11	12	PO-1	PO-2	PO-3
CO-1:	Apply the programming skill	3	-	2	-	1	-	-	-	-	-	-	-	-	3	-
CO-2:	Apply the real time data's into digital	1	3	-	2	3	-	-	-	3	-	2	-	-	3	-
CO-3:	Interact with almost many devices	3	1	-	3	1	-	-	-	3	-	3	-	-	3	-
CO-4:	Learn techniques to handle timer delays and IO devices	1	1	3	2	2	-	-	-	3	-	3	-	-	3	-
CO-5:	Use and modifying the existing libraries	2	-	3	3	3	-	-	-	3	-	3	-	-	3	-

Unit-1 - Introduction to Arduino Platform	12 Hour
Arduino I/O Board Block diagram- AT mega 328p architecture- Pin function- Overview of main features-I/O ports- Features-timers, interrupts- Features-PWM, SERIAL PORT- Features-ADC- Introduction to Arduino IDE- Writing, saving, compiling with IDE.	
Practice: Getting Started With Aduino: CCS And AVR Studio 7 Blinking Led, GPIO LED: Switch Based Led Control, :DISPLAY INTERFACE-7 SEGMENT: LCD 16x2 Matrix	
Unit-2 - Introduction To Arduino C	12 Hour
Arduino C Data Types- Decision Making in C- Program Loops in C- Functions in C- Introduction to Pointers- Using Pointers Effectively- Structures, Unions, and Data Storage- Arduino Libraries	
Practice: -Sensor Interfacing For Temperature Monitoring, Sensor Interfacing For Displacement Measurement, PWM BASED SERVO MOTORINTERFACING	
Unit-3 - Analog and Serial Communication	12 Hour
Introduction To Analog Communication- Pulse Width Modulation- RS232- I2C- SPI Protocol- Interfacing with sensors and actuators	
Practice: SERIAL COMMUNICATION, Actuators – Stepper Motor, DC MOTOR	
Unit-4 - IO Programming	12 Hour
Introduction To Timer/Counters- Timer programming- Interrupts- Interrupts programming- External interrupt	
Practice: Interrupt Programming, Watch Dog Timer, I2C	
Unit-5 - Case Studies	12 Hour
Wireless Communication Using Zigbee- Bluetooth- Robotics -Motor And Sensor- Security-RFID, Infrared- Bio medical application- GPS Navigation	
Practice: RFID, Infrared	

Learning Resources	1. Michael-Margolis, "Arduino-Cookbook", Revised edition, O'Reilly, 1st edition, 2011	4. Jack Purdum, "Beginning C for Arduino", Apress, 2012
	2. D.Dale.Wheat, "Arduino.Internals", TIA publication, 5th edition, 2011	5. Tianhong Pan, Yi Zhu, "Designing Embedded Systems with Arduino", Springer publication. 2018
	3. James M. Fiore, "Embedded Controllers Using C and Arduino ARDUINO open source community, 2018	6. Rajesh singh, "Arduino-Based Embedded Systems", Taylor & Francis, 2018

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	20%	20%	-
Level 2	Understand	20%	-	-	20%	20%	-
Level 3	Apply	30%	-	-	30%	30%	-
Level 4	Analyze	30%	-	-	30%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd.	1. Mr.T.Saminathan, SRMIST

Course Code	21ECO107J	Course Name	EMBEDDED SYSTEM DESIGN USING RASPBERRY PI	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	ECE		Data Book / Codes / Standards	Nil	

[illegible]

Unit-1 - Basic Python Programming

12 Hour

Python Basics- Editing Python Programs with IDLE, Variables, displaying Output, Reading User Input , Arithmetic, Creating Strings, Concatenating (Joining) Strings, Converting Numbers to Strings, Converting Strings to Numbers ,Find the Length of a String, Find the Position of One String Inside Another, Extracting Part of a String, Replacing One String of Characters with Another Inside a String ,Converting a String to Upper- or Lowercase, Running Commands Conditionally, Comparing Values, Logical Operators, RepeatingInstructions an Exact Number of Times ,Repeating Instructions Until Some Condition Changes , Breaking Out of a Loop, Defining a Function in Python, Creating a List , Accessing Elements of a List, Find the Length of a List , Adding Elements to a List , Removing Elements from a List, Creating a List by Parsing a String, Iterating over a List, Enumerating a List, Sorting a List, Cutting Up a List. Applying a Function to a List, Creating a Dictionary ,Accessing a Dictionary, Removing Things from a Dictionary, Iterating over Dictionaries

Practice: Python basics- Arithmetic and string, Loop operations, Lists and Dictionaries

Unit-2 - Controlling Hardware- Motor control, Digital Inputs

12 Hour

Controlling Hardware-Connecting an LED-Controlling the Brightness of an LED,Making a buzzing sound, Switching a High-Power DC Device Using Transistor and Relay,Programming with Interrupts, Controlling Servo Motors using PWM, Controlling the Speed and direction of a DC Motor, Using a Unipolar Stepper Motor, Using a Bipolar Stepper Motor, Digital Inputs-Connecting a Push Switch-Toggling with a Push Switch-Using a Two-Position Toggle or Slide Switch, Using a Rotary (Quadrature) Encoder and Using a Keypad.

Practice: LED blinking and Brightness control, Switching a High-Power DC Device, Programming on interrupts, Programming on Stepper Motor and stepper Motor, : Programming on Switch and keypad

Unit-3 - Sensor Interface and Programming	12 Hour
Detecting Movement-PIR sensor, Data sheet analysis of PIR sensor, Using Resistive Sensors, Measuring Light, Detecting Methane, Data sheet analysis of gas sensor, Measuring a Voltage using MCP3008 And data sheet of MCP3008, Using Resistive Sensors with an ADC, Measuring Temperature with an ADC, Measuring Acceleration and data sheet discussion of Acceleration sensor, Practice: Programming on PIR sensor, light sensor, gas sensor, ADC, Programming on measuring Acceleration.	
Unit-4 - Temperature Sensor and Display Interface Programming	12 Hour
Measuring Temperature Using a Digital Sensor, Data sheet analysis Digital Temperature Sensor, Measuring Distance-ultrasonic rangefinder, Data sheet analysis ultrasonic rangefinder, Logging to a USB Flash Drive, Using a Four-Digit LED Display, Displaying Messages on an I2C LED matrix with data sheet discussion, Displaying Messages on an Alphanumeric LCD. Practice: Programming on Digital Temperature Sensor, ultrasonic rangefinder, Four-Digit LED Display, I2C LED matrix, Alphanumeric LCD	
Unit-5 - Publishing Sensor Data on Web Service	12 Hour
Cloud service for IOT, Publish sensor data on web service-building a home security dash board, MQTT Protocol- installation and setting account ,token creation ,reading sensor data and pushing to things board, basic of java scripts –node.js, Modules-HTML module, Modules –file –event , LED blinking using Node.js, building java script client using MQTT broker Practice: Publish sensor data on web service, Programming on node js -HTML module and event module, Programming on LED blinking using node.js, Programming on LED and Push button using node.js, Building java script client using MQTT broker	

Learning Resources	<ol style="list-style-type: none"> 1. Simon Monk, "Raspberry Pi Cookbook", O'Reilly Media, Inc, 2014. 2. Volker Ziemann, "A Hands-On Course in Sensors Using the Arduino and Raspberry Pi, CRC Press, 2018. 3. Colin Dow, "Internet of Thing: Programming Projects - Build modern IoT solutions with the Raspberry Pi 3 and Python", packtpub 2018. 4. https://thingsboard.io/docs/ 5. https://www.w3schools.com/nodejs/nodejs_raspberrypi_blinking_led.asp
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	25%	25%	-
Level 3	Apply	30%	-	-	30%	30%	-
Level 4	Analyze	30%	-	-	30%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd	1. Mrs.Suganthi Brindha.G, SRMIST

Course Code	21ECO108J	Course Name	3D PRINTING HARDWARE AND SOFTWARE	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	ECE	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the tools available for 3D printing	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Familiarize with 3D design software and hardware	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Understand the 3D design criteria and its limitations																
CLR-4:	Learn the contemporary technology available for 3D design and printing																
CLR-5:	Understand various post processing methods involved in 3D printing technology																
Course Outcomes (CO):		At the end of this course, learners will be able to:	3	-	3	-	-	-	-	-	-	-	-	-	-	-	
CO-1:	Apply the 3D printing tools for components design	2	2	-	-	-	-	-	-	-	-	-	-	-	-	1	
CO-2:	Optimistically select the 3D design software and hardware for the given problem	3	-	2	-	-	-	-	-	-	-	-	-	3	-	-	
CO-3:	Solve 3D components design problems	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-4:	Choose the contemporary technology available for 3D design and printing	2	-	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO-5:	Apply various post processing methods involved in 3D printing technology																

Unit-1 - Introduction to MAYA as a 3D Design Tool	12 Hour
Introduction to Maya GUI - Object creation workflow, Constructing object primitives to scale and with accuracy, Duplication and arrayed duplication - Grid and point/vertexsnapping, Understanding 3D geometry - Modeling workflows for Polygons, Mesh editing, printable polygon meshes, Combining, merging, and sewing up polygon meshes, Understanding manifold and non-manifold geometry, Exporting geometry. Practice: Understanding NURBS: NURBS Surfaces advantages, Comparison between NURBS and CAD drawings, Curve and surface construction, Clean and uniform topology, Illustrator, IGES, and other import/export pipelines, Conversion techniques, NURBS to Polygons, Polygons to NURBS.	
Unit-2 - Introduction to Fusion 360 Tool	12 Hour
An overview of CAD software packages, Introduction to Fusion 360, Drawing based workflow, Drawing constraints, Surfacing operations, Moving Parts and Articulation, Hinges - Ball and sockets, Flexibility and elasticity, Locks, bolts, and fasteners, Threading (taps and dies), Interfacing, support, and reinforcement, Form and function, visualizing the assembly process, Complex interactions and motorizations. Practice: Creating a part negative, Creating Text in Maya the proper way (NURBS Curves, surface lofts, conversion to polygon), Painterly tools, Sketch/drawing based workflows, Overview of manufacturing techniques - Molding, sculpting, lathing, lofting, welding, cutting, drilling, gluing, etc.	
Unit-3 - Design Rules	12 Hour
The good, the bad, and the ugly of design, Prominent Designers, Early decision-making criteria, Knowing the product, Vision and Reality, Scale and cost, Calculating the totalcost, Tolerances, Initial scene set-up, Roughing in the model, Structural integrity, Range of motion. Practice: Franchises Success stories, Pop culture, Brainstorming and critique in the early design phase, Group critiques of in-progress projects	

Unit-4 - Manufacturing Techniques	12 Hour
Evolution of 3D printing - types of 3D Printing technologies and techniques- Stereolithography (SLA), Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS), Fused Deposition Modeling (FDM), Laminated Object Manufacturing (LOM), Electron Beam Melting (EBM), 3D Printing (3DP), Selective laser melting (SLM), Post processing and its techniques.	
Practice: Vacuum forming, Resin casting, Injection Molding, Terms and standards for injection molding systems, Printing Resolutions and Tolerances, Materials Properties (Temperature, Flexibility, Strength, Brittleness), Planning for injection molding - 3D Printing for injection molding	
Unit-5 - 3D Printing Workflow and Product Visualization	12 Hour
Workflows for printing, Software and Drivers, Formats for Printing (SLA, OBJ, CAD, etc.), Clean-up and airtight modelling, Post and export, Print lab setup, Loading models and arranging print stage, Special topics – 3D Scanners and its types, Reverse engineering - Concepts and its hardware and software.	
Practice: Post and Export, Print Lab setup, Printing, Removing support material, High speed machining	

Learning Resources	1. Hod Lipson, Melba Kurman, "Fabricated: The New World of 3D Printing", Wiley, 2013 2. Matthew Griffin, "Design and Modeling for 3D Printing", Maker Media, Inc., 2013.	3. Rob Thompson, "Manufacturing Processes for Design Professionals", Thames & Hudson; Reprint edition, 2007.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1 Mr. Anuj Kumar, Program Delivery Manager, Nagarro Software's Pvt Ltd.	1. Mr. S. Karuppudayan, Mechanical, SRM IST
		2. Dr. Sanjay Kumar Sahu, ECE, SRMIST

Course Code	21EE0301T	Course Name	E-MOBILITY	Course Category	O	OPEN ELECTIVE										L	T	P	C		
																3	0	0	3		
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil														
Course Offering Department		Electrical and Electronics Engineering			Data Book / Codes / Standards			Nil													
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes			
CLR-1:	Afford a classification of electric vehicle				1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3				
CLR-2:	Impart knowledge on E-Mobility																				
CLR-3:	Familiarize the functional requirements of Battery management and Energy storage system																				
CLR-4:	Distinguish different types of power converters for E-mobility																				
CLR-5:	Acquire knowledge on charging station and testing																				
Course Outcomes (CO):		At the end of this course, learners will be able to:																			
CO-1:	Learn the basic concepts of electric vehicle technology and its classifications				3	-	-	-	-	-	2	-	-	-	-	-	-				
CO-2:	Acquire the knowledge on E-Mobility				3	-	-	-	-	-	2	-	-	-	-	-	-				
CO-3:	Acquire knowledge on Battery management and Energy storage system				3	-	-	-	-	-	1	-	-	-	-	-	-				
CO-4:	Recognize suitable power converters for EV applications				3	-	-	-	-	-	1	-	-	-	-	-	-				
CO-5:	Comprehend the concept of charging station and testing methods				3	-	-	-	-	-	2	-	-	-	-	-	-				
Unit-1 - Classification of EVs																	9 Hour				
Overview of EVs and challenges, EV market and Promotion, Parameters comparison, Classification and Configurations of EVs																					
Unit-2 - E-mobility																	9 Hour				
Introduction - concept of E-mobility, E-Mobility Business Models, e-mobility for various transportation, E-mobility for 2 and 3 wheelers																					
Unit-3 - Energy storage																	9 Hour				
Energy Storage Requirements in Hybrid and Electric Vehicles, Various Storage devices, EV energy source technologies, Battery Management System																					
Unit-4 - Power Electronics for E-mobility																	9 Hour				
Basic Power Electronic Devices, DC–DC Converters for Hybrid Vehicle Systems, Rectifiers and Inverters for E-Mobility																					
Unit-5 - Charging Station and Testing																	9 Hour				
Solar Powered Electric Vehicle Charging Station, Requirement to prevent fire for EVs Charging Stations, Testing of EVs charging stations																					
Learning Resources	1. Iqbal Husain, “Electric and Hybrid vehicles Design Fundamentals”, CRC Press, second edition, 2013.				3. Ali Emadi, “Hand book of Automotive Power Electronics and Motor Drives”, CRC Press, second edition, 2015.																
	2. James Larminie, John Lowry, “Electric vehicle technology Explained”, Wiley, second edition, 2012.				4. Ali Emadi, Mehrdad Ehsani, John M. Muller, “Vehicular Electric Power Systems”, Marcel Dekker, Inc., 2014.																

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. K. Kumaresan, NTPC	1. Dr. S. S. Dash, GCE KJR	1. Dr. R. Palanisamy, SRMIST
2. Mr. A. Kannan, Seshasayee Paper Mills Ltd, Tirunelveli	2. Dr. A. Venkadesan, NIT Puducherry, Karaikkal	2. Dr. V. Pradeep, SRMIST

Course Code	21EE0302T	Course Name	WEARABLE TECHNOLOGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Comprehend the need for development of wearable devices and its influence on various sector	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Familiarize about the different sensor used for wearable applications															
CLR-3:	Focus on energy harvesting using wearable devices.															
CLR-4:	Acquire the knowledge of various wearable devices															
CLR-5:	Realize IoT in wearable technology employed for real life applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Integrate the knowledge of wearable devices	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Elucidate the necessity of sensor for wearable systems	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Interpret the level of energy involvement in wearable systems	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Enumerate the taxonomy of the wearable devices based on environmental and health aspects	3	-	-	-	-	-	2	-	-	-	-	-	-	2	-
CO-5:	Identify the role of IoT in wearable technology	3	-	-	-	-	-	2	-	-	-	-	-	-	2	-

Unit-1 - Introduction to Wearable Technology	9 Hour
Fundamentals of wearable technology- History of wearable technology-Need for wearable systems- emergence of wearable computing and wearable electronics, Industry sectors overview, E-Textiles.	
Unit-2 - Wearable Sensors and Applications	9 Hour
Sensors for wearable system-Types -Temperature sensitive fabrics-electrochemical sensors-Resistive sensors-Wearable applications	
Unit-3 - Energy Harvesting for Wearable Devices	9 Hour
Solar cell, heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Wearable Optical Sensors, UV exposure indicators, speech recognition using lasers	
Unit-4 - Wearable Devices	9 Hour
Role of Wearables, Attributes of Wearables, The Meta Wearables, and Social Aspects: Interpretation of Aesthetics, Adoption of Innovation, On-Body Interaction; Case Study, Intelligent clothing, Wearables: Challenges and Opportunities, Future and Research Roadmap.	
Unit-5 - Role of IoT in Wearable Devices	9 Hour
Smart connectivity and Big picture of IoT-smart devices, networks, Wireless technologies and need for data analysis. Evolution of wearable technology, Wearable IoT based case studies.	

Learning Resources	1. Michael J. McGrath, Clodhna Ni Scanail, Dawn Nafus, "Sensor Technologies: Healthcare, Wellness and Environmental Applications", A press Media LLC, first edition, 2015.	3. Edward Sazonov, Michael R Neuman, "Wearable Sensors: Fundamentals, Implementation and Applications", Academic Press, Elsevier, second edition, 2018.
	2. Subhas C. Mukhopadhyay, "Wearable Electronics Sensors-For Safe and Healthy Living", Springer International Publishing, first edition, 2015.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate		-	-	-		-
Level 6	Create		-	-	-		-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Allwyn Blessing Johnson, L&T Energy, Mumbai	1. Dr. Suresh Perumal, Indian Institute of Technology, Jodhpur	1. Dr. S. Lourdu Jame, SRMIST
2. Mr. M. UmaSanker, Bharat Electronics Limited	2. Dr. Pandiyarasan Veluswamy, IIITDM Kancheepuram	2. Dr. V. Pradeep, SRMIST

Course Code	21EE0303T	Course Name	E-WASTE MANAGEMENT			Course Category	O	OPEN ELECTIVE						L	T	P	C					
																	3	0	0	3		
Pre-requisite Courses	Nil		Co- requisite Courses	Nil			Progressive Courses	Nil														
Course Offering Department		Electrical and Electronics Engineering			Data Book / Codes / Standards			Nil														
Course Learning Rationale (CLR):		The purpose of learning this course is to:					Program Outcomes (PO)												Program Specific outcomes			
CLR-1:	Gain the knowledge on environmental impacts of e-waste					Engineering Knowledge	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3	
CLR-2:	Examine the e-waste management hierarchy						Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning					
CLR-3:	Familiarize the role of various national and internal act and laws																					
CLR-4:	Distinguish e-waste management measures on national and global legislations																					
CLR-5:	Acquire knowledge in environmentally sound e-waste management																					
Course Outcomes (CO):		At the end of this course, learners will be able to:					Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CO-1:	Summarize the environmental impacts of e-waste					3	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-2:	Apply various concept learned under e-waste management hierarchy					3	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-3:	Distinguish the act and laws applicable for e-waste management and handling					2	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
CO-4:	Analyze the e-waste management measures					2	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-5:	Apply the concept of ecofriendly e-waste management					2	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Unit-1 - Introduction to e-waste Management																	9 Hour					
Introduction, Indian and global scenario of e-Waste, Possible hazardous substances present in e-waste, Steps in recycling and recovery of materials																						
Unit-2 - E-waste Hazardous on Global Trade																	9 Hour					
Essential factors in global waste trade economy, Import of hazardous e-waste in India, E-waste economy in the organized and unorganized sector. Estimation and recycling of e-waste in metro cities of India.																						
Unit-3 - E-waste Control Measures																	9 Hour					
Need for stringent health safeguards and environmental protection laws in India, Extended Producers Responsibility, Administrative Controls & Engineering controls, Reduction of waste at source																						
Unit-4 - E-waste Legislation																	9 Hour					
E-waste (Management and Handling) Rules, Government assistance for TSDFs. The international legislation – conventions, Restrictions of Hazardous Substances Directive.																						
Unit-5 - Environmental e-waste Management																	9 Hour					
Emerging recycling and recovery technologies, Guidelines for environmentally sound management of e-waste, Life cycle assessment of a product, Case studies and unique initiatives from around the world.																						
Learning Resources	1. Johri R., "E-waste: implications, regulations, and management in India and current global best practices", TERI Press, second edition, 2015.										3. Fowler B, "Electronic Waste – Toxicology and Public Health Issues", Elsevier, first edition, 2017.											
	2. Hester R.E., Harrison R.M, "Electronic Waste Management Science", second edition, 2012.										4. Waste to resources - A waste management Handbook, The Energy and Resources Institute (TERI), 2014.											

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. P. Kanagavel, NIWE, Chennai	1. Dr. S. S. Dash, GCE KJR	1. Dr. R. Palanisamy, SRMIST
2. Mr. A. Kannan, Seshasayee Paper Mills Ltd, Tirunelveli	2. Dr. M. Balaji, SSN CE	2. Dr. V. Pradeep, SRMIST

Course Code	21EE0304T	Course Name	ENERGY EFFICIENT PRACTICES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Interpret present energy scenario and purpose of energy efficiency in engineering and its application	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Comprehend the concept of energy efficiency in electrical supply system and machines															
CLR-3:	Describe energy efficiency practices in various basic electric utilities															
CLR-4:	Inspect problems on lighting and DG systems to provide efficient solutions															
CLR-5:	Analyze energy scenario and efficient solutions in industrial sector															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apprehend energy scenario and efficiency opportunities	3	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-2:	Analyze efficiency of electrical supply system and energy saving methodologies	3	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-3:	Perform energy efficiency practices in electric utility systems through new technologies	3	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-4:	Design the efficient lighting and DG system	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Examine industrial system to determine energy efficient potential	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Energy Scenario	9 Hour
Introduction: Commercial and Non-commercial energy, primary and secondary energy resources, energy needs of growing economy, energy pricing, Energy Conservation Act-2001, Bureau of Energy Efficiency.	
Unit-2 - Electrical Supply System	9 Hour
Electrical supply system, components of AC power, Concept of sanctioned load, maximum demand, contract demand, and AC machines.	
Unit-3 - Energy Efficient Practices	9 Hour
Energy efficiency in electrical utilities, tips for energy saving, compressed air system, Energy saving opportunities in HVAC and refrigeration system, impact of Power Electronics in energy efficiency	
Unit-4 - Lighting and Distributed Generation Systems	9 Hour
Introduction, Basic definitions, Types of different lamps, design and their features, energy efficiency opportunities in lighting and distributed generation systems	
Unit-5 - Industrial Sector	9 Hour
Energy efficiency in industrial sector, main challenges to improve energy efficiency in industry, Energy Efficient Technologies, Industrial Automation, Industrial Sensors	

Learning Resources	1. Bose, B. K., "Global energy scenario and impact of power electronics in 21st century", IEEE Transactions on Industrial Electronics, 60(7), 2638-2651, 2012.	3. El-Hawary, M. E., "Electrical energy systems", CRC Press, second edition, 2018.
	2. Hegger, M., Fuchs, M., Stark, T., & Zeumer, M., "Energy manual: sustainable architecture", Walter de Gruyter, 2012.	4. Malinauskaite, J., Jouhara, H., Ahmad, L., Milani, M., Montorsi, L., & Venturelli, M., "Energy efficiency in industry: EU and national policies in Italy and the UK. Energy", 172, 255-269, 2019.
		5. Dobrotkova, Z., Lukas, A., Singh, J., "Energy Efficiency in Industry", World Bank Group, 2018.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Kusuma Eshwar, Danfoss industries Pvt Ltd, Chennai	1. Dr. K V Praveen Kumar, SVNIT Surat	1. Dr. Ravi Eswar K M, SRMIST
2. Dr. Patnana Hema Kumar, Hella India Automotive Private limited, Pune, Maharashtra	2. Dr. Hari Priya Vemuganti, NIT Raipur	2. Dr. V. Pradeep, SRMIST

Course Code	21EE0305T	Course Name	SURVEILLANCE TECHNOLOGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Analyze the revolutionary technologies of surveillance, their pros and cons	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Learn about the many surveillance technologies and the fields in which they are employed															
CLR-3:	Focus on new trends and developments such as miniaturized devices, wireless communications, analytics, data mining, and social media networks															
CLR-4:	Judge the balance between the invasiveness and implications and need of these surveillance technologies on the society															
CLR-5:																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Assess the history that set the development of modern high-tech equipment in context with surveillance	3	-	-	-	-	1	-	1	2	-	-	-	-	-	-
CO-2:	Compare the contrasting features of optical and satellite visual surveillance techniques	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Distinguish the functional aspects of audio, radio, and net surveillance technologies	3	-	-	-	-	2	-	2	-	-	-	-	-	-	-
CO-4:	Analyze techniques and methods for employers, animals, genetics, and seismic surveillance	3	-	-	-	-	2	-	-	3	-	-	-	3	-	-
CO-5:	List and discuss laws regulating the impact of surveillance technology on human society and their privacy	2	-	-	-	-	2	-	2	-	-	-	-	-	-	-

Unit-1 – Surveillance - History and Development	9 Hour
Surveillance- Its emergence- Abuse and use- Public dispute and accountability-Evolution-Discoveries and Inventions- Devices, components- Computers and World wide web- Long distance communication-Data security- Key developments- Nature of Surveillance.	
Unit-2 - Surveillance by Optics	9 Hour
Visual surveillance-Security with camera vision-New developments- Fish eye lens, scanners, micro cameras-Selective vision-Robotic sensors-CCTV-Aerial surveillance-Balloons-Uninhabited aerial vehicles-Aircrafts (border, military, urban) surveillance – Quadro-copter-Drones - Satellite surveillance - Early warning - GPS –Traffic surveillance- License plate recognition.	
Unit-3 - Radio and Internet Surveillance	9 Hour
Audio surveillance-Applications-Telecom Surveillance-Eavesdropping-Wiretapping-Privacy acts-Multi-functionality Phones as spy- Radio surveillance-RFID chips-Product protection, control and tracking-Internet surveillance-Wired, wireless communications-Spyware-QR codes-Search engine surveillance-Social media monitoring-Web browser surveillance	
Unit-4 - Human, Animal, Sensor Surveillance	9 Hour
Employer surveillance-Data cards-Biometrics-Finger-Iris and retina scanners-Facial recognition-Voice-Speech-Sensor based surveillance-Alcohol sensor-Seismic Surveillance-Animal surveillance-Genetics-DNA sampling, profiling-CODIS-NDIS.	
Unit-5 - Indian Acts, Laws, Agencies, Amendments	9 Hour
Justice AP Shah Privacy Principles-International principles on the application of human rights to communications surveillance-Amendments to National laws on surveillance-Amendments to license agreements-Periodic review of legislation and practices-Penalties-Safeguards for International co-operation-Authorizing authorities-Content requirements for surveillance directions.	

Learning Resources	1. J. K Petersen, "Introduction to Surveillance Studies", CRC Press, first edition, 2013.	3. Vlado Damjanovski, "CCTV-From Light to Pixels", Butterworth-Heinemann, Elsevier, third edition, 2014.
	2. Policy-recommendations-for-surveillance-law-in-india-and-analysis-of-legal-provisions-on-surveillance-in-india-and-the-necessary-and-proportionate-principles.pdf (cis-india.org).	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. G Akilan, Embedded Systems, Croatia	1. Dr. R Selvarasu, Adama Science and Technology University, Ethiopia	1. Dr. K Subha Sharmini, SRMIST
2. Mr. Sumit Barnwal, Honeywell, Czech Republic	2. Dr. G Kumaravel, University of Technology and Applied Sciences, Sultanate of Oman	2. Dr. V Pradeep, SRMIST

Course Code	21EE0306T	Course Name	SUSTAINABLE DEVELOPMENT PRACTICES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Gain a basic understanding on sustainable development	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the necessity of societal development towards sustainability															
CLR-3:	Familiarize the integrated strategies of sustainable development															
CLR-4:																
CLR-5:																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Familiarize the necessity of sustainable development by various stake holders	-	-	-	-	-	-	3	3	-	-	-	-	-	-	-
CO-2:	Recognize the feasibility, approaches, techniques, and outcomes of sustainable development	2	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-3:	Interpret various policies and integrated approaches for adaption of sustainable environment	2	-	-	-	-	-	3	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Sustainable Development	9 Hour
Definition, scope and elements, Stake holders of sustainable development: People, Government, Investors, Industry, Judiciary, and international organizations working for sustainable development.	
Unit-2 - Developmental Needs of Indian Society	9 Hour
Poverty, unemployment, inadequate housing, unsafe drinking water, deficiency of energy sources and supply, sanitation, unscientific waste management, lack of transportation facilities, unskilled work force and apathy towards political activities.	
Unit-3 - Social Interventions for Sustainable Development	9 Hour
Education, skill development, people's participation in decision making, women empowerment, inclusive society, human rights, tolerance to diversity, reduction of health inequality, social safety net and Population control	
Unit-4 - Environment Protection Measures	9 Hour
Environment protection policies, waste management, pollution control, reduce the use, reuse and recycle, sustainable energy, preservation of forest and water sources.	
Unit-5 - Integrated Approaches	9 Hour
Innovative models of sustainable development. Public private partnership, decentralization of power. Strategies to become a developed country, Future trends in integrated approaches, case study	

Learning Resources	1. Ghate, P., "Indian microfinance: The challenges of rapid growth", SAGE Publications, first edition, 2007.	3. Chopra, K., Gopal, K., "Operationalising Sustainable Development", Sage Publications, first edition, 1999.
	2. Green, F.J., Chambers, B.W., "The Politics of Participation in Sustainable Development Governance", United Nations University Press, first edition, 2006.	4. Hans, C.B., Christina, V., "Sustainable Development in International and National Law", Groningen: Maunsbach Europa Law Publishing, first edition, 2008.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. M. Umasankar, Bharat Electronics Ltd, Andhrapradesh	1. Dr. S. S. Dash, GCE KJR	1. Dr. V. Pradeep, SRMIST
2. Dr. P. Kanagavel, NIWE, Chennai	2. Dr. A. Venkadesan, NIT Puducherry, Karaikal.	2. Dr. R. Ramya, SRMIST

Course Code	21EE0307T	Course Name	CLEAN AND GREEN ENERGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Get knowledge on energy system and solar radiation	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Impart knowledge on solar energy and its applications	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	Familiarize the importance of wind, tidal and wave energy																											
CLR-4:	Acquire knowledge on bio – energy																											
CLR-5:	Acquire knowledge on geothermal and oceanic energy																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Learn the basic concepts of energy systems and significance of solar radiation data	3	-	-	-	-	-	2	-	-	-	-	-	-	-	-												
CO-2:	Illustrate the principle of solar thermal conversion, solar PV systems and its applications	3	-	-	-	-	-	2	-	-	-	-	-	-	-	-												
CO-3:	Elucidate the principle of power generation by wind, tidal and wave energy	2	-	-	-	-	-	1	-	-	-	-	-	-	-	-												
CO-4:	Delineate about biomass resources and biomass energy conversion technologies	2	-	-	-	-	-	2	-	-	-	-	-	-	-	-												
CO-5:	Expound the principle of geo and ocean thermal energy	2	-	-	-	-	-	2	-	-	-	-	-	-	-	-												

Unit-1 - Fundamentals of Energy Systems and Solar Radiation	9 Hour
Introduction to Energy, classification of Energy Resources, Energy for Sustainable Development, Analysis of Solar Radiation Data	
Unit-2 - Solar Thermal Conversion and Solar PV Systems	9 Hour
Solar Collectors, Comparison of Collectors, Selection of Collector for Various Applications, History of PV, Equivalent Circuit and Electrical Characteristics of Silicon PV Cells, Solar Panel Applications.	
Unit-3 - Wind, Tidal and Wave Energy	9 Hour
Nature of the Wind, Power in the Wind, Forces on the Blades and Wind Energy Conversion, Types of Wind Machines, Applications of Wind Energy, Tidal Power, Components and Operation of Tidal Power Plant, Wave Energy, Wave Energy Conversion Devices	
Unit-4 - Bio – energy	9 Hour
Photo Synthesis, Usable Forms of Biomass, Biomass Resources, Biomass conversion technologies, Types of Biogas Plants, Applications	
Unit-5 - Geothermal and Oceanic Energy	9 Hour
Energy inside the Earth, Geothermal Wells, Types of Geothermal Power Plants, Ocean Energy Resources, Types of OTEC, Methods of Ocean Thermal Electric Power Generation.	

Learning Resources	1. G.D.Rai, "Non-Conventional Energy Sources", Khanna Publishers, sixth edition, 2009.	3. John Twidell and Tony Weir, "Renewable Energy resources", Routledge, third edition, 2015.
	2. R.K. Rajput, "Non-Conventional Energy Sources and Utilization", S.Chand and Company Ltd. second edition, 2014.	4. B.H.Khan, "Non-Conventional Energy Resources", Tata McGrawHill, third edition, 2017.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. K. Kumaresan, NTPC	1. Dr. S. S. Dash, GCE, KJR	1. Dr. S. Vidyasagar, SRMIST
2. Mr. A. Kannan, Seshasayee Paper Mills Ltd, Tirunelveli	2. Dr. A. Venkadesan, NIT Puducherry, Karaikkal	2. Dr. V. Kalyanasundaram, SRMIST

Course Code	21EE0308T	Course Name	SMART CITIES AND COMMUNITIES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Elucidate the smart city infrastructure	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Acquire the knowledge of Intelligent Transportation Systems															
CLR-3:	Understand the National and Global policies															
CLR-4:																
CLR-5:																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Explain the necessity of infrastructural development and plan for smart cities	3	3	-	-	-	-	2	-	-	-	-	-	-	-	-
CO-2:	Understand smart transport system and water resources systems for smart city and its application	3	3	-	-	-	-	2	2	-	-	-	-	-	-	-
CO-3:	Describe the National and Global policies to implement for smart city development	2	3	-	-	-	-	2	2	-	-	-	-	-	-	-

Unit-1 - Fundamentals of Smart City Infrastructure	9 Hour
Introduction - History of Smart City world and India – Necessity of Smart City - Smart Governance - Challenges of managing infrastructure in world and India.	
Unit-2 - Planning and Development of Smart City Infrastructure	9 Hour
City Wide Network - Wireless Networks - sustainable green building – safety - Policy instruments for inclusive smart city development - Smart infrastructure design principles	
Unit-3 - Intelligent Transport Systems	9 Hour
Introduction to Intelligent Transportation Systems (ITS) - Environmental Aspects of ITS - Conceptualization of smart urban transportation systems - Smart vehicles and fuels GIS, GPS - E-ticketing.	
Unit-4 - Management of Water Resources and Related Infrastructure	9 Hour
Storage and conveyance system of water- sustainable water and sanitation - sewerage system - flood management - conservation system.	
Unit-5 - Infrastructure Management System Policy for Smart City	9 Hour
Integrated infrastructure management systems for smart city - applications for existing smart city - Worldwide policies for smart city - Government of India – policy for smart city, Mission statement and guidelines - Case studies of smart city.	

Learning Resources	1. Xianyi Li, "Smart City on Future Life - Scientific Planning and Construction", Chinese Edition, 2012.	4. Smart cities – Ranking of European medium-sized cities". Smart Cities. Vienna: Centre of Regional Science, Giffinger, Rudolf; Christian Fertner; Hans Kramar; Robert Kalasek; Nataša Pichler-Milanovic; Evert Meijers, 2007. www.smart-cities.eu
	2. Nicos Komninos, "The Age of Intelligent Cities: Smart Environments and Innovation-for-all Strategies (Regions and Cities)", first edition, 2018.	5. Mission statement and guidelines on Smart City Scheme, Government of India, Ministry of Urban Development, http://smartcities.gov.in/upload/uploadfiles/files/Smart City Guidelines .
	3. Anthony Townsend, "Smart Cities: Big Data, Civic Hackers, and the Quest for a New Utopia", W. W. Norton & Company; reprint edition, 2014.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30 %	-	30 %	-	30 %	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Ananda K Akkarapaka, Matter Motor Works Pvt. Ltd, Gujarat	1. Dr. S. Senthil kumar, NIT, Trichy	1. Dr. C. Anuradha, SRMIST
2. Mr. M.Umasankar, Bharat Electronics Ltd, Andhrapradesh	2. Dr. A. Venkadesan, NIT Puducherry, Karaikal.	2. Dr. S. Vijayalakshmi, SRMIST

Course Code	21EE0309T	Course Name	ELECTRICAL TRADING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Gain a basic understanding on needs of Electrical market	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Recognize the feasibility, approaches, techniques of power exchange and outcomes of Electrical trading															
CLR-3:	Importance of Price Prediction, price Volatility and communication information on trading															
CLR-4:																
CLR-5:																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand integrated approaches to Electrical Market	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Identify the needs, approaches, and strategies of power exchange and Trading	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Gain knowledge on price forecasting and ethic on information of trading	2	-	-	-	-	-	-	2	-	2	-	-	-	-	-

Unit-1 - Introduction to Electrical Market	9 Hour
Introduction- Deregulation, Types of Restructuring Model, Major Players, Natural Gas, Electricity, Electrical Generation, Bilateral Contracts Model, Need of ISO, Role of ISO, Hybrid Model, Elastic – Inelastic Markets- Cost components in transmission- Mechanics of the Physical Electricity Market, Crude Oil Markets- Issues in energy trading.	
Unit-2 - Power Transaction on Trading	9 Hour
Formation of power pools- Economic Exchange of Energy - Energy Brokerage system. Types of electricity market- Structure of UK Electricity deregulated market - Structure of Nordic Electricity deregulated Market- Power wheeling - Types of wheeling transactions.	
Unit-3 - Energy Trading	9 Hour
Electric Energy Trading – Introduction-Essence of Electric Energy Trading-Energy Trading Framework -Derivative Instruments of Energy Trading-Forward Contracts-Future Contracts-Option Contracts- Put Options (Puts) contracts- Energy trading HUBS--Brokers in Electricity Trading- Green Power Trading	
Unit-4 - Electricity Pricing	9 Hour
Introduction - Volatility, Risk and-Forecasting-Factors in Volatility-Measuring Volatility-Tutorial Problems of Measuring Volatility-Electricity Pricing Risk-Electricity Price Indexes – case study on volatility -Challenges of Electricity Pricing-Reliable Forward Curves-Construction of Forward Price Curves-Price Forecasting, Short term Price Forecasting.	
Unit-5 - Information Communication on Trading	9 Hour
Open Access Same Time Information System (OASIS) – Introduction-FERC 889-Structure of OASIS – Historical Background-Functionality of OASIS-Architecture of OASIS-OASIS Phases Phase – 1, Phase -1A, Phase -2-Types of information available in OASIS-Information Requirements of OASIS-Users of OASIS-Transfer capability of OASIS –Definitions PJM OASIS, ERCOT OASIS.	

Learning Resources	1. Mohammad Shahidehpoura, Muwaffaq A Iomoush, "Restructured Electric Power System operation trading and volatility", Macscl Dekker Inc, first edition, 2001.	3. Zaccour.G. "Deregulation of Electric Utilities", Kluwer academic publishers, first edition, 1998.
	2. Kankar Bhattacharya, "Operation of Restructured Power Systems", Kluwer academic publishers, first edition, 2001.	4. Lai L L, "Power System Restructuring and Deregulation: Trading, Performance and Information Technology", John Wiley, first edition, 2001. 5. THE ELECTRICITY ACT, 2003, http://www.cercind.gov.in/Act-with-amendment.pdf

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. R.Viswanathan, Power Grid corporation	1. Dr. S.S.Dash, GCE KJR	1. Dr. V. Kalyanasundaram SRMIST
2. Mr. R.Ramar, NTP, Neyveli	2. Dr. A.Venkadesan, NIT Puducherry, Karaikkal	2. Dr. S. Vidyasagar, SRMIST

Course Code	21EE0310T	Course Name	UNMANNED AERIAL VEHICLE	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Electrical and Electronics Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the fundamentals of Unmanned Aerial Vehicles	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Outline the architecture of Unmanned Aerial Vehicle															
CLR-3:	Understand the basic modelling of Quadcopter															
CLR-4:	Apply the concept of Unmanned Aerial Vehicle modeling for Battery management system															
CLR-5:	Understand the customized Unmanned Aerial Vehicle															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Familiarize the different types of Unmanned Aerial Vehicles	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO-2:	Illustrate the various parts of the Unmanned Aerial Vehicles and their functions	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Mathematically model the Unmanned Aerial Vehicle	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Design the lithium-ion/polymer battery models and battery management system	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Enumerate the sensors used in Unmanned Aerial Vehicles	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Unmanned Aerial Vehicles	9 Hour
History of UAVs; Types of UAVs: Based on weight- Nano, Micro, Small, Medium, and Large; Based on structure: Fixed wing, Rotary Wing, Flapping wing, Fixed wing Hybrid VTOL, Airships; Applications of UAVs; Commercial vs. Military UAVs; UAV Market; Safety Guidelines.	
Unit-2 - Architecture of UAV	9 Hour
Parts: Carbon Frame; BLDC Motor: Construction and Working; Flight Controller: Case study PIXHAWK 4; Electronic Speed Controllers; Antenna and Types; Radio controllers; Telemetry; Propeller and its types; Materials, No. of blades; Blackbox; FPV camera; Battery; Gimbal; FPV Goggles. Design: Design Requirements; Trade-off; Design Steps; Flight Time Analysis.	
Unit-3 - Mathematical Modeling of Quadcopter	9 Hour
Quadcopter Dynamic Model and Simplified Dynamic Model; Control System: Root Locus Design Technique and Frequency Domain Design Technique; Controller Configuration and Architecture: State feedback control configuration, Series feedback compensation and Time scaled flight control system architecture; PID Controller: MATLAB example	
Unit-4 - Battery Selection and Management Systems	9 Hour
Selection of battery for UAVs; Requirement of Battery Monitoring; Battery State of Charge Estimation methods; Battery Cell equalization problem; Thermal control; Protection interface; SoC Estimation; Energy & Power estimation; Battery Management System: Definition, Parts: Power Module; Battery; DC/DC Converter; Battery Pack Safety; Battery Standards & Tests	
Unit-5 - Sensors and Applications	9 Hour
Accelerometer Sensor, Gyroscope Sensor, Airspeed sensor, Altitude sensor: Radar and Mechanical Altimeter, Pressure sensor, Clock/Timer, Compass, Magnetometer, MEMS inertial Module, Open-Source Microcontrollers with Case Studies.	

Learning Resources	1. Ministry of Civil Aviation, "The Drone Rules", Gazette of India, 2021, https://digitalsky.dgca.gov.in/assets/files/Draft-DronesRules-2021_Gazette%20version_14-Jul-2021.pdf	3. Mohammad H. Sadraey, "Design of Unmanned Aerial Systems", Wiley, 2020.
	2. Jiuchun Jiang, Caiping Zhang, San Ping Jiang, "Fundamentals and Application of Lithium-ion Battery Management in Electric Drive Vehicles", Wiley, first edition, 2015.	4. Paul Gerin Fahlstrom, Thomas James Gleason, "Introduction to UAV Systems", Wiley Publication, John Wiley and Sons, Ltd, fourth edition, 2012. 5. Landen Rosen, "Unmanned Aerial Vehicle", Alpha Publication, 2015.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Chandrasekhar, DRDO, India	1. Dr. Abhinav Kumar, Indian Institute of Technology Hyderabad.	1. Dr. C. Bharatiraja, SRMIST
2. Mr. Chandru Rajendran, Airdonex, India	2. Dr. Pappa N, Anna University, MIT Campus, Chennai	2. Dr. Phani Teja Bankupalli, SRMIST

Course Code	21GEO101T	Course Name	BEHAVIORAL BIOLOGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Genetic Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Categorize the types of learning, stimuli and conditioning	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Classify concepts of social facilitation and imitation behavior	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	Understand information on kinship theory																											
CLR-4:	Acquire information on the types of communication and territoriality behavior																											
CLR-5:	Summarize concepts on aggression and game theory																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Interpret conditioned and unconditioned stimuli and learnability	-	2	1	-	-	-	-	-	-	-	-	3	-	-	-												
CO-2:	Analyze concepts in social learning	-	2	1	-	-	-	-	-	-	-	-	2	-	-	-												
CO-3:	Discuss the concept of inclusive fitness and family dynamics	-	2	-	3	-	-	-	-	3	-	-	-	-	-	-												
CO-4:	Relate coalition behavior and concept of interspecific mutualism	-	2	-	-	-	-	-	-	2	-	-	3	-	-	-												
CO-5:	Explain the concept of aggression behavior	-	2	-	-	-	-	-	-	3	-	-	2	-	-	-												

Unit-1 - Types of Learning	9 Hour
Introduction to behavior - Natural selection - Individual learning - Cultural transmission - Stimulus - Sensitization - Habituation - Conditional learning - Learnability - Instrumental conditioning	
Unit-2 - Social Transmission	9 Hour
Social facilitation - Imitation in infants - Local enhancement - Social learning in children- Imitation behavior in animals - Vertical transmission - Oblique transmission - Horizontal transmission	
Unit-3 - Kinship Behavior	9 Hour
Kinship, Kinship theory – Relatedness - Inclusive fitness - Family dynamics - Dynasty building in acorn woodpeckers - Parent-offspring conflicts - In-utero conflicts in humans - Sibling rivalry - Kin recognition - Social grooming - Grooming in primates	
Unit-4 - Cooperative Behavior	9 Hour
Coalitions - Interspecific mutualism – Communication - Honey bees and the waggle dance- Chemical communication in ants - Vibrational communication in ants - Habitat choice – Territoriality – Migration - Migration of monarch butterflies	
Unit-5 - Aggression and Play Behavior	9 Hour
Aggression - Fight or flight response - Intruder aggression - Game theory - The hawk-dove game - Effect of intrauterine position on aggression in mice - Play behavior - Object play - Locomotor play - Social play - Play fighting - Effect of testosterone in play fighting	

Learning Resources	1. Dugatkin, L.A. (2020) "Principles of Animal Behavior", Fourth Edition, University of Chicago Press, 576 pp.	3. Attenborough, D. (2022) "The trials of life: A natural history of animal behaviour" William Collins, 288 pp.
	2. Manning, A. and M.S. Dawkins (2012) "An introduction to Animal Behaviour", Sixth Edition, Cambridge University Press, 467 pp.	4. Organ, C.L. (2021) "Animal Behaviour" MJP Publisher, 352pp.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Selvaraj Vellaisamy,, Regenix Drugs Limited, Chennai selvarajv@yahoo.co.in	1. Dr. K. Emmanuel Rajan, Bharathidasan University, Tiruchirapalli, Tamilnadu emmanuel@bdu.ac.in	1. Dr. S. Kirankumar, SRM IST
2. Dr. James Bhaskar, ITC, Bangalore James.bhaskar@gmail.com	2. Dr. M. Singaravel, Banaras Hindu University, Varanasi, Uttar Pradesh m.singaravel@bhu.ac.in	2. Dr. A. Devi, SRM IST

Course Code	21GEO102T	Course Name	MICROBES AND SOCIETY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Genetic Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Illustrate about fundamentals of microbiology	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Create interest in exploring the microbial world															
CLR-3:	Provide knowledge on the use of microbes in biotechnology															
CLR-4:	Initiate interest in microbes and tools of genetic engineering															
CLR-5:	Understand the concept of infectious diseases and treatment															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Recall knowledge about naming, classification, and history of microbiology	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Discuss knowledge about microbial metabolism	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Discover the role of microbes in food, agriculture, and pharmaceuticals.	1	1	-	-	-	-	-	-	-	-	-	2	-	-	-
CO-4:	Identify tools of molecular genetics that are derived from microorganisms	3	3	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply knowledge on studying the role of microbes in public health and infectious diseases	-	3	2	2	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to the Microbial World	9 Hour
Introduction to the microbial world - History of microbiology - Classification of microbes - Morphology and characteristics - Bacteria – Fungi – Protozoa – Virus – Algae.	
Unit-2 - Microbes in Diseases	9 Hour
Microbes in diseases - Water borne infections – Pathogenesis, diagnosis, treatment (Cholera, Typhoid), Foodborne infections types - Botulism, Airborne infections types - Corona virus - Tuberculosis - Anthrax - Sexually transmitted diseases, HIV -Vector-borne disease, Malaria.	
Unit-3 - Microbes in Industrial Products	9 Hour
Role of microbes in industries – Production of Alcohol, wine, beer – Antibiotic – Milk products, cheese, yogurt –Food and fermented products Biofertilizer – Biofuel – Probiotics	
Unit-4 - Microbes in the Environment	9 Hour
Microbes in environment – Microbes in terrestrial environment – Aquatic environment – Microbes in air – Extreme environment – Microbes in skin – Microbes in gut - Microbes in space	
Unit-5 - Control of Microorganisms	9 Hour
Physical method – Chemical method – Antibiotics and antibiotic resistance – Radiation based – Wastewater treatment methods – Hygiene and infection control – Hospital Acquired infection	

Learning Resources	1. <i>Microbiology, An Introduction</i> , Pearson publishing, 12th edition, by Tortora, Funke, and Case, Publishing. ISBN: 978-0-321-92915-0	3. Pelczar MJ, Chan ECS & Kreig NR. 1997. <i>Microbiology: Concepts and Application</i> . TataMcGraw Hill
	2. Weeks, Benjamin S., and I. Edward Alcamo. <i>Microbes and society</i> . Jones & Bartlett Learning, 2008.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rajeev Kumar Sukumaran, NIIST, Trivandrum	1. Dr.Natarajasrinivasan, Professor, Department of Microbiology, Bharathidasan University, Tiruchirappalli	1. Dr. T.Anand, SRMIST
2. Dr.Ayyadurai , Scientist, CLRI , Chennai	2. Dr.Mohammed Jaabir, Associate Professor, National college , Trichirapalli	2. Dr. M.Ramya, SRMIST

Course Code	21GEO103T	Course Name	BIOFERTILIZERS – AN ENTREPRENEURIAL PERSPECTIVE	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Genetic Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the significance of biofertilizers	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Classify the types of microbial biofertilizers															
CLR-3:	Acquire information on vermicomposting															
CLR-4:	Prioritize the packaging , storage and marketing of Biofertilizers															
CLR-5:	Summarize agribusiness and government policies															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe about the biofertilizers	-	-	-	-	2	-	3	-	-	-	-	3	-	-	-
CO-2:	Relate the types of biofertilizers and its applications	-	-	3	2	-	-	2	-	-	-	-	-	-	-	-
CO-3:	Correlate the importance and production of vermicompost	-	-	-	-	-	-	-	3	-	-	2	2	-	-	-
CO-4:	Criticize the policies and steps involved in the agribusiness	-	-	2	-	-	-	3	-	2	-	-	-	-	-	-
CO-5:	Integrate the laws governing the manufacturing	-	-	-	-	-	1	-	2	-	-	-	3	-	-	-

Unit-1 - Fundamentals of Bio fertilizers	9 Hour
Bio fertilizers-Introduction, Classification, Plant Nutrients-sources and its role in plant growth, Role of manures, crop rotation, green manuring, Bio fertilizers in sustainable agriculture, Quality standard for bio fertilizers, Nitrogen fixation-symbiotic – Asymbiotic, Constraints in Bio fertilizer production, Bio fertilizers and their advantages over chemical fertilizers.	
Unit-2 - Microbial Biofertilizers	9 Hour
Microbes in bio fertilizer, Azolla, Bacterial Bio fertilizers, Azospirillum, Azotobacter -classification, characteristics – crop response, Cynobacterial bio fertilizers- Anabaena - Nostoc - fungal bio fertilizers- AM mycorrhiza and ectomycorrhiza, Microbes beneficial for recycling of Organic wastes & Composting, Media used for bio fertilizers - ion chelator - potash mobilizers, Factors affecting plant growth, Endophytes, Importance of mycorrhizae, Types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM,	
Unit-3 - Vermicompost and its types	9 Hour
Vermicompost-Introduction, Earthworms - Ecological strategies, Basic traits and life cycle, Application of earthworms in Waste management, Role of earthworms in Bio fertilizer production. Liquid fertilizers – Vermiwash, Different methods of vermicomposting: Small and Large scale, Bed method, Pit method. Harvesting of vermicompost.	
Unit-4 - Packaging and Market Survey	9 Hour
Methods of quality control assessment in respect to biofertilizers, Methods of packing, Biofertilizers – Storage, shelf life and marketing, Storing and packaging of vermicompost, Marketing of Products – Foreign trade, Market Survey, Concepts of market survey, Survey methods, society need, Application of marketing, BIS standards recommendation for biofertilizers	
Unit-5 - Agribusiness and Funding Opportunities	9 Hour
Agribusiness, Types of companies, Registration, Organic farming – Principles, Policies, Certification agencies, Funding Agencies, Professional selling skills and knowledge, Rural Development programs, NABARD, Self Help Groups, Basic concept & need for auditing, Detection and prevention of frauds and errors.	

Learning Resources	1. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers	4. Charantimath, P.M., 2009, Entrepreneurship development and Small Business Enterprises, Pearson Education, India
	2. Tanenbaum A S, Woodhull A S, 2006. Text book of Agricultural Biotechnology, 3rd Edition. PHI Learning.	5. Smita Diwase. 2017. Indian Agriculture and Agribusiness Management (3rd Edition). KRISHI Resource Management Network
	3. M. K. Rai. 2005. Handbook of Microbial Biofertilizers, Food Products Press, New York.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Mahesh, Senior Lead Scientist - Microbiology, CavinKare Research Center, Chennai	1. Dr. Jibu Thomas, Professor, Karunya Institute of Technology and Sciences	1. Dr. P. Senthikumar, SRMIST
2. Dr. Mithun Chakraborty, Head-R&D, J.K Agri. Genetics Ltd.	2. Dr. Ashok, Associate Professor, Vels Institute of Science Technology and Advanced Studies	2. Dr. S. Iyappan, SRMIST

Course Code	21GEO104T	Course Name	COMPUTATIONAL GENOMICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Genetic Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Summarize the concepts of genomics and central dogma of molecular biology.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Implement the strategy for the usage of different databases and file formats.															
CLR-3:	Correlate the modules and functions of R with genomic data.															
CLR-4:	Test the hypothesis by integrating Bioconductor to transcriptomic data.															
CLR-5:	Manage different biopython modules for the analysis of genomic data.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the basic concepts of biology and genomics.	3	-	2	-	2	-	-	-	-	-	-	-	-	-	-
CO-2:	Apply different bioinformatics databases and file formats to study sequence data	3	3	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-3:	Illustrate the basics of R to be applied to genomic data.	2	2	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Predict the information in the transcriptome data by integrating Bioconductor package.	-	3	2	-	3	-	-	-	-	-	-	-	-	-	-
CO-5:	Devise a strategy to implement Python to study the genomic data using Biopython.	-	3	2	-	3	-	-	-	-	-	-	-	-	-	-

Unit-1 - Genome Structure	9 Hour
Introduction to computational biology – Chromosomes - Genome Structure - Introns & Exons - Basic properties of DNA & its structure - Basic properties and structure of RNA - Types of RNA - Central Dogma of Molecular Biology - Overview of Replication - Overview of Transcription - Genetic Code - Overview of Translation – Genomics – Transcriptomics - Proteomics	
Unit-2 - Biological Resources and File Formats	9 Hour
Basics of Sequence data - Sequence Quality & Phred Score- Basics of Sequence Alignment – Identity – Similarity – Homology - Orthology & Paralogy - Nucleic Acid Sequence Databases - Protein Sequence Databases - Sequence file formats – Genbank - Fastq & Fasta - SAM file format - BAM file format - Gene Ontology - Levels of Gene Ontology - Cancer genome databases – TCGA - Pathways Databases - KEGG	
Unit-3 - : R and Bioconductor	9 Hour
Introduction to R – Installation & R-Studio - Data Types & Data structures – scalars – vectors – matrices - data frames – lists - factors and tables; Data Visualization – charts & types – ggplot2 – String manipulation in R - Bioconductor Project - Installation of Bioconductor Package – Genomic Ranges Package – Grange - Usage & Seqinfo - IRanges & Genomic Structures - Constructing & Interacting IRanges - Introduction to Biostrings – BSgenome - Genomic Features	
Unit-4 - Transcriptomics and Pathway Analysis	9 Hour
Introduction to transcriptomics – Bioconductor - EdgeR Package - Microarray analysis using Bioconductor - LIMMA Package - GEOquery package - biomaRt package- Tools for plotting figures - BioGraph & Gviz - Annotation Hub- Pathway packages - cluster profiler - GSEA	

Unit-5 - Biopython	9 Hour
Basics of Python - Data types in Python - Functions in Python - File and sort Functions in Python - String manipulation in Python - Join- Split & Replace functions in Python - Panda- numpy - Introduction of Biopython - Parsing FASTA and Genbank sequence file formats - Connecting with Biological databases - SeqRecord object – FASTA and Genbank - Turning Seq Objects into strings - String manipulation - Nucleotide sequences and (reverse) complements - MutableSeq objects	

Learning Resources	1. Attwood.T.K.Parry-Smith D.J."Introduction to Bioinformatics"- 1 st Edition- 11 th Reprint- Pearson Education. 2005. 2. Arthur Lesk. "Introduction to Genomics" OUP Oxford; 3 rd edition- 2017. 3. Dan MacLean. "Bioconductor to perform RNAseq genomics data visualization and bioinformatic analysis". Packt Publishing Limited. 2019.	4. Matloff N. "The art of R programming: A tour of statistical software design".No Starch Press; 2011. 5. Online Sources: http://biopython.org/DIST/docs/tutorial/Tutorial.html 6. https://bioconductor.github.io/BiocWorkshops/r-and-bioconductor-for-everyone-an-introduction.html https://www.bioconductor.org/packages/
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	10%	-	10%	-	10%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.C.Ramakrishnan- Principal Scientist- Molecular Design Division, Arontier Co.- Seoul- South Korea, ramakrishnan@arontier.co	1. Dr Shandar Ahamad- Professor- Jawaharlal Nehru University- shandar@jnu.ac.in	1. Dr.Habeeb. S. K. M- SRMIST,
2. Mr. Sudheendra Rao- Director- DataLore Labs- Bengaluru	2. Dr. Michael Gromiha-Indian Institute of Technology Madras- Chennai, gromiha@iitm.ac.in	2. Dr.Thirumurthy Madhavan- SRMIST

Course Code	21GEO105T	Course Name	BIOLOGY FOR EVERYDAY LIFE	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Genetic Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Comprehend the basics of life	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Reconstruct the evolution of life forms															
CLR-3:	Illustrate homeostasis and practicing healthy life															
CLR-4:	Attribute the role of biology in modern-day applications															
CLR-5:	Appraise the role played by biology in the sustainable development of this planet															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Define life and basic biological processes	-	-	-	3	-	-	2	2	-	-	-	-	-	-	-
CO-2:	Recognize various life forms and their interrelations	-	2	-	-	-	-	-	-	-	2	-	2	-	-	-
CO-3:	Employ healthy lifestyle practices for an active life	-	-	2	-	-	3	-	-	-	-	-	3	-	-	-
CO-4:	Execute interdisciplinary projects with biological principles	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Develop biomimetics for various applications	-	-	-	3	-	-	-	3	2	-	-	-	-	-	-

Unit-1 - Diversity of life	9 Hour
Organization of life forms-Classification and Taxonomy- Algae, Fungi and Mosses-Gymnosperms and Angiosperms-Bacteria and viruses,-Protozoans, Metazoans- Sponges and cnidarians-Snails and starfishes-Fishes, Salamanders and frog-Snakes, lizard and birds-Primates-Life Cycle,-Alternations of generations, Reproduction, Aliens	
Unit-2 - Levels of Organization	9 Hour
DNA and RNA-Proteins-Organelle- Mitochondria and Chloroplast- Photosynthesis- Sunlight to Food, Respiration - Food to Energy, Immunity – The arsenal and how to fight the invaders- Nervous system The control center- Hormones The regulators, Reproductive system the Sperm and Ova Fertilization and, Embryogenesis- Digestion and excretion	
Unit-3 - Homeostasis	9 Hour
Feedback systems- Symptoms, disorders, disease, and syndromes- Infectious diseases- Lifestyle diseases- Metabolic diseases,-Hereditary diseases,-Cancer- Xenograft -transplanting organs, Organ donation and organ trafficking- Vaccine, Drugs, and personal medicine- Alzheimer's disease- COVID-Exercise and metabolism- Diet and metabolism-Alternative medicine	
Unit-4 - Ecology and Evolution	9 Hour
Principles of ecology-Speciation-habitat, and diversity- Adaptation-interdependence and evolution-Nutrient cycles,-Ecosystems-Outsized role of the human population-Pollution and its types, Procreation and recreation- Lamarck's theory of evolution-Darwin's theory of evolution- Modern view of evolution-Challenges to evolution theory-Mutation-Genes- Heredity- Principles of heredity-Impact of evolutionary theories on society	

Unit-5 - Bioinspired Applications	9 Hour
Flight of birds, how man conquered the sky- Bio Inspired design in architecture-Biomimetic swimming robots- Down feather insulation-Termite mound cooling, Humpback whale wind turbines-Beetle water collection- Spider web glass-Artificial intelligence-Neural networks-Bio paints and bio cement- Symbiotics-Nanorobots- Nano motors- DNA lithography-DNA as a memory storage device- Synthetic biology- Antibiotics-Honey bee dance- Animals as disease models- Behaviour studies and their applications	

Learning Resources	1. Carl Stone, <i>Basics of Biology</i> , Greenwood publishers, India, ISBN:0313317860 2. <i>Opportunities in Biology</i> , Peter H Raven, National Academy Press, Washington US.ISBN 0309039274	3. Mader Silvia S, <i>Human Biology</i> , 14th Edition, Mc Graw Hill publications, India. ISBN :1260710823 4. <i>Biology: A Global Approach, Enhanced eBook</i> , Global Edition, 12th edition, Neil A. Campbell, Pearsons Publications.ISBN 9781292170435
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ramya. R.G., Senior Manager CMC and Regulatory Affairs (Global), Syner-G Pharma Consulting, LLC, Bangaluru, ramya.swamy@gmail.com	1. Dr. Sathyaraj, Principle scientists, CLRI-CSIR, Adyar, Chennai. vijayagsatya@gmail.com	1. Dr. N S Raja, SRMIST
2. Dr. Arun D, Associate Scientist, L'Oréal, Bangalore, arun.duraisamy@gmail.com	2. Dr.G. Mathan, Associate professor, Bharathidasan University, Tiruchirappalli, mathan@bdu.ac.in	2. Dr. S. lyappan, SRMIST

Course Code	21MHO301T	Course Name	SMART FARMING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechatronics Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Appraise the fundamental concepts and terminologies used in the agriculture and various agricultural machine		1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Acquire the knowledge of sensors and its applications in agriculture																
CLR-3:	Understand the principles of different mechatronics based automated farming systems																
CLR-4:	Apply the concepts of IoT and edge computing in agriculture																
CLR-5:	Acquire the knowledge and applications of Artificial Intelligence and data analytics in agriculture																
Course Outcomes (CO):		At the end of this course, learners will be able to:	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	Learn the basic concepts of agriculture and working principles of different agricultural machines		3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Gain the basic knowledge of sensors and its farming applications		3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Design the automated farming systems and understand its working principle		3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Implement Internet of Things (IoT) and Edge computing techniques in various farming applications		3	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Gain the knowledge of different Artificial Intelligence (AI) and Data Analytics for different agriculture applications.		3	-	2	-	1	-	-	-	-	-	-	-	-	-	-

Unit-1 - Fundamentals of Agriculture Engineering and Agriculture Machines	9 Hour
Classification of soils – Classification of crops – Effect on weather parameters on crop growth and development – Definition and differentiation of agriculture terms - Agriculture machines: Hitching system – Tires and Traction – Soil Tillage methods and equipments – Crop planting methods and equipments – Fertilizer spraying methods and equipments – Grains, fruits and vegetable harvesting methods and equipments	
Unit-2 - Precision Agriculture	9 Hour
History and basics of precision agriculture – Sensing technology for precision crop farming – sensors for Data acquisition – Sensors for soil condition monitoring - precision nutrient management – precision water management – precision weed management – precision crop diseases identification – precision grain quality management	
Unit-3 - Mechatronics Systems for Agriculture	9 Hour
Current trends in smart farming and automation system - Overview of mechatronic system for weed management – Robots for spatially and temporally unstructured agriculture environment – Types of cameras for agriculture - Image processing-based crop segmentation – Image processing based fruit, vegetable sorting systems – Cooperative robotic systems in agriculture – Application of drones in soil fertility management, irrigation and water management	
Unit-4 - Application of IOT and Edge Computing in Agriculture	9 Hour
IoT Introduction – Benefits of IoT in agriculture – Issues and challenges in the adoption of IoT in agriculture – Application of IoT in hydroponic farming – IoT based crop management system – IoT based Smart irrigation and water management system – IoT based plant monitoring – data collection - Edge computing Introduction – Applications of edge computing in agriculture – Implementation of edge computing in agricultural sector	

Unit-5 - Artificial Intelligence and Data Analytics in Agriculture **9 Hour**

Introduction to artificial Intelligence - Prediction of crop yield and pest disease infestation – Decision making system for crop selection based on soil – Soft computing based plant leaf disease detection – Soft computing based fruit sorting system – AI based pest management system – AI based remote monitoring and predictive analytic system for crop and livestock

Learning Resources	<ol style="list-style-type: none"> 1. R.K.Sharma, A.K.Soni, R. Bhagat, N. Pandey and V.K. Pandey, Basics of agriculture for Engineers, Daya Publishing House, 2014 2. Ajit K. Srivastava & Carroll E. Goering - Engineering Principles of Agricultural Machines, Amar Society of agricultural and Biological Engineers, 2nd edition, 2005 3. Ancha Srinivasan, Hand book of precision agriculture: Principles and applications, CRC press, 2020 	<ol style="list-style-type: none"> 4. Dan Zhang, Bin Wei, Robotics and Mechatronics for agriculture, CRC press, 1st Edition, 2017 5. Ajith Abraham, Sujata Dash, Joel J.P.C. Rodrigues, Biswaranjan Acharya, Subhendu Kumar Pani - AI, Edge and IoT-based Smart Agriculture (Intelligent Data-Centric system), Academic press Inc, 2021
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Uthayan Elangovan, Neel smartec consultant, uelan@neelsmartec.com	1. Dr.T. Mohanraj, Assistant Professor, Amrita Vishwa Vidyapeetham, t_mohanraj@cb.amrita.edu	1. Dr.S.Senthilraja, SRMIST
2. Mr.G.Vijayaram, TAFE, vijayaram@tafe.com	2. Dr. R. Jegadeeshwaran, Professor, Vellore Institute of Technology, jegadeeshwaran.r@vit.ac.in	2. Mr. J. Arivarasan, SRMIST

Course Code	21ME0101T	Course Name	FUNDAMENTALS OF COMPOSITE MATERIALS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	mechanical engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the fundamentals of composite materials	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Apply the concept of anisotropic, isotropic, and orthotropic material behavior in the analysis of laminated structural components.															
CLR-3:	Understand how composites are manufactured through various techniques															
CLR-4:	Recognize several methods employed in assessing the performance and quality of composites															
CLR-5:	Gain knowledge on recent advancements in composites and their applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe the properties and characteristics of constituents in a composite material	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Analyze the mechanics of laminated composites subjected under different stresses	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Demonstrate the procedures involved in various composite processing techniques.	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Choose the appropriate testing method to analyze the performance and quality of as-synthesized composites	-	-	2	3	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Express the importance and applications of advanced composites	-	-	-	-	3	-	1	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Composite Materials	9 Hour
Composites – definition and need, properties, advantages, disadvantages, and applications of composites. Composite architectures. Classification– matrix and fiber-based reinforced composites. Reinforcements – particles, flakes, whiskers, short fibers, continuous fibers, or sheets. Matrix materials –metals, polymers, and ceramics. Interfaces- concept of load transfer, bonding mechanisms.	
Unit-2 - Mechanical Analysis of Composites	9 Hour
Micromechanics – rule of mixtures, elastic constants, mechanical and thermal properties, mechanics of load transfer from matrix to fiber. Macro mechanics –elastic constants of an isotropic material and lamina. Laminated composites- stresses and strains and analysis of laminated composites. Stresses and deformations in fiber-reinforced materials. Damage in composite materials – mechanisms.	
Unit-3 - Composite Processing	9 Hour
Thermoset matrix composites–hand layup and spray techniques, filament winding, pultrusion, resin transfer molding, and autoclave-based methods. Thermoplastic matrix composites – injection molding, compression molding, sheet molding compound, and thermoforming. Metal matrix composites: solid, liquid and powder state processes. Ceramic matrix composites: hot pressing, reaction bonding processes, infiltration, in-situ chemical reaction techniques, sol-gel, polymer infiltration and pyrolysis (PIP), self-propagating high-temperature synthesis (SHS), and electrophoretic deposition.	
Unit-4 - Composite Performance and Quality Inspection	9 Hour
Tension, compression, flexural, shear, single fiber pull-out, single fiber push-out and push-down test– indentation and three-point bending. Water absorption and flammability tests. Non-destructive testing methods - ultrasonic inspection, radiography, acoustic emission, and acoustic-ultrasonic method	

Unit-5 - Advanced Composites	9 Hour
Un-conventional composites – carbon fiber/carbon matrix composites and multifilamentary superconducting composites. Nanocomposites – polymer clay nanocomposites, self-healing composites, self-reinforced composites, bio-composites, and hybrid composites. Electronic grade MMCs. Manufacturing of green composites.	

Learning Resources	1. Krishnan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer International Publishing, 2019. 2. An Introduction to Composite Materials, D. Hull & T.W. Clyne, Edition 3rd, Cambridge University Press, 2019. 3. Mallick, P.K. and Newman. S, Composite Materials Technology, Hanser Publishers, 2003.	4. M. Balasubramanian, Composite Materials and Processing, CRC Press, Taylor and Francis Group, 2014. 5. Barbero, Ever J, Introduction to composite materials design, Edition 3rd, CRC press, 2018. 6. Ramesh, Talreja, and Singh V. Chandra, Damage and failure of composite materials, Cambridge, United Kingdom, 2012.
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr S. Srinivasan, Ashok Leylandsrinchand@gmail.com	1. Dr. G. Arthanareeswaran, NIT, Tiruchirappalli arthanareeg@gmail.com	1. Dr. Shubhabrata Datta, SRMIST
2. Mr.A.Venugopal, WABCO venugopal.a@wabco-auo.com	2. Dr. R. Elansezhian, Pondicherry Engineering College. elansezhianr@gmail.com	2. Mr. S.Sasikumar, SRM IST.

Course Code	21ME0102T	Course Name	REVERSE ENGINEERING AND 3D PRINTING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	Familiarize with Reverse engineering principles.												
CLR-2:	Understand various post processing methods involved in Reverse engineering and apply that in the real time applications												
CLR-3:	Learn the contemporary technology available for Rapid prototyping												
CLR-4:													
CLR-5:													

Program Outcomes (PO)												Program Specific outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3

Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	Define reverse Engineering methodologies and Principles												
CO-2:	Apply reverse Engineering Process in real time applications.												
CO-3:	Apply the various processes in Rapid Prototyping												

Unit-1 - Introduction to Reverse Engineering	9 Hour
Reverse Engineering–The Generic Process, Forward Engineering vs Reverse Engineering, Computer Vision and Reverse Engineering, Structured-light Range Imaging, and Scanner Pipeline.	
Unit-2 - Reverse Engineering: Hardware and Software	9 Hour
Classification of measuring devices, Contact Methods, Non-Contact Methods - Optical Techniques, Non-optical Techniques and Transitive Techniques, Destructive Method. Reverse Engineering Software Classification, Reverse Engineering Phases, Fundamental Reverse Engineering Operations.	
Unit-3 - Data Processing	9 Hour
Selecting a Reverse Engineering System - The Selection Process, Point Capture Devices, and Post processing the Captured Data - Case Studies in Post processing of data.	
Unit-4 - Applications of Reverse Engineering	9 Hour
Product Development and Manufacturing, Biomedical Engineering, Case Studies - Reverse Engineering in the Automotive, Aerospace and Medical Device Industry. Legal Aspects of Reverse Engineering. Relationship Between Reverse Engineering and Rapid Prototyping.	
Unit-5 - 3D Printing Techniques	9 Hour
Introduction - Classifications -Stereolithography Apparatus (SLA), Solid Ground Curing (SGC), Selective Laser Sintering (SLS), Laser Engineered Net Shaping (LENS), Fused Deposition Modeling (FDM), Laminated Object Manufacturing (LOM), Multijet Modelling (MJM), Paper Lamination Technology (PLT), Selective laser melting (SLM) - Biomedical applications	

Learning Resources	1. Vinesh Raja and Kiran J. Fernandes Reverse Engineering: An Industrial Perspective(Springer series in advanced manufacturing)	3. Chua C. K., Leong K.F and Lim C.S, RAPID PROTOTYPING: PRINCIPLES AND APPLICATIONS, 2nd Edition, World Scientific Publishing Co. Pte. Ltd.
	2. Kamrani, Ali K. and Nasr, Emad Abouel, Rapid Prototyping:Theory and Practice (Springer series in Manufacturing Systems Engineering)	4. Miltiadis A. Boboulos, CAD-CAM & Rapid Prototyping Application Evaluation, Venus Publishing ApS, 2010.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in	1. Dr. Shankar Krishnapillai, IITMadras, skris@iitm.ac.in	1. Mr. J. Daniel Glad Stephen, SRM IST,
2. Mr. Parameswaran, Nokia, Chennai, parameswaran.s@nokia.com	2. Dr. Raju Abraham, NIOT, Chennai, abraham@niot.res.in	2. Dr. S. Karuppudaiyan, SRM IST

Course Code	21ME0103T	Course Name	FUNDAMENTALS OF BIOMECHANICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the concepts biomechanics and anatomical reference	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand hard& soft tissue mechanics															
CLR-3:	Analyze mechanics applied in various movement and loads in upper extremities															
CLR-4:	Analyze mechanics applied in various movement and loads in lower extremities															
CLR-5:	Understand qualitative aspect in sports biomechanics															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply principles and concepts of kinematics and kinetics in human body	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Apply the mechanics of hard and soft tissue	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Apply the functionality and various forces applied in upper extremities	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Apply the functionality and various forces applied in lower extremities	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Analyze the sports biomechanics activities in qualitative aspect	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Biomechanics	9 Hour
<i>Kinesiology -Kinematics-basic mechanics involved in Anatomy- Standard reference planes, terminology terms, movements with reference planes</i>	
Unit-2 - Tissue Mechanics	9 Hour
<i>Hard Tissue Mechanics: Mechanical properties of bone, cortical and cancellous bones, viscoelastic properties, Maxwell and Voight models – anisotropy. Soft Tissue Mechanics: Pseudo elasticity, nonlinear stress-strain relationship, Viscosity, Structure, Function and mechanical properties of skin, ligaments and tendons</i>	
Unit-3 - Biomechanics of Upper Extremities	9 Hour
<i>The structure, movements and load acting in the upper extremity of shoulder- elbow and radioulnar joints - wrist and fingers</i>	
Unit-4 - Biomechanics of Lower Extremities	9 Hour
<i>The structure, movements and loads acting in the lower extremity - Pelvic and hip - knee joint - ankle and foot. Combined movement of pelvis and trunk - Posture - Conditioning</i>	
Unit-5 - Sports Biomechanics	9 Hour
<i>Introduction to sports Biomechanics-activities- case study on qualitative and quantitative analysis of kicking and batting-drop jump- common sports injuries</i>	

Learning Resources	1. NihatOzkaya and Margareta Nordin, "Fundamentals of Biomechanics: Equilibrium, Motion, and Deformation", Springer- Verlag; Second Edition, 2016. 2. Fung Y C, "Biomechanics: mechanical properties of living tissues", Second Edition. Springer-Verlag, 1993.	3. Susan J Hall, "Basic Biomechanics", McGraw Hill, Columbus - OH, 9th Edition, 2022. 4. Roger Bartlett, Introduction to Sports Biomechanics: Analysing Human Movement Patterns, 3rded., Taylor and Francis, 2014
--------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. Babu, CVRDE, DRDO, Avadi, babu.n.cvrde@gov.in	1. Dr. Amit Roy Chowdhury, amit@aero.iests.ac.in, IISER Shibpur	1. Dr. S. Karuppudaiyan, SRM IST, KTR
2. Mr. Parameswaran, Nokia, Chennai, parameswaran.s@nokia.com	2. Dr. Shankar Krishnapillai, IITMadras, skris@iitm.ac.in	2. Dr. Sandipan Roy, SRM IST, KTR

Course Code	21ME0104T	Course Name	TQM AND RELIABILITY ENGINEERING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	acquire the importance of TQM and its concepts, tools and techniques and apply in the real-world environment	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Analyze the role of human involvement to improve the quality of product and service															
CLR-3:	Understand, apply and evaluate the tools and techniques used for product and service quality															
CLR-4:	familiarize the basic concepts of reliability, apply and evaluate reliability for different systems															
CLR-5:	impart the concept of maintainability of a system to evaluate time for different cases															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Illustrate the importance of TQM and its concepts, tools and techniques.	-	-	-	-	-	1	-	-	-	-	3	2	-	-	-
CO-2:	Define the role of human involvement to improve the quality of product and service	-	-	-	-	2	-	-	-	-	-	3	2	-	-	-
CO-3:	Explore the tools and techniques used for product and service quality	-	-	1	-	-	-	-	-	-	-	3	2	-	-	-
CO-4:	Discuss the concept of reliability	-	1	-	-	-	-	-	-	-	-	3	-	-	-	-
CO-5:	Explain the concept of maintainability of a system.	-	3	-	-	-	-	-	-	-	-	2	-	-	-	-

Unit-1 - Evolution, Theories and Implementation	9 Hour
Evolution of Total Quality Management - Definition of quality, Dimensions of Quality- Deming's theory - Juran and Crosby theories - Taguchi and Ishikawa theories - Quality costs, Product quality Vs Service quality - Goal setting - Strategic Quality planning - TQM implementation - Kaizen - JIT - Kanban - LEAN - Value Stream Mapping - Waste Management.	
Unit-2 - Principles and 7 QC Tools	9 Hour
Customer Satisfaction - Types of customers, customer supplier chain - Customer perception of quality customer feedback - Customer complaints - Customer retention - Service quality - Employee involvement and motivation - Maslow's hierarchy of needs - Herzberg theory - Empowerment and team work - Seven QC tools - Check sheets - Histograms, control charts - Pareto diagram, Cause and effect diagram - Stratification, Scatter diagrams - Problem Solving Technique - using 7QC Tools - ISO9000 Quality system.	
Unit-3 - Management Tools	9 Hour
Affinity diagram - Relations diagram - Tree diagram - Matrix diagram - Matrix data analysis diagram - Process decision program chart, Arrow diagram - 5S Principles - Quality Function Deployment (QFD) - Failure Mode Effects and Criticality Analysis (FMECA) - cause & effect analysis, poka-yoke - Introduction to Six Sigma - Define—Measure—Analyze—Improve—Control (DMAIC) - Measurement System Analysis -Process Capability Study - SMED - TRIZ, Taguchi Loss function. Case studies and problems.	
Unit-4 - Reliability	9 Hour
Probabilistic nature of failures - Mean failure rate - Meantime between failures - Hazard rate - Hazard models - Weibull model - System reliability improvement - Redundancy - Series- Parallel and Mixed configurations - Problems in Series - Problems in Parallel and Mixed configurations - Accelerated Life Testing - Failure Mode Analysis - Distributions Used in Reliability Engineering.	

Unit-5 - Maintainability	9 Hour
Introduction Availability and Maintainability - Types of maintenance strategy - Mean time- to repair (MTTR) - Factors contributing to Mean Down Time (MDT) - Fault diagnosis, and routine testing for unrevealed faults - Factors contributing to Mean Maintenance Time – (MMT) on condition maintenance - Total Productive Maintenance (TPM) - Periodic condition monitoring, Continuous condition monitoring - Economics of maintenance - Overall Equipment Efficiency (OEE) - Phases of TQM implementation.	

Learning Resources	<ol style="list-style-type: none"> 1. M. P. Poonia, S.C. Sharma, "Total Quality Management", Khanna Publishing, 2019. 2. R Kiran, "Total Quality Management: Key Concepts and Case Studies", Elsevier Inc., 2017. 3. Dale H Besterfield, "Total Quality Management", Fourth Edition, Pearson Education Asia, 2015 4. John Oakland, Peter Morris "TQM – A pictorial guide for managers", Routledge, 2011. 5. Roderick A Munro, Govindarajan Ramu and Daniel J Zrymiak, "The Certified Six Sigma Green Belt Handbook", Second Edition, American Society for Quality, USA, 2015. 6. L S Srinath, "Reliability Engineering", Fourth Edition, Affiliated East West Press, 2008. 7. E Balagurusamy, "Reliability Engineering", Tata McGraw Hill Education, 2010. 8. Total Quality Management and Operational Excellence: Text with Cases, Routledge, 2014. 9. A Textbook of Reliability and Maintenance Engineering, Charles Ebeling, UBSPD, 2017.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Gowrishankar, NIQR Secretary	1. Dr. Raju Abraham, Scientist-F, National Institute of Ocean Technology, Velachery- Chennai 601 302, abraham@niot.res.in	1. Dr. E. Vijayaragavan, SRM IST, KTR
2. Dr. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley, Chengalpattu	2. Dr. N. Arunachalam, Associate Professor, IITM	2. Dr. J. Santha Kumar SRM IST, KTR

Course Code	21ME0105T	Course Name	OCCUPATIONAL SAFETY AND DISASTER MANAGEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the causation and prevention approaches of accident	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Classify the Occupational Hazards and its associated risk															
CLR-3:	Portray the safety consideration in an industrial operation to conduct risk assessment in material handling process															
CLR-4:	Perform the Environmental Impact Assessment for any projects and understand the concept of disaster management															
CLR-5:	Identify the various regulations, acts and rules in terms of Health, Safety and Environment															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Categorize the accident theories and its predominant safety factors	2	-	-	1	-	1	-	-	-	-	-	-	-	-	-
CO-2:	Classify the Occupational Hazards and its associated risk	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-3:	Portray the safety consideration in an industrial operation to conduct risk assessment in material handling process	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
CO-4:	Perform the Environmental Impact Assessment for any projects and understand the concept of disaster management	-	-	-	-	-	3	1	-	-	-	-	-	-	-	-
CO-5:	Identify the various regulations, acts and rules in terms of Health, Safety and Environment	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-

Unit-1 - Principles of Safety Management	9 Hour
Concept of an accident, reportable and non-reportable accidents, unsafe act and condition - contribution factor for accident – Theories and principles of accident causation - accidents - Accident reporting and investigations, Safety Performance Monitoring - Reactive and proactive monitoring techniques , Calculation of accident indices - Risk Assessment –Safety Education and Training - Importance of training-identification of training needs-training methods – training evaluation methods, Safety committees and their need, types and advantages	
Unit-2 - Occupational Hazards	9 Hour
Physical Hazard – Noise, Vibration, Temperature and Radiation – measuring methods, standards and its impact – Chemical Hazard - recognition of chemical hazards-dust, fumes, mist, vapour, fog, gases and its concentration - Exposure vs. Dose, TLV - Methods of Evaluation- Material Safety Data Sheet- Biological Hazard - classification of Bio-hazardous agents –bacterial agents, fungal, parasitic agents, infectious diseases -Biohazard control program- Mechanical Hazards – Psychological Hazards – Ergonomics and its concept.	
Unit-3 - Safety in Industrial Operation	9 Hour
General safety consideration in material handling - Ropes, Chains, Sling, Hoops, Clamps - Selection, operation and maintenance of Mobile cranes, Tower crane and industrial trucks – Working at Heights - Safe Access - Safe Use of Ladders and Scaffoldings - Fall Prevention & Fall Protection - Safety Belts - Safety nets - Work permit system – Fire Safety – fire extinction, stages and modes of fire, classes of fire – fire extinguishers and types- Safety color codes – OSHA and ANSI standards	

Unit-4 - Environment and Disaster Management	9 Hour
Introduction to Environment – assessment of and quality standards and impact in air, water and soil – Environmental impact assessment - Legislative and environmental clearance procedure in India- Disaster Management – Types of disaster, phases and levels – Disaster Management Cycle – Hydrological disasters – Technological Disasters – Manmade disasters – Resettlement and Rehabilitation - Disaster Case Studies.	
Unit-5 - Regulations for Health, Safety and Environment	9 Hour
Factories act and rules - Workmen compensation act – Gas Cylinder rules – Environmental Pollution act – Bio-medical waste Management rules - Building and other construction act – Green Building Concept – Indian motor vehicle act and rules- Indian Petroleum act – Sendai Framework on Disaster Risk Reduction	

Learning Resources	<ol style="list-style-type: none"> 1. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259007361 2. Rieske, David W., Asfahl and C. Ray, "Industrial Safety and Health Management", 6th Edition, Prentice Hall Professional Technical Ref. 2009 3. Heinrich.H.W, "Industrial Accident Prevention", McGraw-Hill, 1980. 4. Alexandrov.M.P, "Material Handling Equipment", Mir Publishers, Moscow, 1981. 5. Lees.F.P, Loss "Prevention in Process Industries", Butterworths, NewDelhi, 1986. 6. Canter.R.L, "Environmental Impact Assessment", (2nd Edition), McGraw Hill, 1996 7. IS CODES: IS 5903, IS 807, IS 2760, IS 14469, IS 13367-1, IS 5324, IS 7167, IS 7155, IS 1800.1, IS 3521 of Oil Industry Safety Directorate, Govt. of India 8. Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978- 9380386423 9. Moore, T. "Handbook of Disaster and Emergency Management: Principles and Practice" (2016).
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Rajkumar, Cluster EHS Manager (South), L&T Construction, PVT. LTD.	1. Dr S. Kalai Selvam, Professor, Anna University	1. Dr Vignesh K.S, SRM IST
2. Mr. Karthik Rajan. Lead EHS Specialist, Grundfos Pumps PVT. LTD.	2. Dr. Anil Kumar Gupta, NIDM, New Delhi	2. Mr. Thirugnanam. A, SRM IST

Course Code	21ME0106T	Course Name	INTRODUCTION TO ROBOTICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Discuss the basic terminologies and classifications associated with Robot and Manipulators]	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Analyze robot kinematics and its associated transformation of joints															
CLR-3:	Acquire the knowledge about robotic control system, sensors and feedback devices															
CLR-4:	Develop programs for robot applications															
CLR-5:	Recognize different robot and its working principle															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Explain the basic terminologies and classifications of Robot and Manipulators	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Analyze robot kinematics and the transformations associated with the joint motion	-	3	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Acquire the knowledge about robotic control system, sensors and feedback devices	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Develop programs for robot applications	-	2-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Recognize different robot and its working principle	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Robot Fundamentals and Manipulators	9 Hour
Robotics - Concepts, RIA Definition, Laws, Anatomy, Joints and links, Notations, Motion, Configurations. Degree of freedom-redundant system, Precision Movement – Spatial resolution, Compliance, Accuracy and repeatability of Robotics-Simple problems-Specifications of Robot-Speed of Robot- Robot Drive systems. Mechanical grippers-Actuation - Slider crank, Screw, Rotary, Cam -Magnetic grippers-Vacuum grippers-pneumatic, hydraulic operated grippers, needle gripper, bellows gripper, Flexible grippers, soft gripper-Gripper force analysis-Gripper design-Simple problems	
Unit-2 - Robot Kinematics	9 Hour
Robot kinematics- open chain, closed chain kinematics. Transformation of joints and links-Forward and Inverse - simple problems, Homogeneous Transformation, Multiple transformation-Simple problems. Solving problems using programming software	
Unit-3 - Control System, Sensors and Robot Vision.	9 Hour
Control system for robot joint-Control actions-P, PI, PID controllers. Adaptive controller, optimal controller, Motion Interpolations and positioning Sensors in robot – Touch sensors-Tactile sensor – Proximity and range sensors Feedback devices-Encoder, Resolver, LVDT – Force sensor-Light sensors -Pressure sensors Robotic vision sensor- Sensing and digitizing. Image processing and analysis.	
Unit-4 - Robot Programming	9 Hour
Programming methods, OFF and ONLINE programming, Lead through method, powered and Manual lead through and Teach pendent method, Fundamentals of RAPID Programming, ROS and simulation software with Simple program.	

Unit-5 - Robot Types and Application	9 Hour
Micro/Nanorobot, Wall climbing micro robot -Biomimetic robot-Swam robot-Corobot, Universal Robot, Mobile Robot, Mecanum wheel robot, Delta Robot working principle. Robot applications in manufacturing Inspection, assembly, material handling, spraying. Applications in medical field surgical robot, Rehabilitation Robots, Nanorobot in targeted drug delivery system. Robot application in space, under sea water and agriculture.	

Learning Resources	<ol style="list-style-type: none"> 1. Mikell P. Groover, "Industrial Robotics Technology Programming and publications", McGraw Hill Co., New Delhi, 2012. 2. Deb .S.R, "Robotics technology and flexible automation", Tata McGraw Hill publishing company limited, New Delhi, 2010. 3. Niku, Saeed B., Niku, Saeed Benjamin. Introduction to Robotics: Analysis, Control, Applications. United Kingdom: Wiley, 2020. 4. Gonzalez, Rafael C., Lee, C. S. George., Fu, King Sun. Robotics: Control, Sensing, Vision, and Intelligence. Singapore: McGraw-Hill, 1992. 5. Klafter.R.D, Chmielewski.T.A and Noggins, "Robot Engineering: An Integrated Approach", Prentice Hal of India Pvt. Ltd., New Delhi, 2010. 6. Craig, John J... Introduction to Robotics: Mechanics and Control. United Kingdom: Pearson, 2018. S. Mukherjee, Robotics, Khanna Book Publishing Co., New Delhi 7. Xi, Ning. Liu, Leaning. Wang, Zhidong. Yuan, Shuai. AFM-Based Observation and Robotic Nano-manipulation. Germany: Springer Nature Singapore, 2020. 8. Selected Topics in Micro/Nano-robotics for Biomedical Applications. Netherlands: Springer New York, 2013.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	20%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-		-	-	-
Level 6	Create	-	-		-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley, .SARAVANAN@mahindra.com	1. Dr.Saravananaperumal, Assistant Professor, Department of Mechanical Engineering, Thiagarajar College of Engg., Madurai.	1. Dr.R.Ambigai, SRMIST

Course Code	21ME0107T	Course Name	FUNDAMENTALS OF NANO ENGINEERING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Find the fundamental properties of functional materials, nano engineering and nanotechnology	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Outline the uses of carbonaceous nanomaterials in engineering applications															
CLR-3:	Examine the principle of synthesis and characterization of nanomaterials															
CLR-4:	Illustrate the concept of biomedical materials engineering															
CLR-5:	Explain the concepts on fabrication methods and applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Identify the fundamental factors using engineering and nanotechnological knowledge	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Explain the role of carbonaceous nanomaterials on nano engineering and technology	3	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO-3:	Discuss the techniques of synthesis and characterization of nanomaterials and their uses	2	-	-	-	3	-	-	-	-	-	-	1	-	-	-
CO-4:	Determine the fundamental ideas of nanotechnology on biomedical materials	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-5:	Perform the effective nanotechnology on various fabrications and nano engineering applications	3	-	-	-	3	-	-	-	-	-	-	5	-	-	-

Unit-1 -Introduction to Nanotechnology	9 Hour
Fundamental of Nanotechnology; Ideas on quantum dot; Possible application of Nanoengineering in Science & Technology; Ethical aspects of Nanotechnology; Scientific revolution; Emergence of nanotechnology; Challenges in nanotechnology; Classification of Nanomaterials; Advanced Nanomaterials.	
Unit-2 - Nanotechnology in Carbon Materials	9 Hour
Allotropy of Carbon; Carbon age - new forms of carbon graphene sheet to CNT; Fullerenes and Carbon Nanotubes; Fullerenes as nano-structures - structures of C60, C70 and higher fullerenes; Carbon Tubules as Nano-structures; Observation of Carbon Nanotubes; Mechanical Properties of CNTs & Graphene; Electronic structure of CNTs & Graphene; Electronic and Biological properties of Nanomaterials.	
Unit-3 - Synthesis and Characterization	9 Hour
Nanomaterial synthesis; Macroscopic to microscopic crystals and nanocrystals; Large surface to volume ratio; Top-down and bottom-up approaches; Self-assembly process; Grain boundary volume in nanocrystals; Defects in nanocrystals; Surface effects on the properties; Nanomaterial Characterizations - Techniques.	
Unit-4 - Biomedical Materials	9 Hour
Introduction to Biomaterials; Surface and Bulk Properties of Bio materials; Biological Building Blocks; Size of building Blocks and Nanostructures; Biological nanostructures -Examples of Proteins, Miscells and Vesicles, Multilayer Films; Drug delivery; Soft tissue engineering; Hard tissue engineering; Implants & Prosthetics.	
Unit-5 - Fabrications and Applications	9 Hour
Nano MMCs; Nano PMCs; Nano CMCs; Electronic cooling system; Integrated circuits; MEMS; NEMS; Sensors; Nano-magnetics and bioengineering.	

Learning Resources	1. M.A. Shah & M.A. Shah, <i>Nanotechnology: The Science of Small</i> , Wiley, 2nd Edition, (2020).	5. Hari Singh Nalwa, <i>Handbook of Nanostructured Materials & Nanotechnology Optical Properties</i> , Academic Press, (2000).
	2. T.I. Awan, A. Bashir, & A. Tehseen, <i>Chemistry of nanomaterials: fundamentals and applications</i> . Elsevier, (2020).	6. Guozhong Cao, <i>Nanostructures and Nanomaterials, Synthesis Properties and Applications</i> , Imperial College Press, (2004).
	3. S. M Lindsay, <i>Introduction to Nanoscience</i> , Oxford, (2010).	7. Niemeyer, Christof M., and Chad A. Mirkin, eds. <i>Nanobiotechnology: Concepts, Applications and Perspectives</i> . Vol. 1. John Wiley & Sons, 2004.
	4. C.P. Poole Jr. and F.J. Owens, <i>Introduction to Nanotechnology</i> , Wiley Interscience, (2003).	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Sumitesh Das, Chief Graphene Business, Tata Steel	1. Dr. Sudip Kr. Sinha, Assistant Professor, NIT Raipur	1. Dr. Sumit Pramanik, SRMIST
2. Dr. Tapas Senapati, Senior Manager HPC at Emami Limited	2. Dr. Sk. Ariful Rahaman, Professor, VIT, Vellore	2. Dr. Shubhabrata Datta, SRMIST

Course Code	21ME0108T	Course Name	COMPUTER NUMERICAL CONTROL PROGRAMMING AND OPERATION	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Impart knowledge of CNC Architecture, Hardware, and Software	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	familiar with types of CNC machines															
CLR-3:	conversant with basic concepts of part programming															
CLR-4:	acquainted with part programming for turning operations															
CLR-5:	familiar with part programming for milling operations															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Familiarize the basics of CNC, CNC hardware, and Software	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Acquire knowledge of types of CNC Machines	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Acquaint knowledge of the basics of part programming for lathe and milling operations	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Develop part programming for machining components using CNC Lathe	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Develop part programming for machining components using CNC Milling Machine	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Numerical Control and CNC	9 Hour
Definition of Numerical Control, Conventional and CNC Machining - Numerical Control Advantages - Types of CNC Machine Tools - Personnel for CNC, Safety Related to CNC Work - CNC Machine Architecture - Guide Systems - Transmission Systems, Motors - The CNC Controller - Controller Hardware, Control Software	
Unit-2 - CNC Machines - Operation	9 Hour
CNC Milling: Types of Milling Machines - Machine Axes, Vertical Machining Centers - Horizontal Machining Centers - Horizontal Boring Mill, Typical Specifications. CNC Turning: Types of CNC Lathes, Number of Axes - Axes Designation, Two-Axis Lathe, Three-Axis Lathe - Four-Axis Lathe & Six-Axis Lathe - Features and Specifications, Typical Machine Specifications - Control Features. Special CNC Machines – Wire Cut EDM, Routers	
Unit-3 - Basics of CNC Programming	9 Hour
Coordinate Geometry, Real Number System, Rectangular Coordinate System, Machine Geometry – Control System, General Description, System Features, Manual Program Interruption, Manual Data Input (MDI), Program Data Override, System Options – Program Planning, Steps in Program Planning – Part Program Structure, Basic Programming Terms, Programming Formats, Word Address Format, Format Notation – Symbols in CNC Programming, Typical Program Structure, Program Header – Preparatory Commands (G – Codes) & Miscellaneous Functions (M Codes) – Sequence Block, Input of Dimensions, Spindle Control, Feed rate Control, Tool Function – Reference Points, Register Commands, Position Compensation - Work Offsets, Tool Length Offset, Simple CNC Programs – Tutorials	
Unit-4 – CNC Programming – Turning	9 Hour
Rapid Positioning, Machine Zero Return - Linear Interpolation, Block Skip Function, Dwell Command - Fixed Cycles: G81, G82, G83, G73, G84, G74, G85, G86, G87, G88, G89, G76 - Machining Holes: Single Hole Evaluation, Drilling Operations, Peck Drilling, Reaming, Boring, Tapping, Pattern of Holes - Lathe Cycles: G90, G94, G71, G72, G73, G70, G74, G75 - Grooving on Lathes - Part-Off & Single Point Threading - Live Tooling on Lathes - Math in CNC Programming: Geometry, Taper & Advanced Calculations - Tutorials on Programming	

Unit-5 - CNC Programming – Milling **9 Hour**

Face Milling, Circular Interpolation - Cutter Radius Offset, Plane Selection - Contour Milling - Slots and Pockets - Subprograms, Datum Shift, Mirror Image - Coordinate Rotation, Scaling Function - Helical Milling - Horizontal Machining - Tutorials on Programming, Introduction to APT Programming

Learning Resources	1. Thyer G. E., Computer Numerical Control of Machine Tools, Industrial Press, 1988	5. Gibbs D and Crandell T M, Introduction to CNC Machining and Programming, Industrial Press, 2003
	2. Smid P, CNC Programming Handbook, Industrial Press, 2008	6. Marciniak K, Geometric Modeling for Numerically Controlled Machining, Oxford University Press, 1991
	3. Madison J, CNC Machining Handbook: Basic Theory, Production Data and Machining Procedures, Industrial Press, 1996	7. Overby, Alan. CNC machining handbook: building, programming, and implementation. McGraw-Hill, Inc., 2010.
	4. Mattson M, CNC Programming Principles and Applications, Cengage Learning, 2009	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Vignesh Shanmugam, Manager, Hyundai Motors India Ltd.	1. Dr. Davidson Jebaseelan, Professor, VIT Chennai	1. Mr. V. Veeranaath, SRMIST
2. Dr. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra Research Valley, N.SARAVANAN@mahindra.com	2. Dr. Raju Abraham, Scientist-F, National Institute of Ocean Technology, Velachery-Tambaram Road, Pallikaranai, Chennai 601302, abraham@niot.res.in	2. Dr.J.Santhakumar, SRMIST

Course Code	21ME0109T	Course Name	RESOURCE MANAGEMENT TECHNIQUES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Discuss the necessity, scope, applications of operations research in industries	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Outline various resource management techniques and their applications in industries	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Construct real life problems into modeling and solving for decision making															
CLR-4:	Apply cost effective techniques for cost and time reduction of the projects with reduced resources															
CLR-5:	Recommend suitable decisions under competitive and uncertain environments															

Course Outcomes (CO):	At the end of this course, learners will be able to:	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CO-1:	Create the linear programming model and apply various techniques to optimize the objective function within the given constraints	-	1	3	-	1	-	-	-	-	-	-	-	-	-	-
CO-2:	Solve transportation and assignment models for cost effective solutions	-	1	-	-	1	-	-	-	-	-	3	-	-	-	-
CO-3:	Identify suitable job sequencing for reducing idle time of resources, and to identify ideal time of replacement of individual, group items for saving investment	-	1	-	-	1	-	-	-	-	-	3	-	-	-	-
CO-4:	Evaluate decision variables of queuing and inventory models for ensuring prompt service with limited resources	-	1	-	-	1	-	-	-	-	-	3	-	-	-	-
CO-5:	Construct the project network for cost and time effective project completion with limited resources, and to apply various techniques to determine best strategies under competitive and uncertain environments	-	1	-	-	1	-	-	-	-	-	3	-	-	-	-

Unit-1 - Linear Programming Model	9 Hour
Necessity of OR in industry – Concept and formulation of LP models for the real life and industrial problems – Graphical method – Simplex method – Big M method. Solving tutorial problems using software.	
Unit-2 - Transportation & Assignment Models	9 Hour
Transportation model – basic feasible solution using Least Cost, VAM – Optimality test using U-V method. Assignment model – Minimization and Maximization problems. Solving tutorial problems using software.	
Unit-3 - Sequencing & Replacement Models	9 Hour
Sequencing model – Processing of 'n' jobs on 2 & 3 machines. Replacement models – items that deteriorate with time – items that fail completely – individual and group replacement policy. Solving tutorial problems using software.	
Unit-4 - Queuing & Inventory Models	9 Hour
Queuing theory - Poisson arrival and exponential service times – single server with limited, unlimited number of arrivals allowed. Inventory models – Purchase and Manufacturing deterministic models without shortages allowed. Solving tutorial problems using software.	
Unit-5 - Project Network Model & Game Theory	9 Hour
PERT & CPM techniques – Project completion time – CPM cost model. Game theory- 2 persons zero sum games. Pure and mixed strategies. Method of dominance – Matrix oddment method for n x n matrix. Solving tutorial problems using software.	

Learning Resources	1. Hamdy A Taha, Operations Research : An Introduction, 10th edition, Prentice Hall of India, New Delhi, 2017	4. Duraivelu K and Balasubramanian M, Operations Research, 2nd Edition, DeaR Publications, 2022
	2. Gupta, P.K. and Hira, D.S, Operations Research, 3rd Edition, S.Chand and Company Ltd., New Delhi, 2015	5. Sundaresan V, Ganapathy Subramanian and Ganesan K, Operations Research, 4th Edition, A.R.Publications, 2006.
	3. Panneerselvam R, Operations Research, Prentice Hall of India, 2nd edition, New Delhi, 2016	6. Software tool for solving tutorial problems : TORA software: www.mediafire.com/file/t48w3vjo6os9pxp/ToraSystem7th.zip/file

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. A. Muguntharajan, Vice President, OBTim Consulting Services, Bangalore	1. Dr. M. Raj Mohan, Professor, Dept of Industrial Engineering, CEG campus, Anna University, Chennai	1. Dr. K. Duraivelu, SRMIST
2. Dr. D. Arivudainambi, Secretary, Operations Research Society of India, Chennai Chapter	2. Dr. Usha Mohan, Professor, Dept of Management Studies, IIT-Madras, Chennai	2. Dr. S. Oliver Nasaraj, SRMIST

Course Code	21ME0110T	Course Name	ENERGY SYSTEMS FOR SUSTAINABLE BUILDINGS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Describe the energy transfer in buildings	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Represent the solar passive heating and cooling systems															
CLR-3:	Examine the lighting systems of buildings															
CLR-4:	Implement the Heat control and ventilation methods in buildings															
CLR-5:	Propose and analyze the concept of green buildings															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Compute the heating and cooling load calculations on energy efficient buildings	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Analyze the concept of solar passive heating and cooling	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Create the design parameters influencing thermal design of buildings	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Evaluate the concept of day lighting and electrical lighting systems	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply the concept of green buildings and certifications	2	-	-	-	-	-	3	-	-	-	-	-	-	-	-

Unit-1 - Energy Transfer in Buildings	9 Hour
Concepts of thermal comfort and energy efficient buildings; Conventional versus Energy Efficient Buildings-Climate and its influence in building design for energy requirement- Thermal properties of building materials; Heat transmission in building structures; Energy balance for cooling and heating of buildings- Estimation of heating and cooling loads; Low and zero energy buildings- Global and Indian energy scenario-Future building design aspects.	
Unit-2 - Solar Heating & Cooling	9 Hour
General principles of active and passive solar heating- Key design elements of passive heating- Direct solar heat gain by Trombe mass walls- Passive cooling and its key design elements, - Water walls, evaporative cooling- Convective air loops and solar chimney effects, Thermal Bridge and barrier, Thermal insulation, load control, air infiltration- Odor removal and heat recovery in large buildings.	
Unit-3 - Heat Control & Ventilation	9 Hour
Air currents around the building, Air movement through the buildings, air changes, quality of air- Psychometrics, Design parameters influencing thermal design of buildings- Impact of micro and macro climatic changes- Heat transmission through building sections-Effect of orientation of buildings. Ventilation, requirements for heat control in buildings- Standards for ventilation-Ventilation designs.	
Unit-4 - Lighting Systems of Buildings	9 Hour
Introduction to lighting systems of building-Functional and aesthetic aspects of lighting - Offices, Residences, Hospitals, Malls, Museum Lighting-Glazing materials: Sources and concepts of optical materials- Concepts of day lighting- Components of daylight factors and Recommended daylight factors- Day lighting analysis- Electrical lighting and Illumination requirement-Selection of luminaires and performance parameters-Electric lighting control for day lighted buildings- Comparison of day and electrical lighting	

Unit-5 - Green Buildings and Standards	9 Hour
Sustainability - need and challenges, Environment benefits of green buildings, Integrated ecological design, Effluent management systems-environmental acts and protocols-ISO 14000-Green building features and green construction materials-Green building standards, ratings and certifications - Green Globe, LEED, GRIHA, IGBC, Socioeconomic aspects of green buildings, Sustainable urbanization, Governmental proposal on green buildings.	

Learning Resources	1. Means R.S., "Green building: project planning and cost estimating", Kingston, 2006 2. Kibert C.J., "Sustainable Construction: Green Building Design", 2nd edition, Wiley, 2007 3. Boecker J., Scot Horst, Tom Keiter, Andrew Lau, Markes Sheffer, Brian Toevs, Bill Reed, "Integrative Design Guide to Green Building", Wiley, 2009.	4. Eicker U., "Low Energy Cooling for Sustainable Buildings", Wiley, 2009 5. Gevorkian P., "Alternative Energy Systems in Building Design", McGraw-Hill, 2010 6. Jan. F. Kreider, "Hand book of heating, ventilation and Air-conditioning", 1st Edition, CRC press, 2019 7. Eagan D. M., "Architectural Lighting", 2nd Ed. McGraw-Hill, 2002.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	60%	-	60%	-	60%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. R.Karthick GM Operations Flexiflo India Pvt Limited Alwarpet Chennai, karthik@flexiflo.ae	1. Dr. S. Suresh, Associate Professor, Dept. of Mechanical Engineering, National Institute of Technology, Tiruchirappalli - 620 015	1. Dr C. Selvam, SRMIST
2. Mr R.M Raghunathan Assistant Vice President, TamilNadu PetroProducts Limited, Manali Chennai, mlrmr@hotmail.com	2. Dr. Lovelyn Theresa Innocent, Senior Project Manager, Energy, Environment & Climate Change (EECC), Renewable Cogen Globe, St. Thomas Street, Egattur, Navalur, Chennai – 603103	2. Dr. R. Senthil, SRMIST
		3. Dr.P. Sundaram, SRMIST

Course Code	21ME0111T	Course Name	ENVIRONMENTAL POLLUTION AND ABATEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Familiar the principles and methods of controlling various types of pollution.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the emission control techniques.															
CLR-3:	understand water treatment and solid removal methods															
CLR-4:	Familiar with aerobic and anaerobic treatments.															
CLR-5:	Familiar with the nature of solid waste and their disposal.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Explain the basics of pollution and the control methods	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
CO-2:	Differentiate about various air pollutants and emission control techniques.	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-
CO-3:	Compile the water treatment methods and solid removal	-	-	3	-	-	2	-	-	-	-	-	-	-	-	-
CO-4:	Describe the Aerobic and anaerobic treatments	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-5:	Analyze the various Solid waste disposal methods.	-	-	1	-	-	2	3	-	-	-	-	-	-	-	-

Unit-1 - Basics of Pollution and Prevention	9 Hour
Environmental Laws, Rules and Standards – Classification of pollutions, Sources of pollutions and its impacts, Process modification: alternative raw material, recovery of by product, Recycle and reuse of waste, energy recovery and waste utilization, Material and energy balance for pollution minimization. Air pollution- effects, control, Water use - effects, control, Land pollution - effects, control, Noise pollution- effects, control, Solid waste -- effects, control Nuclear waste- effects, control, e-waste material and its impact, Pollution control through housekeeping and maintenance, Fugitive emission, effluents and leakages	
Unit-2 -Air Pollution	9 Hour
Air quality – factors affecting air quality- standards of air quality, Air pollution from Industry, power plants, Vehicle air pollution, Sources and formation of Sulfur oxides (SO _x); nitrogen oxides (NO _x), Sources and formation of carbon monoxide, Total Suspended Particulate Matter, Respirable Particulates, Photo-chemical oxidants. Other pollutants, Greenhouse effect, -greenhouse gases: CO ₂ , CH ₄ , N ₂ O, CFCs, water vapor concentration, alternatives for CFCs, global warming and climate change, Ozone layer depletion- ozone depleting processes, ozone hole, Environmental effects and strategies for ozone layer protection, Acid rain-sources and its impact, Control techniques of air pollutions, Wet Gas Scrubbing Techniques, Gaseous Emission Control By Absorption Methods and Adsorption Methods, Cyclones, Electrostatic Precipitation- Design, Fabric filters and absorbers, Pollution control - Design consideration and limitations, Modern Tool usage - monitoring	
Unit-3 - Water Pollution	9 Hour
Water pollution – Domestic and industry, Water pollution from dye industry and ink industry, Water pollution from textile, leather industry, Biological uptake of pollutants, Effect Of Pollutants On Land Vegetation, Effect Of Pollutant, Consequences on human health., Physical treatment- pre-treatment, solids removal by settling and sedimentation, Filtration and centrifugation, Coagulation and flocculation's On Land Animals And Human Health, Bio-deterioration, bioaccumulation, Bio-magnification and eutrophication, Infectious microbial agents in water system	

Unit-4 - Biological Treatment	9 Hour
Anaerobic degradation of organic matter, Trickling filter – Process description, Aerobic treatment – aeration units, Biochemical kinetics: hydraulic detention time, mean residence time, Types of activated sludge process, Tapered aeration, Stepped aeration, sludge separation, Aerobic treatment units (ponds, lagoons, oxidation ditch, Factors affecting anaerobic digestion process, Secondary Biological treatment: Aerobic activated, sludge process, Sequential batch process, fluidized bed Reactor, Secondary Biological treatment: Anaerobic-UASB, MBR –Merits and Demerits, Sludge Treatment: Volume Reduction, Dewatering; Sludge drying; Composting, Sludge Treatment: Fluidized bed, incineration	
Unit-5 - Solids Disposal	9 Hour
Solids waste disposal – composting process and its phases, Sanitary landfill- Principle and process, Gasification process, Upward, Downward, cross draft gasifier, Incineration and Pyrolysis, Quantum and nature of solid waste, bio methanation -phases involved and factors, Pelletization, landfill and gas recovery municipal solid waste disposal- Best management practices for containers, Reuse, Recycling, and Resource Recovery, Hazardous Waste- Waste Processing And Handling- Transportation Of Hazardous Wastes- Recovery Alternatives, Radioactive Waste – Source of radioactive waste, Health effects, Solid and Hazardous, Waste Law.	

Learning Resources	1. Vallero D; "Fundamentals of Air Pollution", 4 th Ed; Academic Press, 2008 2. Eckenfelder W.W; "Industrial Water Pollution Control", 2 Ed; McGraw Hill, 2000 3. Kreith F. and Tchobanoglous G., "Handbook of Solid Waste Management", 2 Ed; McGraw Hill, 2002	4. Pichtel J; "Waste Management Practices: Municipal, Hazardous and Industrial", CRC, 2005 5. Tchobanoglous G., Burton F. L. and Stensel H.D., "Waste Water Engineering: Treatment and Reuse", 4th Ed; Tata McGraw Hill, 2010 6. Ruth F.Weiner and Robin A.Mathews Environmental engineering 4th edition
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. M Malathi, Manager R &D, IP Rings	1. Dr. S.K. Rani Professor & Dean (SP &CS) Crescent Institute of Science and Technology	1. Dr. V. Praveena, SRMIST
2. Mr. R.Karthick GM Operations Flexiflo India Pvt Limited Alwarpet Chennai, karthik@flexiflo.ae	2. Dr. P. Thirumal, Government College of Engineering Bargur	2. Dr. P. Chandrashekar, SRMIST

Course Code	21ME0112T	Course Name	RENEWABLE ENERGY SOURCES AND APPLICATIONS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Enrich the students in the basics of solar energy	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Develop knowledge in wind energy conversion system															
CLR-3:	Knowledge on ocean, tidal energy and geothermal															
CLR-4:	Enrich knowledge in energy generation by biomass															
CLR-5:	Acquire knowledge in fuel cell and other energy conversion systems															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Recognize solar energy systems and current applications	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-2:	Describe knowledge on wind energy conversion systems	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-3:	Discuss the ocean, hydro and geothermal energy theories and concept	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-4:	Enumerate the use biologically degradable resources and its energy conversion processes	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-5:	Identify renovate future energy need towards renewable energy	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-

Unit-1 - Solar Energy	9 Hour
Introduction to Energy Science & Technology, Forms of Energy, Nature of solar radiation - spectrum - constant - extra-terrestrial radiation on a horizontal surface, attenuation of solar radiation, beam, diffuse and global radiation. Measurement of global - diffuse - beam radiation. Principle of working of solar water heating systems - cookers- desalination systems - ponds - chimney power plant, central power tower power plants. Classification of solar concentrators, Basic definitions - concentration ratio, angle of acceptance, Drawbacks/Real field issues in solar thermal systems, sensible and latent heat thermal energy storage systems, Solar photovoltaic systems: basic working principle, components, and its applications.	
Unit-2 - Wind Energy	9 Hour
Wind energy scenario in India and the world, Origin of wind, nature of wind, wind data measurement, Variation of Wind Speed with Height, Basics of fluid mechanics, Estimation of Wind Energy at a Site: Types of Horizontal axis wind turbine such as Single blade, Two blades, Types of Horizontal axis wind turbine such as Multi blades, Dutch and Sail type, Vertical axis wind turbine such as Savonius Rotor, Darrieus Type, Betz's law, Wind Turbine Aerodynamics, wind turbine types and their construction, wind-diesel hybrid system, environmental aspects, Wind Energy Storage.	
Unit-3 - Ocean, Hydro and Geothermal Energy	9 Hour
Current scenario of Ocean Thermal Energy Conversion (OTEC) system - open cycle & closed cycle, environmental impacts, challenges, tidal energy - single basin and double basin plants. Wave energy conversion systems, Geothermal energy: Origin, applications, types of geothermal resources. Hydroelectric power plant.	
Unit-4 - Biomass	9 Hour
Biomass, Sources of biomass, Pyrolysis, combustion and gasification process, Updraft and downdraft gasifier, Fluidized bed gasifier, Fermentation and digestion process, Fixed and floating digester biogas plants, Operation of biogas plants, Applications	

Unit-5 - Hydrogen and Fuel Cell Technology	9 Hour
Hydrogen - properties - production techniques - storage - transportation. Fuel cell principles and its classification, Types - Phosphoric acid, polymer electrolyte membrane fuel cell, molten carbonate fuel cell and solid oxide fuel cell, Fuel cell conversion efficiency and applications.	

Learning Resources	1. G.D Rai, "Non-Conventional Energy Sources", Khanna Publishers, 5th Edition, New Delhi, 2011 2. Godfrey Boyle, "Renewable energy", 2nd Edition, Oxford University Press, 2010	3. B.H Khan, "Non-conventional Energy Resources", 2nd Edition, New Delhi, Tata McGraw Hill, 2009 4. S.P. Sukatme, J.K. Mayak, "Solar Energy-Principles of thermal collection and storage", 3rd edition, New Delhi, McGraw Hill, 2008
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	25%	-	25%	-	25%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	50%	-	50%	-	50%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Gireesh Yanamashetti, National Aerospace Laboratory, Bangalore	1. Dr. T. Venugopal, VIT Chennai	1. Dr. V. Mathanraj SRMIST
2. Dr. G. Muthuselvan, National Aerospace Laboratory, Bangalore	2. Dr. Saleel Ismail, NIT Calicut	2. Dr. S. Balaji, SRMIST

Course Code	21ME0113J	Course Name	ELECTRONICS THERMAL MANAGEMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the thermodynamics and heat transfer for electronic cooling applications	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand how to apply conduction heat transfer knowledge for electronic cooling															
CLR-3:	Understand the use of convection heat transfer techniques for the thermal management of electronics															
CLR-4:	Familiarize with radiation heat transfer for electronic cooling applications															
CLR-5:	Familiarize with methods for the thermal management of electronics															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Explain the thermodynamics and heat transfer for electronic cooling applications	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Apply the concepts of electronics thermal management design process in printed circuit boards	3	1	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-3:	Use conduction heat transfer methods for electronic cooling applications	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-4:	Apply radiation heat transfer methods for electronic cooling applications	-	-	-	1	3	-	-	-	-	-	-	-	-	-	-
CO-5:	Analyze the instrumentation methods for the thermal management of electronics	-	-	-	1	3	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction	12 Hour
Semiconductor technology trends, electronic packaging and materials, heat transfer mechanisms in electronic chips, requirement for electronic cooling, Modeling and simulation of electronic systems' cooling.	
Unit-2 - Conduction Heat Transfer	12 Hour
Conduction- thermal resistance networks, conduction in chip carriers and PCB. Modeling and simulation of electronic systems' cooling...	
Unit-3 - Convection Heat Transfer	12 Hour
Natural and forced convection, heat sinks, fan selection, cold plate - mini and microchannel heat exchangers, jet impingement, modeling and simulation of electronic systems' cooling.	
Unit-4 - Radiation Heat Transfer	12 Hour
Radiation intensity - emissive power- blackbody radiation- radiative properties of surfaces, radiosity, view factors, radiation transfer between black bodies-nonblack bodies, modeling and simulation of electronic systems' cooling..	
Unit-5 - Electronic Systems and Measurements	12 Hour
Measurements in electronic systems, flow Rate - pressure -velocity - temperature - acoustic Noise, simulation of electronic systems' cooling.	

Learning Resources	1. A Younes Shabany, "Heat Transfer", CRC Press, Taylor & Francis Group, 2010	4. Santiago Pagani Jian-Jia Chen, Muhammad Shafique Jörg Henkel, "Advanced Techniques for Power, Energy, and Thermal Management for Clustered Manycores", Springer Nature, 2018.
	2. L. T. Yeh, R. C. Chu, "Thermal Management of Microelectronic Equipment", ASME Press Book Series on Electronic Packaging, ASME Press New York, 2007	
	3. Ansys® Academic Research Mechanical, Release R 2021, Help System, Coupled Field Analysis Guide, ANSYS, Inc. Drive Canonsburg, PA 15317, July 2021.	5. Kothandaraman. C. P, Subramanyan, S, "Heat and Mass Transfer Data Book", New Age International, 7th edition, 2012.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	25%	25%	-
Level 3	Apply	30%	-	-	30%	30%	-
Level 4	Analyze	30%	-	-	30%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Prabhakar Subrahmanyam prasub@gmail.com	1. Dr. Raju Abraham Scientist NIOT, Chennai	1. Prof. B. K. Gnanavel, SRMIS
2. Dr. N Saravanan, Principal Engineer, Smart Implements & Machinery and Sustainability, Mahindra	2. Dr. Pandiyarasan Veluswamy, IITDM, Chennai Email: pandiyarasan@iitdm.ac.in	2. Dr. S. Manikandan, SRM IST

Course Code	21ME0114T	Course Name	SOLAR ENERGY FOR SOCIETAL APPLICATIONS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Familiarize with the basics of solar radiation data and its measurement	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Familiarize with the construction and applications of low-temperature solar thermal energy systems	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Comprehend the operation of high-temperature solar systems and solar thermal power plants															
CLR-4:	Familiarize with the design of solar photovoltaic systems for standalone and grid-tied applications															
CLR-5:	illustrate solar energy utilization in buildings and architectural applications															

Course Outcomes (CO):	At the end of this course, learners will be able to:	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CO-1:	Recognize solar radiation geometry, solar angles, and the working of solar radiation measuring instruments	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Analyze the components and working of low-temperature solar thermal systems for domestic and industrial applications	-	3	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-3:	Identify the selective processes of concentrated solar collectors for maximum utilization of solar radiation	-	3	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-4:	Utilize solar radiation for photovoltaic power generation and selective applications	-	2	-	-	-	-	3	-	-	-	-	-	-	-	-
CO-5:	Utilize solar energy for building thermal and visual comforts through active and passive techniques.	-	2	-	-	-	-	3	-	-	-	-	-	-	-	-

Unit-1 - Solar Radiation Measurements	9 Hour
Solar radiation-sun earth geometry, solar angles, radiation measuring instruments – Pyranometer, Pyrheliometer, Pyrgeometer and Sunshine recorder	
Unit-2 - Low-Temperature Solar Systems	9 Hour
Solar thermal collectors – Flat plate and evacuated tube solar collectors- solar dryers- desalination-solar pond. Case studies on Flat plate solar collectors.	
Unit-3 - High-Temperature Solar Systems	9 Hour
High temperature solar collectors – Concentration principles, Compound parabolic collectors, Parabolic trough collectors, Parabolic dish collectors, Linear Fresnel collectors, Direct Steam generation, Central tower power generation. Industrial process heating applications. Case studies on Community Cooking	
Unit-4 - Solar Photovoltaics	9 Hour
Solar photovoltaics, components of photovoltaic power plants, fill factor, maximum power point tracking, standalone and grid-connected systems, Street lighting, bifacial PV, floating photovoltaic plants, hybrid energy systems, Building integrated photovoltaic systems. Case studies on solar photovoltaic plants.	
Unit-5 - Solar Energy Utilization in Buildings	9 Hour
Active and passive heating, solar passive architecture, building orientation, sunspaces, Trombe mass wall, daylighting, light pipe, solar earth tunnel, Solar photovoltaic operated vapour compression refrigeration systems, solar vapor absorption cooling systems.	

Learning Resources	1. Soteris A Kalogirou, <i>Solar Energy Engineering: Processes and Systems</i> , Academic Press, UK, 2nd Edition, 2014.	4. G.N. Tiwari, A. Tiwari, Shyam, <i>Handbook of Solar Energy: Theory, Analysis and Applications</i> , Springer, Singapore, 2016.
	2. S P Sukhatme, J K Nayak, <i>Solar Energy</i> , McGraw Hill Education, 4th Edition, 2017.	5. D. Yogi Goswami, <i>Principles of Solar Engineering</i> , 4th Edition, CRC Press, 2015.
	3. John A. Duffie, William A. Beckman, <i>Solar Engineering of Thermal Processes</i> , Wiley, 4th Edition, 2013.	6. R. Foster, M. Ghassemi, A. Cota, <i>Solar Energy: Renewable Energy and the Environment</i> , CRC press, 1st Edition, 2010.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%-	-	30%-	-	30%-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Soumitra Mukhopadhyay, SMS India Pvt. Ltd, Kolkatta	1. Dr. M.K. Gaur, MIGTS, Gwalior	1. Dr. R. Senthil, SRMIST
2. Mr. Prabhat Kumar, Adani Power Ltd, Pune	2. Dr. P. Thirumal, Government College of Engineering Bargur	2. Dr. S. Manikandan, SRMIST
		3. Dr. V. Thirunavukkarasu, SRMIST

Course Code	21ME0115T	Course Name	INTRODUCTION TO DRONES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Mechanical Engineering	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Classify the basics of aerial vehicles	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Explain the basics principles of flight															
CLR-3:	Understand the components of flight control systems															
CLR-4:	Examine the navigation and control of aerial vehicle															
CLR-5:	Acquire knowledge of design principles of drones															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Classify the various unmanned aerial vehicles	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-2:	Examine the various principles involved in flight control system	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Classify the various devices of drones	1	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Classify the navigation and control devices of aerial vehicles	2	1	-	-	1	-	-	-	-	-	-	-	-	-	-
CO-5:	Investigate the design analysis and manufacturing of drones	-	1	-	2	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Unmanned Aerial Vehicle	9 Hour
UAV history, Director General of Civil Aviation (DGCA) classifications of UAVs, Types and Characteristics of Drones - Fixed rotor, multirotor, and flapping wing, Applications - Defense, civil and environmental monitoring, futures of UAV.	
Unit-2 - Fundamentals of Flight	9 Hour
Different types of Flight vehicles, Components and functions of an airplane, Forces acting on airplane, physical properties and structure of atmosphere, Aerodynamics - aerofoil nomenclature, Characteristics, Lift and Drag, Propeller theory/Momentum theory, propulsion and airplane structures	
Unit-3 - Elements of Unmanned Vehicle	9 Hour
Components - Arms, motors, propellers, electronic speed controller (ESC), flight controller - propulsion, Data link, Sensors and Payloads, GPS, IMU, Light Detection and Ranging (LiDAR), Imaging Cameras, Hyper spectral sensors, Laser Detection and Ranging(LADAR), Synthetic Aperture Radar(SAR), Thermal cameras, ultra - sonic detectors.	
Unit-4 - Navigation and Guidance	9 Hour
Introduction to navigation systems, types of guidance, mission planning and control, case studies on payloads.	
Unit-5 - Design and Simulation of Drones	9 Hour
Design of drone components, structural and Aerodynamic analysis, Building of Drones - main parts - 3D printing, Case studies	

Learning Resources	1. Andey Lennon, "Basics of A/C Model aircraft Design" Model Airplane News Publication, 1996	4. John Baichtal, Building your Own Drones; A Beginners' Guide to Drones, UAVs, and ROVs, Pearson Education, 2015
	2. Terry Kilby and Belinda Kilby, "Make: Getting Started with Drones", Maker Media, Inc, 2016.	5. K. Valavanis, George J Vachtsevanos, handbook of Unmanned Aerial Vehicles, New York, Springer, 2016.
	3. Donald Norris, "Build Your Own Quadcopter -Power up Your Designs with the Parallax Elev-8", McGraw-Hill Education, 2014.	6. Randal W. Beard, Timothy W. McLain, "Small Unmanned Aircraft", Theory and Practice, Princeton University Press, 2012.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Gireesh Yanamashetti, National Aerospace Laboratory, Bangalore	1. Dr. Ranjith Mohan, IIT Madras	1. Dr M. Gunasekaran, SRMIST
2. Dr. G. MuthuSelvan, National Aerospace Laboratory, Bangalore	2. Dr. V. Babu, IIT Madras	2. Dr P. Balakrishnan, SRMIST

Course Code	21NTO301T	Course Name	APPLICATIONS OF NANOTECHNOLOGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Acquire knowledge on environmental applications of nanotechnology	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the theory of nanotechnology in agriculture and food technology															
CLR-3:	Familiarize Electrical, Electronics and Energy Applications of Nanotechnology															
CLR-4:	Know Nanotechnology in Textiles and Cosmetics															
CLR-5:	Explore the concept of Biomedical Applications of Nanotechnology															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply skills to identify new materials for environmental applications	3	-	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Analyze the role of nanotechnology in agriculture and food technology	-	-	-	2	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Discriminate electrical, electronic and energy applications of nanotechnology	3	-	-	3	-	-	-	-	-	-	-	-	-	3	-
CO-4:	Apply the techniques of nanotechnology in textile and cosmetics	-	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO-5:		3	-	-	-	3	-	-	-	-	-	-	-	-	-	3

Unit-1 - Environmental Pollution Treatment Using Nanotechnology	9 Hour
Environmental pollutants in air, water, soil- Types of toxic and hazards wastes. Nanomaterials - Introduction- Application. Nanotechnology - Introduction- Application of nanotechnology in industrial waste- Application of nanotechnology in wastewater treatment- Drinking water purifications- Air purifications- Gas purifications- Nano Monitoring- Nano Biosensors – Overview.	
Unit-2 - Nanotechnology in Agriculture	9 Hour
Nanotechnology in Agriculture - Precision farming - Smart delivery system - Nano fertilizers and types - Nano urea and mixed fertilizers- Nano fertigation- Nano pesticides- Nano-seed Science- Nano Biosensors for Pesticide Detection- Nano Biosensors for Plant Pathogen Detection- Nano Bioremediation- Pesticide Degradation- Soil Structure- Soil structure Remediation - Nanotechnology in Food industry- Nano packaging for enhanced shelf life- Smart packaging- Intelligent packaging- Food processing- Food safety- bio-security- Electrochemical sensors- sensors for food analysis-contaminant detection	
Unit-3 - Nanotechnology in Energy Devices Applications	9 Hour
Electronic circuit chips- ICs-Moore's law- Nanosensors and actuators- Optical switches- Diodes- Nano-wire transistors- Advantages of nano electrical and electronic devices- Memory storage- Lighting displays and filters- Quantum computers- Medical diagnosis and conductive additives- Lead-free solder- Nano coatings and EMI shielding- Energy devices- Fuel cells- role of nanomaterials in fuel cell Applications- Photovoltaic cells- Application of nanotechnology in solar cells- Application of power in transportation. MEMS and NEMS-overview.	
Unit-4 - Nanofibre and Nanomaterials for Textile and Cosmetic Industries	9 Hour
Modern applications of Nanotechnology in textiles-Nanofibre production in Textiles- Electrospinning- Controlling morphologies of nanofibers- Nano-fillers embedded polypropylene fibers- Bionics- Swim-suits with shark-skin effect- Soil repellence- Lotus effect- Nano finishing in textile- Modern textiles Nano polymers in medical Textiles- Introduction to cosmetics-Polymers, nanocomposites, -Transdermal and bioactive nanocarriers-Nanoemulsion for cosmetic product-Polymeric nanocarriers for topical drug delivery in skin cream-Organic UV filter loaded nanocarriers with broad spectrum photoprotection-Emerging applications: water based nanoperfumes, sun care products, hair care-Toxic risk of nanocosmetics.-Biocompatibility	

Unit-5 - Nano biomedical applications	9 Hour
Introduction to biomedical applications- Bioreceptors and their properties- Biochips- Integrated nanosensor- DNA based biosensors- Natural nanocomposite systems- Nanomaterials in bone substitutes and Dentistry- Implants and Prosthesis- Tissue Engineering- Neuroscience- Neuro-electronic Interfaces- Nanorobotics- Photodynamic Therapy- Protein Engineering- Nanosensors in Diagnosis- Drug delivery- Cancer therapy- Other therapeutic applications. Nanobots – overview	

Learning Resources	<ol style="list-style-type: none"> 1. Fulekar, M. H., and Bhawana Pathak. <i>Environmental nanotechnology</i>. CRC Press, 2017. 2. Lynn J. Frewer, Wilhelm Norde, R. H. Fischer and W. H. Kampers, <i>Nanotechnology in the Agri-food sector</i>, Wiley-VCH Verlag, (2011). 3. Jennifer Kuzma and Peter VerHage, <i>Nanotechnology in agriculture and food production</i>, Woodrow Wilson International Center, (2006). 4. Axelos, Monique AV, and Marcel Van de Voorde, eds. <i>Nanotechnology in agriculture and food science</i>. John Wiley & Sons, 2017 5. P.J. Brown and K. Stevens, <i>Nanofibers and Nanotechnology in Textiles</i>, Woodhead Publishing Limited, Cambridge, (2007). 6. Nanda, Arun, Sanju Nanda, Tuan Anh Nguyen, Yassine Slimani, and Susai Rajendran, eds. <i>Nanocosmetics: fundamentals, applications and toxicity</i>. Micro and Nano Technologies, 2020. 7. Neelina. H, Malsch (Ed.), "Biomedical Nanotechnology", CRC Press 2005
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. VIJAYAN, CSIR-NPL, nvijayan@nplindia.org	1. Prof. S. Balakumar, University of Madras, balakumar@unom.ac.in	1. Dr. J. Archana, SRMIST
2. Dr. Krishna Surendra Muvvala, Saint Gobain Research India, India, Krishna.muvvala@saintgobain.com	2. Prof. V. Subramaniam, IIT Madras, vsbubu@iitm.ac.in	2. Dr. S. Harish, SRMIST

Course Code	21NTO302T	Course Name	SOLID STATE ELECTRONIC DEVICES	Course Category	0	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology		Data Book / Codes / Standards	Nil	

[illegible]

Unit-1 - Basics of Solid State Physics	9 Hour
Crystal structure in solids, Electronic band structure. Energy bands in solids, Band structure calculation, Elemental and compound semiconductors, Doping in semiconductors, Shallow and deep levels, Carrier statistics, Carrier transport, Carrier mobility, Scattering mechanisms, Non-equilibrium conditions, Quasi Fermi levels, Recombination processes, Current density, Continuity equations, Surface recombination, Surface states, Excitons in semiconductors, Carrier concentration, Hall effect, Hall resistivity, Hall resistivity dependence on magnetic field, Quantum Hall effect	
Unit-2 - Understanding of Diode Characteristics	9 Hour
Basic structure of p-n junction, Current transport in p-n junction diode, Zero applied bias: Electric field, Built-in potential, junction capacitance, Diffusion capacitance, Generation-recombination currents, Junction breakdown mechanisms, Zener diode, Unique features associated with Zener diode, Heterojunctions: Band alignments, Energy band diagrams of heterojunctions, Two dimensional electron gas, Metal-semiconductor contacts, Schottky barrier diode, Fermi level pinning, C-V characteristics of a Schottky diode, Current transport processes	
Unit-3 - Transistor Types and Operations	9 Hour
Transistor, Bipolar transistors, Theory of operation and action of PNP and NPN transistors, Description of majority and minority carrier distribution, Terminal currents in transistors, Transistor as amplifier, Transistors as switch, Application of transistor in switching, Open-circuited transistors-biasing in active region, Ways to bias a transistor, Schottky transistors, Operation of Schottky transistors, Optical transistors, Application of Optical transistors	

Unit-4 - Field Effect Transistors and Metal Oxide Semiconductor FET	9 Hour
Field Effect Transistors (FET), Working principle of FET, Junction FET, Theory of operation and current equation, Metal semiconductor FET (MESFET), Application of MESFET, Metal oxide semiconductor FET, (MOSFET): working principle, Application of MOSFET, VI Characteristics of MOSFET, Depletion and enhancement types - threshold voltage, Gate capacitance inversion and accumulation layers, Complementary MOSFET, High electron mobility transistor (HEMT), Ways to achieve HEMT, Charge coupled devices (CCD)	
Unit-5 - Semiconductive Devices Application	9 Hour
Light emitting diode (LED), Materials for LED, Multilayers heterojunctions for LED, Photodiodes-current and voltage in an illuminated junction, Photodetectors-noise, Bandwidth of photodetectors, Semiconductor lasers, Population inversion at a junction, Emission spectra for p-n junction lasers, Heterojunction lasers-materials for semiconductor lasers, Semiconductor laser applications, Solar cells, Relevance of semiconducting materials in solar cell application, Transistors as building block of memory devices, Solid state memory devices and comparison with magnetic memory devices	

Learning Resources	1. Solid State Electronic Devices, by Streetman and Ben Garland, Prentice Hall, 2000 2. Physics of Semiconductor Devices, by S. M. Sze and Kwok. K. Ng, John Wiley & Sons, Inc., 2007	3. Art of Electronics, by Horowitz and Hill, Cambridge University Press, 2nd ed., 1989 4. Fundamentals of Solid State Engineering, Manijeh Razeghi, Springer, 2019
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Hemant Dixit, GlobalFoundaries,USA, aplahemant@gmail.com	1. Dr. Debanjan Bhowmik, IIT Delhi, debanjan@ee.iitd.ac.in	1. Dr. Jaivardhan Sinha, SRMIST
2. Dr. Krishna Surendra Muvvala, Saint Gobain Research India, India, Krishna.muvvala@saintgobain.com	2. Dr. M. S. Ramachandra Rao, IIT Madras, msrrao@iitm.ac.in	2. Dr. S. Chandramohan, SRMIST

Course Code	21NTO303T	Course Name	MICRO AND NANOELECTRONICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Acquire knowledge on basic electronic components and physical effects at semiconductor junctions	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Learn construction of MOSFETs and its operation															
CLR-3:	Understand operation of various types of amplifiers															
CLR-4:	Realize IC and its passive components															
CLR-5:	Get acquainted with the future of micro and nanoelectronics															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply basic semiconductor physics for the working of semiconductor devices, Boolean algebra, operation of logic gates	3	-	-	2	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Analyze models of MOSFET and CMOS	2	-	-	2	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Apply CMOS designing and circuits	3	-	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Evaluate importance of interconnects and its usage	3	-	-	2	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Visualize futuristic nanomaterials and its usage in advanced electronic devices	2	-	-	3	-	-	-	-	-	-	-	-	-	3	-

Unit-1 - Electronic Materials and Components	9 Hour
Introduction to electronic materials and classification, Origin of energy band gap, Density of states, Fermi energy level, Types of semiconductors, Doping in semiconductors, Formation of p-n junction, Electrostatics of p-n junction transport and operation, Diode as circuit element, Large signal and small signal operation of diode, Applications of diodes: limiting circuits-voltage doubler-shifters and switches, Current-voltage characteristics and operation of bipolar junction transistors, Ebers-Moll representation of transistor for circuit element, AC operation of transistor, Large and small signal model, Amplifiers, Transistor connections in various modes, Number systems: Binary and octal numbering-Hexadecimal numbering-Conversions between number systems, Boolean algebra, Logic gates: Truth tables for AND, OR, NOT, NAND, NOR gates	
Unit-2 - MOSFET and CMOS	9 Hour
Introduction to MOSFET, N- and P-MOSFET, DC operation of MOSFET, Derivation of I-V characteristics, Modelling of MOSFET, Small signal model, AC operation of MOSFET, Enhancement and depletion modes, Threshold voltage, Introduction to Complementary Metal Oxide Semiconductor (CMOS), CMOS inverter and its operation	
Unit-3 - Types of Amplifiers	9 Hour
MOSFET amplifiers, Realization of current sources, Differential amplifier: general considerations-MOS differential pair-cascade diff. amp, Cascade stages and current mirrors, Operational amplifier: as an black box-Op-Amp based circuits-non-linear functions and non-idealities, Frequency response of MOSFET: concepts-high frequency models-low and high frequency response	
Unit-4 - IC, Passive Components and Interconnects	9 Hour
Introduction to Integrated circuits (ICs), Monolithic integration, Active and passive devices, Passive devices: resistor-capacitor-inductor, Interconnects, Interconnect Parameters: Capacitance-Resistance-Inductance, Electrical wire model: ideal wire-lumped model-lumped RC model, Transmission line response, Types of terminations	

Unit-5 - Futuristic Electronic Devices with Nanomaterials	9 Hour
Introduction to 1D CNT and 2D materials for electronic devices, Operation and Characteristics of 2D-Materials-Based FETs, Important Figures of Merit, Negative differential resistance-resonant diode-applications, Tunnel Field-Effect Transistors, Concept of Negative Capacitance and its devices, Introduction to spintronics and spin-based devices	

Learning Resources	<ol style="list-style-type: none"> 1. Behzad Razavi. <i>Microelectronics</i>, 2nd Ed, John Wiley & Sons, 2015 2. Jan M Rabaey; Anantha P Chandrakasan; Borivoje Nikolić. <i>Digital integrated circuits : a design perspective</i>, Pearson Education, 2003 3. Ke-Hong Chen. <i>Power management techniques for integrated circuit design</i>, Wiley, 2016 4. Majumder, Kumbhare, Japa, Kaushik, <i>Introduction to Microelectronics to Nanoelectronics</i>, Taylor & Francis and CRS Press, 2021 5. Muhammad Mustafa Hussain, <i>Advanced Nanoelectronics</i>, Wiley-VCH, 2019
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Pramod Rajanna, HHV Bangalore, pramod@hhv.in	1. Dr. Aditya Sadhanala, IISc Bangalore, sadhanala@iisc.ac.in	1. Dr. Abhay A. Sagade, SRMIST
2. Dr. Krishna Surendra Muvvala, Saint Gobain Research India, India, Krishna.muvvala@saintgobain.com	2. Dr. N. N. Murthy, IIT Tirupati, nnmurthy@iittp.ac.in	2. Dr. P. Malar, SRMIST

Course Code	21NTO304T	Course Name	ENVIRONMENTAL NANOTECHNOLOGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Acquire knowledge on Nanotechnology in environmental and health effects	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the effect of Nanomaterials for Environmental Protection															
CLR-3:	Describes the effect of nanomaterials in Environment															
CLR-4:	Explains the nanomaterials for Environmental remediation															
CLR-5:	Gain knowledge on different Sustainable Nanotechnologies															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Elucidate the effects to human health and the environment	3	-	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Analyze the Relationships between key properties of nanomaterials and environment protection	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Utilize the different nanomaterials for hazardous management	2	-	-	3	-	-	-	-	-	-	-	-	-	3	-
CO-4:	Approach the influence of the behaviour of nanomaterials in the environment remediation	2	-	-	-	-	-	3	-	-	-	-	-	-	2	-
CO-5:	Elucidate the use of nanoparticles and nanotechnology for environmental remediation and sustainability	-	-	2	-	-	-	3	-	-	-	-	-	-	-	2

Unit-1 - Nanotechnology in Environmental and Health Effects	9 Hour
Nanotechnology in environmental and health effects- Natural and artificial nanoparticles - Environmental pollutants in air- Environmental pollutants in water- Environmental pollutants in soil- Hazardous and toxic wastes- Challenges to occupational health- Challenges to occupational hygiene- Toxicity of nanoparticles- Effects of inhaled nanosized particles- Skin exposure to nanoparticles- Impact of CNTs on respiratory systems- Hazards of exposure to nanoparticles- Risks of exposure to nanoparticles- Diseases directly related to nanoparticles - Screening of nanomaterials for understanding potential effects to human health and the environment- Mapping of the environmental fate of nanomaterials- Relationships between key properties of nanomaterials and their environmental fate- Transport and transportation of nanomaterials- Bio-distribution and toxicity of nanomaterials – Effect of micro/nano plastics in human health.	
Unit-2 - Nanomaterials for Environmental Protection	9 Hour
Nanomaterials for Environmental Protection- Nano technology processes- Nano Engineering materials for Pollution Prevention- Green Chemistry- Energy efficient resources and materials- Nano technology products- Nanomaterials- Nanodevices and nanosystems- Synthesis of nanomaterials by Physico-chemical approaches-Bionanocomposites- Nano particles and Microorganisms- Microbial Synthesis of Nano materials- Biological Methods for Synthesis of nano-emulsions using bacteria- Fungi and Actinomycetes- Different plants based nanoparticle synthesis- Plants based nanoparticle synthesis- Nano composite biomaterials – Fibres- Devices and Structures- Nano Bio systems	
Unit-3 - Nanomaterials for Hazard Management	9 Hour
Identification and characterization of Hazardous waste- Nano Pollution- Air/Gas Contaminants- Water Contaminants- Soil Contaminants- Identification and Characterization of Organic and inorganics- Identification and Characterization of Organic and inorganics- Nanomaterials-Remediation- Nano Membranes- Nano Meshes- Nano Fibres- Nano Clays and Adsorbents, Zeolites, Nano Catalysts, Carbon NanoTubes,- Bio Polymers- Single Enzyme Nano particles- Bio Metallic Iron Nano Particles- Nano Semi-Conductors- Photo catalysis- Nano-sensors	

Unit-4 - Environmental Nano Remediation	9 Hour
Environmental Nano Remediation Technology- Thermal methods- Physical methods- Chemical methods- Biological Methods- Nano Filtration methods for treatment of waste water- removal of organics & inorganics and pathogens- removal of inorganics- removal of pathogens- Nanotechnology for water remediation and purification- Treatment of hi-tech industrial waste waters using nano particles/ modified structures/devices- Treatment of hi-tech industrial wastewaters using modified structures- Treatment of hi-tech industrial wastewaters using dyes-Groundwater remediation- Surface water treatment-Titanium dioxide- Challenges- Environmental Benefits of nanomaterials- Oleophilic nano materials for problem due to oil spills, nano materials for dye degradation in fresh waters.	
Unit-5 - Sustainable Nanotechnology	9 Hour
Sustainable Nanotechnology- Application of industrial ecology to nanotechnology- Fate of nanomaterials in environment- environmental life cycle of nano materials- environmental impacts of nano materials- health impacts of nano materials- toxicological threats- eco-toxicology- exposure to nano particles – biological damage- threat posed by nano materials to humans- environmental reconnaissance and surveillance- Corporate social responsibility for Nanotechnology- Combining Life Cycle and Risk Assessment- Proposed Solutions to prevent toxicology- Safety measurements- Education and understanding of sustainable nanotechnology- Applications of nanotechnology for sustainability- Nano materials in future – implications, roles and responsibilities for nanotechnologists for safer implementation of nanotechnology.	

Learning Resources	1. Nanotechnology: Health and Environmental risk by Jo Anne Shatkin. CRC press, 2017. 2. Nanotechnologies, Hazards and Resource efficiency by M. Steinfeldt, Avon Gleich, U. Petschow, R. Haum. Springer, 2007.	3. Environanotechnology by Mao Hong fan, Chin-pao Huang, Alan E Bland, Z Honglin Wang, RachidSliman, Ian Wright. Elsevier, 2010. 4. Nanostructured conductive polymers. Edited by Ali Eftekhari. Wiley, 2010.
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. VIJAYAN, CSIR-NPL, nvijayan@nplindia.org	1. Prof. S. Balakumar, University of Madras, balakumar@unom.ac.in	1. Dr. M.Navaneethan, SRMIST
2. Dr. Krishna SurendraMuvvala, Saint Gobain Research India, India, Krishna.muvvala@saintgobain.com	2. Prof. V. Subramaniam, IIT Madras, manianvs@iitm.ac.in	2. Dr. E. Senthil Kumar, SRMIST

Course Code	21NTO305T	Course Name	MEDICAL NANOTECHNOLOGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understanding the basics of medicine	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Know the various classification of nanomedicine															
CLR-3:	Getting knowledge about interaction of nanomaterials with biological environment															
CLR-4:	Gain a broad understanding about nanosystems for the diagnosis and therapy															
CLR-5:	Get acquainted with future aspects of nanosurgery															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	To distinguish the advantages between conventional and nanomedicine	3	-	-	2	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Analyze the concepts of medical nanotechnology	3	-	-	2	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Apply concepts of nanomedicine to a focused clinical area of their choice	3	-	2	-	-	-	-	-	-	-	-	-	-	3	-
CO-4:	Apply the nanosystems for diagnosis and therapy	3	-	3	-	-	-	-	-	-	-	-	-	-	2	-
CO-5:	Apply the concepts of nanosurgery	3	-	2	-	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Nanotechnology in Medicine	9 Hour
Conventional medicine-- Prospect of nanomedicine- Current Medical Practice- Challenges in Current Medical Practice- Evolution of Scientific Medicine- Drawinian medicine- Volitional Normative Model of Disease- Disease Nominalism, Disease Relativism- Treatment Methodology- Conventional methods- Evolution of Bedside Practice- Benefits of Bedside Practice- Molecular Nanotechnology- Introduction and Basic principles- Pathways to Molecular Manufacturing- Molecular Transport- Molecular Sortation- Types of Molecular Sortation	
Unit-2 - Nano sensors for Monitoring	9 Hour
Nanosensors & nanoscale scanning- Nanosensor Technology- Chemical Nanosensor- Molecular Nanosensor- Displacement Sensor- Motion Sensors- Force Nanosensor- Thermal Nanosensor- Electric and Magnetic Sensing- Cellular Bio scanning –Macrosensing- Intergated nanosensor technologies- Genomics- Methods in Genomics- Proteomics- Methods in Proteomics- Real-time monitoring- in vivo medical monitoring, molecular nanobots for medicinal applications	
Unit-3 - Nanoparticles for Imaging and Drug Delivery	9 Hour
Nanoparticles for imaging & drug delivery- Types of Nanoparticles for drug delivery- Nanoparticles for medical imaging- Enhancement for X-ray- MRI imaging- IR imaging- Visible imaging- UV imaging- Nanoparticles for targeted imaging- Targeting moieties- Nanoparticles for delivery of energy- Types of nanoparticles for delivery of energy- Nanoparticles for delivery of drugs- Types of nanoparticles for delivery of drugs- Materials for drug delivery- Fabrication for drug delivery- Nanocapsulation for drug delivery- Application of Nanocapsulation for drug delivery – target specification and controlled drug delivery.	

Unit-4 - Nanotechnology in Diagnosis and Therapeutics		9 Hour
Nanodiagnostics- Nanosensors for Diagnosis- Nanoarrays for Molecular Diagnostics- Types of Nanoarrays- Nanoparticles for Molecular Diagnostics- Gold Nanoparticles- Magnetic Nanoparticles- Quantum Dots for Molecular Diagnostics- DNA Nanomachines- DNA Nanomachines for Molecular Diagnostics- Nanobarcodes Technology- Commercially available Nanobarcodes- Cantilevers as Biosensors for Molecular Diagnostics- Types of Cantilevers as Biosensors for Molecular Diagnostics- Nanodiagnostics for the Battle Field- Uses of Nanodiagnostics for the Battle Field- Nanodiagnostics for Integrating Diagnostics with Therapeutics.- Advantages of Integrating Diagnostics with Therapeutics. Nano coating sensors for diagnosis of diabetes		
Unit-5 - Nanodevices for Clinical Nano Diagnostics		9 Hour
Nanodevices for Clinical Nanodiagnostics- Types of Nanodevices for diagnosis- Nanoendoscopy- Uses and advantage of nanoendoscopy- Nanobiotechnology and Drug Delivery Devices- Types of Nanodevices for drug delivery- Tools for Nanosurgery- Nanoscale Laser Surgery- Nanorobotics for Surgery- Nanotechnology for Detection of Cancer- QDs for Sensing Cancer Cell Apoptosis- Dendrimers for Sensing Cancer Cell Apoptosis- Gold Nanoparticles for Cancer Diagnosis- Nanotubes for Detection of Cancer Proteins- Nanoparticles for the Optical Imaging of Tumours- Nanolaser Spectroscopy for Detection of Cancer in Single Cells- Nanoparticles-MRI for Tracking Dendritic Cells in Cancer Therapy- Advantages of Nanoparticle tracking		
Learning Resources	1. Robert .A. Freital.Jr, "Nanomedicine"- Landes Bioscience Press2010.	4. Mahendra Rai, Mrunali Patel, "Nanotechnology in Medicine: Toxicity and Safety"Wiley-Blackwell,October 2021
	2. Harry F.Tibbals, "Medical nanotechnology & Nanomedicin' - CRCpress, 2011. 3. Jain.K.K, "Handbook of Nanomedicine"- Springer, 2012.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. K. Chandru Trivitron Healthcare Pvt. Ltd. Chennai, chandru.k@trivitron.com	1. Dr. Amit Kumar Mishra , IIT Jodhpur, amit@iitj.ac.in	1. Dr. Devanandh venkata subhu, SRMIST
2. Dr.Nagesh Kini,Thermax,Pune,Maharastra,nagesh.kini@gmail.com	2. Dr. Sampath Kumar T.S,IIT Madras, tssk@iitm.ac.in	2. Dr. K. Janani Sivasankar, SRMIST

Course Code	21NTO306T	Course Name	NANOSCALE SURFACE ENGINEERING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Obtain vast knowledge on Surface and Interfaces and its structure	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the process involved in surface and Interfaces															
CLR-3:	Understand the Diffusion process involved in surface and related laws															
CLR-4:	Describe the laws related to surface phenomena															
CLR-5:	Gain knowledge on Surface Analysis Techniques															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the concept of Surface crystallography to understand the surface structure	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Able to analyze surface related process and its measurements	3	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-3:	Apply the concept of Fick's law to have clear a understanding on surface diffusion process	-	-	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Analyze the different mechanisms involved in surface diffusion and Kinetics	-	-	-	3	-	-	-	-	-	-	-	-	2	-	-
CO-5:	Utilize the Photoelectron spectroscopic and Secondary electron techniques to understand the properties of Surface	-	-	-	2	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to Surfaces and Interfaces	9 Hour
Surfaces and interfaces in materials surface energy, surface tension and surface states- Some basic concepts of bulk crystallography: Direct lattices and directions- Symmetry groups and planes- Structure of the unit cell, Primitive cell in bulk crystals- Concept of ideal crystal Surface structure and surface order- surface crystallography- Surface Crystallography of a plane- And its point and space group symmetry-Unit mesh transformation approach- Wood notation description- Unit mesh transformation approach- Matrix notation and classification of overlayer meshes- Electronic structure (for three dimension)- Density of States (Surface states)- Surface states structure (for two dimension)- Surface electronic structure (for two dimension)	
Unit-2 - Surface Adsorption and Desorption	9 Hour
Adsorption and desorption: Definition & Concept- Various types of adsorptions and desorption- Basics of adsorption kinetics- Concept of coverage dependence- Coverage dependence derivation- Langmuir Isotherm- Temperature dependence Kinetics- Temperature dependence derivation- Angular dependence Kinetics- Kinetic energy dependence Kinetics- Thermal deposition- Theory of Desorption kinetics- Thermal desorption spectroscopy: Basic working Principle- Thermal desorption spectroscopy: Instrumentation- Adsorption Isotherms: A detailed study- Various types of Adsorption Isotherms- Non-Thermal desorption- Types of Non-Thermal desorption	
Unit-3 - Surface Diffusion	9 Hour
Concept of Random-walk motion- Basic equations -random-walk motion- Fick's laws: Definition and its explanation- Tracer diffusion- Chemical, diffusion- Intrinsic diffusion- Mass transfer diffusion- Anisotropy of surface diffusion- Atomistic mechanisms of surface diffusion and its types- Atomistic mechanisms of surface diffusion: hopping mechanism- Atomistic mechanisms of surface diffusion: Vacancy mechanism- Atomistic mechanisms of surface diffusion: Atomic exchange mechanism- Atomistic mechanisms of surface diffusion: Tunneling mechanism- Nucleation and Equilibration via Surface Diffusion- Experimental study of surface diffusion	

Unit-4 - Surface Characterization Tools		9 Hour
Surface specificity- Spectrum of secondary electrons- Photoelectron spectroscopy – Physical process: photoemission, spectral feature- Photoelectron spectroscopy -depth specificity- Photoelectron spectroscopy (XPS and UPS) - compositional information- Photoelectron spectroscopy (XPS and UPS) - elemental sensitivity- Photoelectron spectroscopy (XPS and UPS) - chemical-state information- Photoelectron spectroscopy (XPS and UPS) -spectral resolution and depth profiling- Photoelectron spectroscopy (XPS and UPS) -Modular instrumentation: excitation sources- Energy analyzers and detectors- Auger Electron spectroscopy (AES): physical process: photoemission- Ion Scattering Spectroscopy (ISS): physical process: photoemission- Spectral feature and depth Specificity- AES and ISS: compositional information- AES and ISS: elemental sensitivity- AES and ISS: chemical-state information & spectral resolution and depth profiling- AES and ISS: excitation sources- AES and ISS: energy analyzers and detectors		
Unit-5 - Nanoscale Studies of Surfaces and Interfaces		9 Hour
Nanoscale Characterization for Surfaces- Scanning tunneling microscopy (STM) – historical perspective and theory- STM: electron tunnelling- STM imaging- Scanning tunneling spectroscopy- STM: Instrumentation- Semiconductor surfaces- Semiconductor surfaces: Si (111)- Semiconductor surfaces: Si (100)- Semiconductor surfaces: GaAs (110)- Photo induced process- Different types involved in Photo induced process- Metal – semiconductor surfaces- Analysis of Metal – semiconductor - Analysis of Alkali – metal – semiconductor interfaces properties Growth of trivalent metals on Si (001) and its surface interface studies		
Learning Resources	1. John DiNardo N., "Nanoscale Characterization Of Surface And Interfaces", Wiley-VCH, 2008	
	2. Oura K., V. G. Lifshits, A. A. Saranin, A. V. Zotov and M. Katayama, "Surface Science – An Introduction" Springer, 2013.	
	3. Unertl W.N., "Physical structure" Elsevier Science B. V, 2006	
	4. Riviere J.C and Myhra S., "Handbook of Surface and Interface analysis", CRC Press, 2009	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Solomon Jonnes,Bengaluru,solomon@terracarb.com	1. Dr.Amit Kumar Mishra , IIT Jodhpur, amit@iitj.ac.in	1. Dr. V. Kathirvel, SRMIST
2. Dr.Nagesh Kini,Thermax,Pune,Maharastra,nagesh.kini@gmail.com	2. Dr.Sampath Kumar T.S, IIT Madras, tssk@iitm.ac.in	2. Dr. A. Alagirisamy SRMIST

Course Code	21NT0307T	Course Name	NANOCOMPUTING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Acquire knowledge on nanoelectronics and its importance	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Introduce the concept of molecular computing															
CLR-3:	Understand about biocomputers and related nanomachines															
CLR-4:	Learn basics and advancements of quantum computing and quantum dot cellular automata															
CLR-5:	Understand the architecture of processing in nanosystems, Gain knowledge on processing															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Acquire basics of nanocomputing and nanoelectronic devices	3	-	-	3	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Explain major advances in molecular computing	2	-	-	2	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Recognize the evolution and advancements of biocomputers	3	-	-	2	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Express the principles and development of quantum computers	2	-	-	2	-	-	-	-	-	-	-	-	3	-	-
CO-5:	Realize the importance of quantum dot cellular automata	2	-	2	-	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Basics of Nanocomputing and Nanoelectronics	9 Hour
History of computing- Nanocomputing- Transistors inside the Machine- Quantum computers- Nanocomputing technologies- From Microelectronics to Nanoelectronics- From Nanoelectronics to Nanoelectronics computers- Alternative to Transistor technology –quantum computing-Nano information processing – Prospects and challenges- Digital signals and gates- Silicon nanoelectronics-short channel effects- Leakage current in scaled devices-process variation- Carbon nanotube electronics- Band structure of carbon nanotubes- Carbon Nanotube properties- Carbon nanotube field effect transistors-	
Unit-2 - Molecular Computing	9 Hour
Molecular computing- Brief background of molecular electronics- Origin of molecular computing- Molecular computing architecture- Some techniques of molecular computing-Adleman's landmark experiment- DNA computation in ciliates-Bacteriorhodopsin- Challenges of molecular computing-Reliability, Efficiency and Scalability- Encoding problem-Error-preventing codes- Building and programming molecular computers-	
Unit-3 - Biocomputers Evolution and Developments	9 Hour
Biological networks and neurons- Function of neuronal cell- Biology-inspired concepts- Biological Neuronal cells on silicon- Modeling of neuron cells by VLSI circuits- Neuronal networks with local adaptation- Distributed data processing- Biocomputers – biochemical computers- Biomechanical computers- Bioelectronic computers- Engineering biocomputers- DNA computer- Information processing with chemical reactions- Peptide computing- Development of a peptide computer	
Unit-4 - Quantum Computing and Quantum Dot Automata	9 Hour
Quantum computers-Bit and Qubit- Coherence and entanglement- Quantum parallelisms- Classical gates- Reversible operations- Beyond Classical Gates-Superposition- Sqrt(NOT) operation- Quantum algorithms- Necessity of quantum software in Conjunction with the hardware- Searching by using Sqrt(NOT)- Hardware challenges to large Quantum Computers- Ion traps-Solids Quantum dot cellular automata- Computing with QCA- QCA clocking- QCA design rules	

Unit-5 - Architectures of Processing in Nanosystems		9 Hour
Parallel Architectures for Nanosystems-Architectural principles- Mono and multiprocessor systems- Some considerations to parallel processing- Influence of delay time- Power dissipation and Parallelism- Architecture for processing in nanosystems-Classic systolic arrays- Processor with large memories- Processor array with SIMD and PIP architectures- Reconfigurable computers- Teramac concept as a prototype-		
Learning Resources	1. Vishal Sahni and Debabrata Goswami, "Nanocomputing: The Future of Computing", Tata McGraw-Hill Education, 2008	2. Karl Goser, Peter Glösekötter and Jan Dienstuhl, "Nanoelectronics and Nanosystems: From Transistors to Molecular and Quantum devices", Springer, 2005

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Hemant Dixit, Global Foundaries, USA, aplahemant@gmail.com	1. Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in	1. Dr. V. J. Surya, SRMIST
2. Dr. Krishna Surendra Muvvala, Saint Gobain Research India, India, Krishna.muvvala@saintgobain.com	2. Dr. G. P. Das, IIT Kharagpur gpdas@metal.iitkgp.ac.in	2. Dr. Saurabh Ghosh, SRMIST

Course Code	21NTO308T	Course Name	SMART SENSOR SYSTEMS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1: Acquire knowledge on various sensor systems		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2: Understand different conversion phenomena involved in sensors																
CLR-3: Describe construction and function of different sensors																
CLR-4: Gain knowledge on the material requirement for different sensing mechanisms																
CLR-5: Gain knowledge on individual sensing devices and integration of technologies																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1: Explain basic concepts, principals and means of detection in smart sensing.		3	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2: Apply acoustic, magnetic, Force, Strain, and Tactile and pressure sensors		3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-3: Explain the detection concepts and devices for light, radiation, thermal and chemical sensing		3	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-4: Apply suitable techniques for biosensing and microsystem engineering and integration		3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-5: Explain Microsystem fabrication techniques and prospectus of Nanotechnology, future trends		3	2	-	-	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Introduction to Sensor Systems	9 Hour
Definitions of Sensors and Smart Sensors, Integrated Smart Sensors and Applications, Sensors classifications, Detection means used in sensors and conversion phenomena, Measurements, Units of Measurements, Sensor Characteristics: Transfer Function, Calibration, Static Characteristics, Accuracy, Calibration Error, Hysteresis, Nonlinearity, Resolution, Dynamic Characteristics, Physical principles of sensing: electric charges, Electric fields, and potentials, Capacitance, dielectric constant, Magnetic Principle, Induction Principle, Electrical Resistance, Piezoelectric effect, Pyroelectric effect, Hall effect Principle, Seebeck and Peltier effects	
Unit-2 - Conversion Phenomena in Sensors	9 Hour
Acoustic waves: Fundamentals, Piezoelectric materials for acoustic sensors, Solid state SAW sensors, Applications of SAW sensors, Acoustic Sensors: Resistive Microphones, Condenser Microphones, Piezoelectric Microphones, Magnetic Effects and materials, Magnetic sensors, Integrated Hall sensors, Magneto transistors, Strain Gauges, Tactile Sensors, Piezoelectric Force Sensors, Piezoresistive Pressure Sensors, Capacitive Pressure Sensor	
Unit-3 - Functional Sensors	9 Hour
Light Detectors, Photodiodes, Photoresistors, HgCdTe infrared sensors, Visible-light color sensors, high-energy photodiodes, Radiation Detectors: Scintillating Detectors, Semiconductor Radiation Detectors, Thermal Sensors: Functional Principle, Heat Transfer Mechanisms, Temperature Sensors, Thermo resistive Sensors, Thermoelectric Contact Sensors, Thermocouple Assemblies, Semiconductor PN-Junction thermal Sensors, Optical Temperature Sensors, Chemical sensors: Classes of Chemical Sensors, Interaction of gaseous species at semiconductor Surfaces, Catalysis, the acceleration of chemical reactions, Thin-film sensors (Chemoresistive sensors), Field Effect Transistor for Gas sensing, FET devices ion sensing	

Unit-4 - Biosensing, Microsystem Engineering and Integration	9 Hour
Biosensors definition, Bioreceptors, Construction of different biosensors, Immobilization of biological elements, Transduction principles used in biosensing, Lab-on-chip/Microsystems/MicroTAS, Microfluidics, Microfluidic unit operations, Microsystem Integration, System organization and functions, Interface electronics, Fundamentals of interfacing, Signal Conditioning, Universal transducer interface-Three-Signal Technique, Introduction to microsystems engineering, Micro technologies, Systems development: methods and tools, Constructive and connective techniques	
Unit-5 - Micro Fabrication Tools and Prospects of Nanotechnology	9 Hour
Fundamentals of MEMS-Fabrication: Frequently Used Microfabrication Processes, Lithography, thin film deposition, Oxidation, Etching (wet and dry), MEMS fabrication technologies: Bulk micromachining and structures, Surface micromachining and structures, High-aspect-ratio technology, LIGA (Lithographie, Galvanoformung, Abformung), Microsystem components, Application of different Microsystem, components, Integration of Micromachining and Microelectronics, Semiconductor Packaging Applied to Sensors, Nanotechnology: product prospects - applications Future trends	

Learning Resources	1. Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs, and Applications", Springer; 4th ed. 2010 2. S. M. Sze, "Semiconductor Sensors", Wiley-Interscience, 1994 3. Gerard Meijer, "Smart sensor systems", Wiley, 2008	4. Gerard Meijer, Kofi Makinwa, Michiel Pertijs Smart Sensor Systems: Emerging Technologies and Applications 1st Edition, Wiley, 2014 5. Randy Frank, Understanding Smart Sensors, 3rd Edition, 2013 Artech House
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. VIJAYAN, CSIR-NPL, nvijayan@nplindia.org	1. Prof. S. Balakumar, University of Madras, balakumar@unom.ac.in	1. Dr. A. Karthigeyan, SRMIST
2. Dr. Krishna Surendra Muvvala, Saint Gobain Research India, India, Krishna.muvvala@saintgobain.com	2. Prof. V. Subramaniam, IIT Madras, manianvs@iitm.ac.in	2. Dr. M.Kiran, SRMIST

Course Code	21NTO309T	Course Name	2D MATERIALS AND APPLICATIONS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	Acquire knowledge on graphene and its unique combination of physical properties												
CLR-2:	Gain the knowledge on atomically thin semiconducting Nanosheets and their layer dependent physical properties												
CLR-3:	Understand top-down and bottom-up production techniques for the synthesis of 2D materials												
CLR-4:	Understand the 2D materials physical properties using microscopy and spectroscopy techniques												
CLR-5:	Gain knowledge on applications 2D materials in biomedical and engineering applications												
Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	Understand the scientific knowledge on producing graphene												
CO-2:	Analyze different types of 2D layered nanomaterials in comparison with their bulk counterparts												
CO-3:	Extract optimized space parameters for the preparation of 2D materials												
CO-4:	Utilize microscopic and spectroscopic concepts to understand the properties of materials												
CO-5:	Know the usage of the 2D materials for Optoelectronics and Biomedical applications												

Program Outcomes (PO)												Program Specific outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3

Unit-1 - Various Forms of Carbon and Properties of Graphene	9 Hour
Hybridization of Carbon, its allotropes and binding energy - Band structure of Graphene - Brillouin Zone - Electronic properties of graphene and carrier density - Klein Tunneling - High Mobility of graphene - Minimum Conductivity and Universal Optical Conductivity of graphene – Magnetic field effect on graphene - Homogeneous Magnetic Field – Landau Levels in Bilayer Graphene - Anomalous Quantum Hall Effect - Mechanical properties, Lattice Deformation and Elastic strain.	
Unit-2 – 2D layered Nanomaterials and Devices	9 Hour
Graphite intercalated compounds – Graphene/graphite Oxide - Graphene composites -Transition metal dichalcogenides (TMD), Crystal structures and allotropes – Brillouin Zone - Electronic and optical properties - Traps and defects - Mechanical properties - Strain effect on band gap – Layer dependant physical properties and spin-orbit coupling –Density Functional theory calculations- other Monoelemental Nanosheets -2D Topological Insulators – Black phosphorus Nanosheets and its physical - 2D Crystals Based Heterostructures - Transistors Based on 2D Heterostructures	
Unit-3 – 2D Materials Preparation Methods and Characterization Tools	9 Hour
Top down and bottom up methods and working principles– Chemical Vapor Deposition - Pulsed Laser Deposition - Epitaxial growth - Physical Vapour deposition – Micro-mechanical Exfoliation - Liquid phase exfoliation - Electrochemical exfoliation - Ball Milling - Basic Characterization of 2D materials - UV-Vis absorption Spectroscopy - Raman spectroscopy – Electron interaction with matter and electron microscopy techniques for 2D materials quality and composition– Principles of Atomic force microscopy and contact and non-contact modes	
Unit-4 - Applications of 2D Materials	9 Hour
Applications of 2D materials - Biomedical applications of graphene oxide – Graphene networks for Drug delivery, bioimaging and biosensing - Photothermal therapy - anti-bacterial applications – Biocompatibility - Scaffolds for tissue engineering - Cancer therapy– Photocatalysts - Graphene oxide for Dye degradation - Pollutant adsorption - Hydrogen production form water splitting - TMDs based 2D materials for Electrocatalysis and electrochemical sensing - Hydrogen evolution reaction and oxygen evolution reaction photo-catalysts.	

Unit-5 - Graphene Based Electronic and Optoelectronic Device	9 Hour
Graphene based Radio Frequency transistors for Flexible electronics - 2D TMD based Photodetectors – Phototransistors - Hybrid Phototransistors- Heterostructure Photodetectors - 2D TMD based Light Emitters - Hot Carrier EL - Light-Emitting Diodes Circularly Polarized Light Emission - 2D TMD-Based Photovoltaics applications - Graphene membranes for water purification and separation – 2D Membranes as barrier materials - Supercapacitor electrodes - 2D Black phosphorus based FET for Sensors.	

Learning Resources	<ol style="list-style-type: none"> 1. Banks, Craig E., and Dale AC Brownson, eds. "2D Materials: Characterization, Production and Applications"- CRC Press, 2018. 2. Houssa, Michel, Athanasios Dimoulas, and Alessandro Molle, "2D Materials for Nanoelectronics"- CRC Press, 2016. 3. Tiwari, Ashutosh, and Mikael Syväjärvi, eds. "Advanced 2D Materials"- John Wiley & Sons, 2016. 4. Dragoman, Mircea, and Daniela Dragoman, "2D Nanoelectronics: Physics and Devices of Atomically Thin Materials"- Springer, 2016.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Hemant Dixit, GlobalFoundaries,USA, aplahemant@gmail.com	1. Dr. Ramaprabhu, IIT Madras, ramp@iitm.ac.in	1. Dr. Eswaraiah Varrla, SRM IST
2. Dr. Krishna Surendra Muvvala, Saint Gobain Research India, India, Krishna.muvvala@saintgobain.com	2. Dr. M. S. Ramachandra Rao, IIT Madras, msrrao@iitm.ac.in	2. Dr. Archana, SRMIST

Course Code	21NTO310T	Course Name	NANO AND MICROELETROMECHANICAL SYSTEMS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Acquire knowledge on MEMS and NEMS fundamentals	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand different principles involved in MEMS devices															
CLR-3:	Describe construction and function of MEMS actuators															
CLR-4:	Gain knowledge on the material requirement for different actuation mechanisms															
CLR-5:	Gain knowledge on individual sensing and Micromechanical components and their integration															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the principles of sensing and actuation to design NEMS and MEMS devices	3	-	-	2	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Analyze the suitability of a actuation mechanism for a particular application	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Utilize the suitable material properties to design a MEMS structure	2	-	-	3	-	-	-	-	-	-	-	-	3	-	-
CO-4:	Apply a suitable microsystem technology to create different nano and micro mechanical structure	2	-	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Design high aspect ratio structure and integration with microsystem technologies	3	-	-	3	-	-	-	-	-	-	-	-	2	-	-

Unit-1 - Fundamentals of MEMS and NEMS	9 Hour
Micro- and nanoelectromechanical systems-MEMS and NEMS: An overview - Nanoelectromechanical Systems – Current Development and Needs - Scaling Laws – Modeling - The input-output concept - Sensors and Actuators - Energy Domains and Transducers – Mechanical MEMS - Thermal MEMS - Micro-Opto-Electro-Mechanical Systems - (MOEMS) - Magnetic MEMS, Radio-Frequency MEMS - Microfluidic systems - Bio-Chemo devices – Biomimetics Fundamentals – Biomimetics for NEMS and MEMS - MEMS Architectures - NEMS Architectures	
Unit-2 - Construction of MEMS Devices, Integration of MEMS	9 Hour
Photolithography – Types and Applications - Structural and sacrificial materials - Thin film deposition - Physical Vapor Deposition, Chemical Vapor Deposition techniques – Oxidation - Doping - Etching (Wet and Dry) – Metallization - Bulk micromachining - Surface micromachining – High Aspect Ratio (LIGA and LIGA like) technology - MEMS Integration - Packaging considerations - Basic Modelling elements: Mechanical - Basic Modelling elements: Electrical systems - Basic Modelling elements: Fluid systems - Basic Modelling elements: Thermal systems - Translational pure mechanical systems - Rotational pure mechanical systems.	
Unit-3 - Various MEMS Devices	9 Hour
Sensors and Actuators – Basic Principles - Components: Beam - Cantilever, microplates - Capacitive effects - Piezo elements - Strain Measurements - Pressure and flow measurements - MEMS Gyroscopes - Shear model piezo actuators - Gripping piezo actuators - Strain Measurement - Thermal sensors and actuators - Thermal basics – Thermocouples – Thermoresistors - Actuators based on thermal expansion - Applications of thermal actuators	
Unit-4 - Magnetic Materials in MEMS	9 Hour
Magnetic materials used in MEMS - Magnetic Properties used in MEMS - Magnetic sensing and detection - Magneto resistive sensor - Hall Effect based sensors – Magnetodiodes – Magnetotransistor - Magnetic actuation Principles - Essential magnetic actuation concepts - Magnetic MEMS actuators - Bidirectional Microactuators - RF based communication systems - RF MEMS - MEMS inductor - MEMS Varactors - MEMS Tuner/filter - MEMS Resonators - MEMS Switches - MEMS Phase shifter	

Unit-5 - Principles and Applications of Micro Optic Electro Mechanical Systems	9 Hour
Principles of MOEMS technology - Applications of MOEMS - Properties of Light - Light modulators - Beam splitters - Micro lens - Micro mirror - Digital micromirror device - Optical switch, Wave guide and tuning - Properties of fluid - Fluid actuation methods – Dielectrophoretic - Electrothermal flow - thermo capillary effect - Micropumps: design consideration - Lab-on-chip - IC technology - MEMS Fabrication versus IC fabrication – Integrating IC and MEMS - Prospects	

Learning Resources	1. Mahalik N P, "MEMS", Tata McGraw-Hill Education, 2008 2. Sergey Edward Lyshevski, "Micro-Electro Mechanical and Nano-Electro Mechanical Systems, Fundamental of Nano-and Micro-Engineering", Second Edition, CRC Press, 2005 3. Chang Liu "Foundation of MEMS", Prentice Hall, 2012
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. VIJAYAN, CSIR-NPL, nvijayan@nplindia.org	1. Prof. S. Balakumar, University of Madras, balakumar@unom.ac.in	1. Dr. R. AJAY RAKKESH, SRMIST
2. Dr. Krishna SurendraMuvvala, Saint Gobain Research India, India, Krishna.muvvala@saintgobain.com	2. Dr. M. S. Ramachandra Rao, IIT Madras, msrrao@iitm.ac.in	2. Dr. M. Kiran, SRMIST

Course Code	21NTO401T	Course Name	SCIENTIFIC RESEARCH PRINCIPLES	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Familiarize with the concept of research ethics	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the concept of academic plagiarism															
CLR-3:	Understand the concept of Good, Bad science and pseudoscience															
CLR-4:	Gain knowledge on research methodology															
CLR-5:	Learn the process of scientific writing															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the scientific concepts of ethics and plagiarism	1	-	-	-	-	-	-	3	-	-	-	-	-	-	-
CO-2:	Acquire the knowledge of global and national research ethics	-	-	2	-	-	-	-	3	-	-	-	-	2	-	-
CO-3:	Ability to appreciate the importance of honesty and integrity in academic life	-	2	-	-	-	-	-	3	-	-	-	-	-	-	-
CO-4:	Apply scientific research methodology for real life problems	-	-	3	-	-	-	-	3	-	-	-	-	2	-	-
CO-5:	Utilize the method of scientific writing	-	-	3	-	-	-	-	3	-	-	-	-	-	-	2

Unit-1 - Ethics of Science, Concept and Examples	9 Hour
Principles of MOEMS technology - Applications of MOEMS - Properties of Light - Light modulators - Beam splitters - Micro lens - Micro mirror - Digital micromirror device - Optical switch, Wave guide and tuning - Properties of fluid - Fluid actuation methods – Dielectrophoretic - Electrothermal flow - thermo capillary effect - Micropumps: design consideration - Lab-on-chip - IC technology - MEMS Fabrication versus IC fabrication – Integrating IC and MEMS - Prospects	
Unit-2 - Scientific Misconduct, Plagiarism and Examples	9 Hour
Research and ethics, Scientific misconduct and its consequences, Forms of misconduct, Lancet MMR autism fraud case, Cheating, Plagiarism, Recognizing plagiarism, Self-plagiarism, Reverse plagiarism, Ghost writing and detection, Honor code system, academic dishonesty, Prejudice, Intuition, Observation bias, Self-misunderstanding, Egoism, Some plagiarism cases in India, Consequence of Plagiarism	
Unit-3 - Good, Bad and Pseudo-Science	9 Hour
Good science vs. Bad science, Pseudoscience, Ways of identification, Curiosity and research, Empiricism, Rationalism, Intuition, Literature review, Elementary scientific methods, Observations and observational bias, Problem identification, Basic assumptions, Hypothesis, Formulation of an hypothesis, Hypothesis driven research design, Verification of Hypothesis, Identification of experimental techniques, Implementation of the experimental techniques	
Unit-4 - Research Design	9 Hour
Research design, Design of the apparatus, Design issues and remedies, Experimentation – sampling, Experimentation –measurements, Replication of the data, Data analysis, Error identification, Error in measurement, Classification of errors, Errors analysis, Interpretation of the data, Test of the hypothesis, Mathematical modelling, Numerical computation, Result presentation	

Unit-5 - Scientific Writing	9 Hour
Scientific Writing, Authenticity, accuracy, Originality of the work, Title preparation, List of authors and addresses, Abstract writing, introduction writing, Description of methods, Description of methodology, Measurements, Description and types of measurements, Analysis of results, Explanation of results, Result and analysis, Discussion and acknowledgement, Conflict of interest declaration, References, paper/poster presentation, Electronic publication	

Learning Resources	<ol style="list-style-type: none"> 1. National academy of Science, National academy of Engineering, and Institute of Medicine, "On being a scientist: A guide to responsible conduct in research", Third edition, The National Academics Press, 2009 2. Adam Briggie and Carl Mitcham, "Ethics and science: An Introduction", Cambridge University Press, 2012 3. David B. Resnik, "The ethics of science: An introduction", Routledge Publication, 1998 4. John G D'Angelo, "Ethics in Science: Ethical Misconduct in Scientific Research", Second Edition, CRC Press, Taylor & Francis Group, 2018
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Narayanasvamy Vijayan, National Physical Laboratory, nvijayan@nplindia.org	1. Prof. V. Subramaniam, IITM, Chennai, manianvs@iitm.ac.in	1. Dr. Sandeep Kumar Lakhera
2. Dr.A. Pandikumar, Scientist, CSIR-CERL, pandikumar@cecni.res.in	2. Prof. D. Arivuoli, Anna University, arivuoli@annauniv.edu	2. Dr. A. Karthigeyan, SRMIST

Course Code	21NTO402T	Course Name	MICRO AND NANOFLUIDIC TECHNOLOGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the theory of fluidics in a micro scale	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Gain knowledge in micro fluidics equations															
CLR-3:	Understand the concept behind viscous flow in micro scale															
CLR-4:	Acquire the knowledge in Micro fluidic devices and manufacturing															
CLR-5:	Gain knowledge scaling materials for manufacturing															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the concept of fluidics in micro and nanoscale	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Analyze the flow and viscosity of the fluidics	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Analyze the viscous flow of micro/nano fluidic devices	3	-	2	-	-	-	-	-	-	-	-	-	-	2	-
CO-4:	Utilize the knowledge gained for designing micro/nano fluidic devices	2	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply the various fluidic equations to design micro/nano fluidic devices	3	-	2	-	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Theory of Fluidics in Microscale	9 Hour
Introduction to Fundamentals of kinetic theory, Fundamentals of molecular models, Kinetic theory of micro and macroscopic properties, Binary collisions, Distribution functions, Boltzmann equation, Maxwellian distribution functions, Wall slip effects, Accommodation coefficients, Flow and heat transfer analysis of microscale, Couette flows, Pressure driven gas micro-flows, Micro flows with wall slip effects, Concept of Heat transfer in micro-Poiseuille flows, Expression for Poiseuille flows, Mechanism of micro flows under compression, Compressibility and its effects, examples	
Unit-2 - Micro and Nanofluidic Equations	9 Hour
Introduction to Micro and nanofluids, Basic concepts in microfluidics and Nanoscale fluidics, Governing equations, Applications-Preparatory concepts, Laws of fluid flows determination of transport properties, Classification of fluid flow, Continuum approximation, Limitations and drawbacks, Kinematics of Microscale Liquid flow, Derivation of Kinematics of Microscale Liquid flow, Liquid flow along surface, Effect of body forces in liquid flow, Navier-Stokes equation and its properties, Theory of Two-dimensional Navier-Stokes equation, Two-dimensional Navier-Stokes equation in terms of Reynolds Equation, Navier-Stokes equation for Steady and compressible flow, Steady and incompressible flow Navier-Stokes equation	
Unit-3 - Viscous Flow in Micro/Nano Fluidic Devices	9 Hour
Introduction to Microscale Viscous flow, Structure of flow in a pipe or channel, Poiseuille's equation, Poiseuille flow in a pipe, Velocity in slip flow of gases, Velocity in slip flow of liquids, Theory of flow in a thin film under gravity, Two and Three-dimensional approach, Derivation-thin film under gravity, Properties of thin film equation, Developing suction and Laminar flows, Flow control, Surface tension driven flow and its limitations, Sedimentation of a solid particle, Simple model for blood flow, Non-Newtonian properties of blood	

Unit-4 - Materials and Fabrication Tools for Micro/Nano Fluidic Devices	9 Hour
Introduction to concepts of microfluidic devices, Microfluidic Technology, Micro fabrication tools -Fabrication of a Simple Microfluidic chip, Advantages of microfluidic devices, Fluidic transport mechanisms in Microfluidic devices, Pressure-driven and electro-kinetically driven flows in Devices, examples of micro fluidic devices, Scaling of materials, Silicon materials for the manufacture, Glass materials for the manufacture, Polymer materials for the manufacture, Fluidic structures, Manufacturing a fluidic structure, Stacking sequence, Stacking sequence, Stacking-fabrication methods, Surface modifications, Different techniques involved in Surface modifications, Spotting mechanisms, Detection mechanisms-	
Unit-5 - Electrochemical Fluidic Devices	9 Hour
Introduction to Electrochemistry, Electrical double layer, Electrochemical potential, Chemical potential-acid and base, Electrolyte and electrical conductivity, Semi-permeable membrane, Micro and nano fluidics devices, Applications in different fields, Fabrication and design of microfluid device, Testing of microfluid device, DNA transport ,Development of artificial kidney, Electrochemical sensing ,Electrochemical Micro/Nano fluidic devices, Receptor and Transducer based classification of biosensors, Types of Biotransducers, Nanopores and nanopore membrane for biochemical sensing, Single Molecule sensing devices	

Learning Resources	1. Terrence Conlisk, "Essential of Micro and nano fluidics: with application to biological and chemical sciences", Cambridge University Press, 2012 2. Joshua Edel, "Nanofluidics", RCS publishing, 2009 3. Henrik Bruus, "Theoretical Microfluidics", Oxford Master Series in Physics, 2007 4. Patric Tabeling, "Introduction to Microfluids", Oxford U. Press, 2005
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Nagesh Kini, Thermax, Pune, Maharashtra, nagesh.kini@gmail.com	1. Dr. Sampath Kumar T.S, IIT Madras, tssk@iitm.ac.in	1. Dr. Junaaid Masud Laskar, SRMIST
2. Mr. K. Chandru Trivitron Healthcare Pvt. Ltd. Chennai, chandru.k@trivitron.com	2. Dr. Amit Kumar Mishra, IIT Jodhpur, amit@iitj.ac.in	2. Dr. V. Eswaraiyah, SRMIST

Course Code	21NTO403T	Course Name	THINFILM PHOTOVOLTAICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Review the basic principles and design of photovoltaic cell technology	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the key properties of semiconductors films used in photovoltaic technology															
CLR-3:	Review the basic photovoltaic device structure and design															
CLR-4:	Develop an understanding of different thin film photovoltaic device technologies and their design															
CLR-5:	Gain exposure to the various tools and techniques used in thin film photovoltaics															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Differentiate between different types of photovoltaic technologies	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	Interpret important properties of semiconductors relevant to thin film photovoltaics	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Apply different photovoltaic device design concepts for different applications	-	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-4:	Appreciate advancement of different types of thin film solar cells	-	-	2	-	-	-	-	-	-	-	-	-	3	-	-
CO-5:	Appreciate the advanced concepts and explorations in thin film photovoltaics	-	-	-	3	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Basic Principle and Design of Photovoltaic Cells	9 Hour
Basics and basic components of PV systems-Mechanism of PV-Sun as a source of energy-Solar spectrum , air mass-Solar Cell parameters-Device testing-Efficiency measurements-FF, VOC, JSC etc for ideal cells-Non-idealities, Loss mechanisms – S-Q limit -Optical & electrical loss mechanisms-Basics of solar cell device design-Minimization of losses-Lateral design-Vertical design-Optical versus electrical tradeoffs-Optimization-Examples of semiconductors in PV-Device types in PV	
Unit-2 - Semiconducting Films for Solar Cells	9 Hour
Semiconductor thin films-Optical absorption-Carrier photo generation-Band gap-Direct vs. indirect bandgaps-Carriers-Carriers transport-Minority carrier transport properties-Carrier recombination-lifetime and defects-Band to band and Shockley-Read-hall recombination-High injection effects-Surface and interface recombination-Implications on device performance-PN homojunctions-Carrier transport under broad spectrum illumination-Photocurrent and Spectral response-Ideal diodes-Real p-n diodes-Temperature effects	
Unit-3 - Different Thin Film Photovoltaic Device Technologies	9 Hour
Different generations of PV-Thin film solar cells-Silicon solar cells, First generation silicon solar cells, second generation thin film solar cells, third generation DSSC, perovskite, organic and polymer solar cells- pros and cons of Thin film solar cells – Basic configuration of thin film solar cells - Thin film Silicon solar cells-Amorphous Silicon based solar cells-a-Si and a-Si: H solar cells-II-VI thin film PV-Chalcopyrite photovoltaics-CdTe/CdS thin film solar cells-Superstrate structure-CuInGaSe2/CdS thin film cell technologies-Earth abundant alternatives-Thin film solar cells based on Cu2ZnSnS4-other materials-3 rd generation thin film solar cells: DSSCs-QDSSCs, heterojunctions-3 rd generation thin film solar cells: organic PV-Hybrid, perovskite solar cells etc.	

Unit-4 - Preparation Techniques, Characterization and Device Modelling	9 Hour
Thin film deposition-Variou techniques - Physical and chemical deposition techniques -Evaporation techniques-Sputtering techniques-MBE-Laser based techniques-CVD, PECVD-Spray and Non vacuum routes - Techniques to measure thickness-Optical and electronic properties of thin films-Fabrication process of thin film solar cells-Specific techniques used-Established parameters in thin film cell technologies-Basic characterization tools-Advanced characterization methods for device quality & defects-Study of interfaces, recombination etc-Basics of device modelling-Simulation softwares	
Unit-5 - Device Architecture and Advanced Designs	9 Hour
Device architectures-Flexible substrates, transparent devices-Multi-junctions-Tandem solar cells-Bandgap profile optimization-Solar spectrum matching-Light trapping-Antireflection coatings-Self-cleaning coatings-Plasmonic enhancements-Luminescence concentrators-Up conversion-New concepts-quantum dots, & wires-Intermediate band solar cells-Multiple exciton generation, hot carrier solar cells-Commercial status-Hopes and challenges for thin film PV	

Learning Resources	1. Solanki C.S., "Solar photovoltaics - fundamentals, technologies and applications", 3rd edition, PHI Learning Pvt Ltd, New Delhi, India 2. Fonash S.J., "Solar Cell Device Physics", Academic, 2010 3. Moller H.J., "Semiconductors for Solar Cells", Artech House, 1993 4. Green M.A., "Third Generation Photovoltaics: Advanced Solar Energy Conversion", Springer, 2006 Fundamentals of Solid State Engineering, Manijeh Razeghi, KLUWER ACADEMIC PUBLISHERS, 2002 5. Rointan. F, Bunshah," Hand Book of Deposition technologies for Thin Films and coatings by Science, Technology and Applications", Second Edition , Noyes Publications, 1993
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. D.K. Aswal, National Physical Laboratory, dkaswal@nplindia.org	1. Dr. Ramesh Chandra Mallik, IISc Bangalore, rcmallik@iisc.ac.in	1. Dr. P. Malar, SRMIST
2. Dr. S. Sudhakar, CSIR-CECRI, sudhakar@cecri.res.in	2. Dr. Bhaskar Chandra Mohanty, Thapar University, bhaskar@thapar.edu	2. Dr. C. Gopalakrishnan, SRMIST

Course Code	21NTO404T	Course Name	NANOTECHNOLOGY IN SOCIETAL DEVELOPMENT	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Provide an insight into the fundamentals of social-economic implications of nanotechnology	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Provide an insight into knowledge of technology needs, social, political, and economic implications pertaining to nanotechnology															
CLR-3:	Understand the impact of nanotechnology, challenges, ethical issues															
CLR-4:	Understand the societal implications, economics, policy regulations to Improve the quality of life															
CLR-5:	Understand the issues of public awareness and risks associated with nanotechnology															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Address the socioeconomic implications of nanotechnology	2	-	-	-	-	-	-	3	-	-	-	-	2	-	-
CO-2:	Apply the knowledge of technology needs, social, political, and economic implications pertaining to nanotechnology	2	-	-	-	-	-	-	3	-	-	-	-	3	-	-
CO-3:	Address the impact of nanotechnology, challenges, ethical issues	2	-	-	-	-	-	-	2	-	-	-	-	-	3	-
CO-4:	Address the societal implications, economics, policy regulations to Improve the quality of life	3	-	-	-	-	-	-	3	-	-	-	-	-	2	-
CO-5:	Handle the issues of public awareness and risks associated with nanotechnology	2	-	-	-	-	-	-	3	-	-	-	-	-	-	2

Unit-1 - Knowledge and Scientific Understanding of Nature	9 Hour
Knowledge and Scientific Understanding of Nature - Industrial Manufacturing, Materials and Products - Medicine and the Human Body - Sustainability: Agriculture, Water, Energy, Materials, and Clean Environment - Space Exploration - National Security- Moving into the Market - The Interactive Process of Innovation and Diffusion - - Ethical Issues and Public Involvement - Social Science Research Approaches and Methodologies	
Unit-2 - Technology Growth- Social, Political Implications	9 Hour
National Nanotechnology Initiative - The Age of Transitions - Technological Implications of Nanotechnology: Why the Future Needs Us - National Needs Drivers for Nanotechnology - Nanotechnology and Societal Transformation - Focus on Economic and Political Implications of Potential Technology - Impact of Nanotechnology on the Chemical and Automotive Industries - Societal Implications and Scaling down to Nanoelectronics - Future Implications of Nanoscale Science and Technology: Wired Humans, Quantum Legos, and an Ocean of Information - Implications of Nanotechnology in the Pharmaceuticals and Medical Fields - An Economist's Approach to Analyzing the Societal Impacts of Nanoscience and Nanotechnology - The Strategic Impact of Nanotechnology on the Future of Business and Economics - - Implications of Nanoscience for Knowledge and Understanding-	
Unit-3 - Nanotechnology Challenges Education, Ethics and Legal Aspects	9 Hour
Nanotechnology, Education, and the Fear of Nanobots - Mathematical Challenges in Nanoscience and Nanotechnology - Implications of Nanotechnology for the Workforce - Societal Impacts of Nanotechnology in Education and Medicine - Technological and Educational Implications of Nanotechnology: Infrastructural and Educational Needs - Dynamics of the Emerging Field of Nanoscience - Focus on Medical, Environmental, Space Exploration and National Security – Implications - Challenges and Vision for Nanoscience and Nanotechnology in Medicine: - Lifecycle/Sustainability Implications of Nanotechnology - Implications of Nanotechnology for Space Exploration - Security Aspects of Nanotechnology - Focus on Social, Ethical, Legal, and Cultural Implications - Social Science Research Methods for Assessing Societal Implications of Nanotechnology - Ethical Issues in Nanotechnology -	

Unit-4 - Nanotechnology-Unintended Consequences, Risks, Toxicity and Governance	9 Hour
Societal Implications of Nanotechnology - Socio-economic Research on Nanoscale Science and Technology: A European Overview and Illustration - Nanotechnology and Unintended Consequences - A Cultural Ecology of Nanotechnology Envisioning and Communicating Nanotechnology to the Public Vision, innovation, and policy Challenges for government and universities - Nanoparticle Toxicity and risk - Social impacts of nano biotechnology – issues; Problems of governance of nanotechnology Negotiations over quality of life in the nanotechnology initiative – Governance Technological revolutions and the limits of ethics in an age of commercialization - Regulatory structures and society - Nanotechnology and social trends	
Unit-5 - Public Awareness and Perception of Nanotechnology	9 Hour
Public Perceptions of Nanotechnology - Public Awareness of Nanotechnology - Public interaction research - Nanotechnological risks - Assessment of nanotechnological risks - Importance of Risk communication - Problems in Risk communication - Nanotechnology's social impacts - A preliminary analysis of nanotechnology in the media - Nanoscience and engineering – Public engagement - Nanophobia – Fear of Nanotechnology - Public Engagement with nanotechnology - Nanotechnology: moving beyond risk - Communication streams and nanotechnology: interpretation of a nanotechnology - Individual perspectives of nanotechnology - The case of Cold Fusion - The case of Recombinant DNA	

Learning Resources	1. Mihail C.R., and William S.B., "Nanotechnology: societal implications", Springer publication, 2011 (978-1-4020- 5432-7 (e-book)) 2. Ronald sandler, "Nanotechnology the Social & Ethical Issues", Woodrow Wilson, 2009	3. Mihail C. Roco and William Sims Bainbridge," Societal Implications of Nanoscience and Nanotechnology", National Science Foundation, 2001 (978-0-7923-7178-6)
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Ajay Kumar, Avansa Technology and services, India ajaykumar@avansa.co.in	1. Dr. Hirendra N Ghosh, Institute of Nanoscience and Technology, Punjab, hngghosh@inst.ac.in	1. Dr. R. Ajay Rakesh, SRMIST
2. Dr.Tanvi Sharma, Nanoshel LLC, Chandigarh, India, tanvisharma@nanoshel..com	2. Dr. Asish Pal, Institute of Nanoscience and Technology, Punjab, apal@inst.ac.in	2. Dr. C.Gopalakrishnan, , SRMIST

Course Code	21NTO405T	Course Name	POLYMER ENGINEERING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Acquire basic knowledge about the structure and property of polymers	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Impart chemistry aspects on various polymer materials															
CLR-3:	Acquaint with various compounding ingredients and mixing equipments															
CLR-4:	Understand the principles behind the elasticity of the polymers															
CLR-5:	Gain knowledge about reinforcements and effect of nanofillers															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the engineering principles underlying the processing of polymer raw materials	3	-	-	2	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Extend and apply the knowledge of polymers to materials science and engineering	-	2	1	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Identify different fillers as reinforcements	-	-	3	2	-	-	-	-	-	-	-	-	-	3	-
CO-4:	Illustrate the working of moulding and extrusion techniques	3	-	2	-	-	-	-	-	-	-	-	-	-	3	-
CO-5:	Evaluate the mechanical behavior of polymers	2	-	3	-	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Basics and chemistry of polymeric materials	9 Hour
Historical developments in polymeric materials and general applications Materials- Monomer & functionality- Oligomer- Polymer structure- Methods of synthesis- Addition polymerization- Condensation polymerization- Co- polymers- Cross linked polymers- Crosslinking plasticizers and fillers- Crystallinity- Glass transition temperature- Degree of polymerization- Classification of polymers- Molecular weight- Molecular weight distribution.- Determination of number and average molecular weight	
Unit-2 - Polymers materials science and engineering	9 Hour
Mechanical behavior of Polymers-uses of polymers based on their mechanical property, Deformation- Fracture in polymers- Crack growth- Tensile strength,- Flexural strength- Impact resistance- Percentage elongation- Griffin theory- Tear test- Fatigue and wear- Hardness- Compressive strength- Time dependent properties- Creep- Effect of weathering- Stress-strain behavior of polymers- Mechanical behavior of biomedical Polymers, mechanical testing system for polymers	
Unit-3 - Polymer viscoelasticity and rheology	9 Hour
Polymer Viscoelasticity and Rheology- importance-Definition of elastomers- Requirements of polymer to be elastomer- Nature of viscoelasticity- Definition of elastomers- Classifications of elastomers- Stress relaxation- Relaxation and retardation times- The time - temperature superposition principle- Dynamic properties- Zener model- Polymer melt viscosity- Plasticizers- Lubricants- Polymer Rheology- Rheological concepts of polymer solutions and melts- Degradation plasticization- Various rheology modifiers, rheometer-Working principle and instrumentation	

Unit-4 - Reinforced polymers and composites	9 Hour
Reinforced plastics- Nanofillers and reinforcements with examples- Synthesis methods for composite polymers, Effect of reinforcements like calcium carbonate, dolomite, silica glass- Fibrous reinforcements (inorganic and organic)- Glass fiber and boron fiber- Carbon fiber and aramide fibers- Compression moulding- Classification and characteristics of composite materials- Fibrous composite materials- Laminated composite materials- Particulate composite materials- Combinations of composite materials- Strength of composites- Failure modes of long, fibre composites- Axial tensile failure- Transverse tensile failure, shear failure- Applications of fiber reinforced polymer composites	
Unit-5 - Engineering & high-performance plastics	9 Hour
Elements of Design- Engineering thermoplastics- Applications of thermoplastics, Thermosets and composites- Compression moulds : positive, semi- Positive- Flash mould with horizontal and vertical Flash- Injection moulds : Two plate and three plates types- Joining and fastening- Post extrusion techniques- Metallization- electroplating- Stamping- Welding and bonding- printing and painting on plastics- Cross-linking of thermoplastics materials- Cellular plastics- Compound development- Principles of mixing- Rubbers, designing for strength	

Learning Resources	1. Sperling L.H., Introduction to Physical Polymer Science, Wiley inter science, 4th Edition, 2006 2. Mc Crum, Principles of polymer Engineering, 2nd Edition, Oxford, 2001	3. Hull D., and Clyne W., An Introduction to Composite Materials, Cambridge University Press, 2nd Edition, 1996 4. Jones R.M., "Mechanics of Composite Materials", Taylor & Francis, 2nd Edition, 1999
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Pankaj Poddar, National Chemical Laboratory, p.poddar@ncl.res.in	1. Dr. G. Arthanareeswaran, NIT Trichy, arthanareeg@gmail.com	1. Dr. N. Angeline Little Flower. SRMIST
2. Dr. P. Sudhakara, CLRI – CSIR, Jalandhar, sudhakar@clri.res.in	2. Dr. A. Kannan, IIT Madras, kannan@iitm.ac.in	2. Dr. C. Siva, SRMIST

Course Code	21NTO406T	Course Name	INDUSTRIAL NANOTECHNOLOGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology		Data Book / Codes / Standards	Nil	

[illegible]

Unit-1 - Nanotechnology based industrial applications	9 Hour
Nano electrical, Nano electronic devices and its advantages - Data storage, Memory devices - Micromechanical systems, Nanoelectromechanical systems - Lasers, Use of lasers in lighting and displays - Rechargeable batteries, Nanostructured electrodes - Basic concepts of fuel cells, Different types of fuel cells - Photovoltaic cells characterization, Nanomaterials and different types of photovoltaic cells - Electric double layer capacitors, Capacitance versus pore size - Characterization of nanoparticle coatings, Nanoparticle coatings: Electrical and electronic applications and nanoparticle coatings for electrical products	
Unit-2 - Nanomaterials in bio application	9 Hour
Nanoparticles in bone substitutes, Nanoparticles in dentistry - Tissue engineering, Regenerative medicine - Tissue engineering and nanotechnology, Incorporated scaffolds for tissue engineering - Nanorobotics in surgery , Role of nanoparticles in drug delivery - Nanoparticles in targeted drug delivery, Metal oxide nanocarriers for drug delivery - Silica-based nano drug delivery , Polymer based nanomaterials for drug delivery - Cancer diagnostics: nanotechnology, Cancer therapy: nanotechnology - Nano-sensor in cancer, Nanoparticle probes and molecular imaging in Cancer - Nanomedicine-based use of siRNA in cancer , Magnetic nanoparticles and cancer	
Unit-3 - Role of nanotechnology in water and environment remediation industries	9 Hour
Background of TiO ₂ as a semiconductor photocatalyst, Photocatalytic mechanism and general pathway -Photocatalytic kinetics, TiO ₂ nanoparticles for water purification - Photocatalytic degradation of specific waterborne pollutants, Nanomaterials in water treatment – photocatalytic water splitting - Origin of arsenic in groundwater, Health impacts of arsenic, Nanoparticles for treatment of arsenic - Mechanism of treatment methods of arsenic-contaminated water , Treatment of arsenic using nanoparticles other than TiO ₂ - CNTs in water treatment technology , Functionalized graphene for removal of contaminations and water treatment, Gas-sensor: Techniques used for gas- sensor, Conduction mechanism in semiconducting sensing films - Metal-oxide based gas-sensor devices, Classification of semiconductor sensors - Challenges and opportunities in solid state sensors, Small dimensional toxic gas sensor for air- quality monitoring	

Unit-4 - Nanotechnology based applications in agriculture	9 Hour
Applications of nanotechnology in the agriculture, Agriculture chemicals - Nanomaterials in plant protection, Diagnosis and control of plant diseases - Potential of nano-fertilizers, Nano-fertilizers: Nutritional value and health - Applications of nanotechnology in food industry, Protein nanostructures - Engineered nanoparticles in food, Silica (SiO ₂) and silicates nanoparticles in food - Nanomaterials in active packaging for food preservation, Barrier nanomaterials for food packaging - Nano-enabled indicators of food quality and safety, Challenges of using nanotechnology in agriculture and food sectors, Nanomaterials in active packaging for food preservation, Principles of involved nano-enabled sensing, Nanocomposite with antimicrobial properties, Nanotechnology for intelligent packaging as food freshness and safety monitoring solution -Examples	
Unit-5 - Nanofibres and nanomaterials in textiles and cosmetics	9 Hour
Nanotechnology and Nanofibers, Nanofibre production: Electrospinning - Basic to Electrospinning: Solution surface tension, Polymer solubility, viscosity, Electrospinning parameters: Controlling morphologies of nanofibers - Electrospun Polycrylonitrile Nanofibers, Electrospun TiC/C composite for energy related application - Light-emitting polymer nanofiber, Polymer nanofiber field-effect transistors - Multifunctional polymer nanocomposites, Electrospun carbon nanofiber: electrode material - Nano finishing in textiles: UV resistant, Antibacterial, Nano finishing in textiles: hydrophilic, self- cleaning - Protective textile against electromagnetic radiation, Nanotechnology: Self-Cleaning textile - Safety evaluation of nanomaterials in cosmetic products, Nanomaterial in cosmetic: determination of physicochemical properties - Cosmetic formulation: TiO ₂ and ZnO nanoparticles, Nanotechnology in shampoos, hair- conditioners: Hair follicle targeting	

Learning Resources	<ol style="list-style-type: none"> 1. Kenneth E.G., Craig R.H., Cato T.L., Lakshmi S.N., Biomedical Nanostructures, John Wiley & Sons Inc., 2008 2. P. J. Brown, K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead Publishing Limited, Cambridge, 2007 3. C. M. Hussain, A. K. Mishra, Nanotechnology in Environmental Science, Volume 2, John Wiley & Sons, 2018 4. M. A. Axelos, M. H. Van de Voorde, Nanotechnology in Agriculture and Food Science, John Wiley & Sons, 2017 5. M. H. Fulekar, Nanotechnology: Importance and Applications, IK International Publishing House Pvt. LTD, 2010
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Hemant Dixit, GlobalFoundaries,USA, aplahemant@gmail.com	1. Dr. Pradeep T, IIT Madras, pradeep@iitm.ac.in	1. Dr. Debabrata Sarkar, SRMIST
2. Dr. Krishna SurendraMuvvula, Saint Gobain Research India, India, Krishna.muvvula@saintgobain.com	2. Dr. M. S. Ramachandra Rao, IIT Madras, msrrao@iitm.ac.in	2. Dr. Senthilkumar E, SRMIST

Course Code	21NTO407T	Course Name	QUANTUM COMPUTING	Course Category	0	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology		Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:
CLR-1:	Outline the importance of quantum computation	
CLR-2:	Understand the aspects of quantum computational models	
CLR-3:	Comprehend the concepts of quantum mechanics involved in quantum computing	
CLR-4:	Familiarize with quantum circuits	
CLR-5:	Realize the various aspects of quantum algorithm and quantum computer hardware	
Course Outcomes (CO):		At the end of this course, learners will be able to:
CO-1:	Understand the evolution of quantum computing	
CO-2:	Analyze the various quantum computational models	
CO-3:	Apply the principles of quantum mechanics in quantum computing	
CO-4:	Employ the quantum gates for designing quantum circuits	
CO-5:	Utilize the quantum algorithm for real time applications	

Unit-1 - Introduction to Quantum Computing	9 Hour
What is information? Is information physical? - Quantitative measure of information - Shannon's first coding theorem - More about the bit - Why do we need to know how to manage information? - Which technology? - The qubits - A brief history of quantum computation and quantum communication.	
Unit-2 - Quantum Computational Models	9 Hour
Quantum computational models: Elementary idea of complexity of an algorithm - Turing machine, Deterministic Turing machine - Probabilistic Turing machine - Reversible Turing machine – Quantum Turing machine – Circuit model of computation - Computational complexity and related issues	
Unit-3 - Principles of Quantum Mechanics in Quantum Computing	9 Hour
Basic ideas of quantum mechanics - A little more of quantum mechanics - Density operator and density matrix - Density operator of pure states - Density operator of mixed states - The meaning of entanglement - Bell's inequality and nonlocality – A little more algebra for quantum computing – Bell measurement and entanglement - Partial trace - 1 Quantum bit commitment and quantum coin - Schmidt decomposition - Partial transpose and test of entanglement - Entanglement witness - State discrimination - Trace distance and fidelity – No cloning theorem - Conclusions from no cloning theorem - Other no-go theorems.	
Unit-4 - Quantum Gates and Quantum Circuits	9 Hour
Quantum gates and quantum circuits - Single qubit gates - Two qubit gates - Three qubit gates - A little more on quantum gates – Quantum circuits – Quantitative measures of quality of a circuit - Gate count or circuit cost - Garbage bit – Quantum cost - Depth and width of a circuit - Total cost - Circuit optimization rules - Moving rule – Template matching - Visualizing the quantum gate.	
Unit-5 - Quantum Algorithms for Real Time Applications	9 Hour
Quantum logic gates - The Deutsch algorithm - Generalization to $n+m$ qubits - The Grover search algorithm - The quantum Fourier transform - The period of a function - Classical algorithms and quantum algorithms. Physical realizations: Trapped ions - Superconducting qubits - Quantum dot.	

Learning Resources	1. Anirban Pathak, Elements Of Quantum Computation, CRC Press, First Edition, 2013	3. Michael A Nielsen; Isaac L Chuang, Quantum computation and quantum information, Cambridge university press, 2010.
	2. Michel LeBellac, , A Short Introduction To Quantum Information And Quantum Computation, Cambridge university press, 2006	4. Tim Spiller, Hoi-Kwong Lo, Introduction to quantum computation and quantum information, World Scientific Publishing Company, 2001.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Prabha Narayan , QKRISHI	1. Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in	1. Dr. RM Hariharan, SRMIST
2. Dr. Hemant Dixit, Global Foundaries, USA, aplahemant@gmail.com	2. Dr. G. P. Das, IIT Kharagpur gpdas@metal.iitkgp.ac.in	2. Dr. C. Siva, SRM IST

Course Code	21NTO311T	Course Name	NANOMATERIALS IN COSMETICS AND COSMOCEUTICALS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Express the basis of cosmeceuticals	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Demonstrate the classification and various types of cosmetics															
CLR-3:	Analyze about ingredients and effect of inclusion of nanoparticles in cosmetics															
CLR-4:	Get acquainted with current trends in the field of nano based cosmetics															
CLR-5:	Get acquainted with future aspects of cosmeceuticals															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply basic concepts of nanotechnology in cosmetics	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	Distinguish effects of using nanoparticles over conventional methods in cosmetics	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Analyze about current trends in the field of cosmetics	-	-	-	2	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Apply basic cosmetic concepts in making nanoformulation	-	-	2	-	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Apply knowledge in making organosilicone formulation	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Cosmetics basis	9 Hour
Introduction to cosmetics-Purpose of cosmetics-Meaning of cosmetics-Classification of cosmetics-Cosmeceuticals-Pharmaceuticals in cosmetics-Quality characteristics-Quality assurance-Development process of cosmetics-Cosmetics for Skin- Cosmetics for hair-Cosmetics for nails-Cosmetics colour materials-Cosmetics and fragrances-Oral care cosmetics-Body cosmetics-Physical chemistry of cosmetics-Stability of cosmetics	
Unit-2 - Cosmoceuticals	9 Hour
Oily materials: introduction, oils and fats, wax-Hydrocarbons-Higher fatty acids-Higher alcohols, esters, silicones-Surface active agents : introduction-Anionic surfactant-Cationic surfactants-Amphoteric surfactant-Non-ionic surfactant-Other surfactants- Humectants : introduction-Choice of humectants-Unusual humectants-Special uses of humectants-Antioxidants : introduction-General oxidative theory, measurement of-oxidation-Assessment of oxidant efficiency-Choice of antioxidant	
Unit-3 - Nanoparticles in cosmetics	9 Hour
Film formers-Polymers as film formers-Thickeners-Types of thickeners-Polymers in hair colouring-Types of polymers in hair colour-Conditioning polymers-Surfactants in conditioners-Cleansing agents-Ethoxylated alcohols-Silicones-Emulsions Types of polymeric systems-Natural polymers-Stimuli responsive polymeric systems-pH-responsive- Thermal responsive- Photo responsive	
Unit-4 - Nanoformulations in Cosmetics	9 Hour
Multiple emulsions as novel delivery systems-Nano emulsion in cosmetics-Nano crystals in cosmetics-Silicones and beyond-Organ modified silicones-New esters mimicking property for organ modified silicones-Silicones in shampoo-Minimalizing undesirable side effects-Substantive silicones-Effect of substantive silicones-Organo-modified delivery systems-Types of Organo-modified delivery systems-Silicones personal care delivery system-Liposomes in cosmetics-Niosomes in cosmetics-Micro emulsion in cosmetics-Nano emulsion in cosmetics-Cyclodextrin complexes in cosmetics	

Unit-5 - Prospects of cosmoceuticals	9 Hour
Dual Nano delivery systems-Dual Nano delivery systems-Introduction-Synthesis of dual Nano delivery systems containing vitamin e for cosmetics-Synthesis of dual Nano delivery systems containing vitamin e for pharmaceuticals-Characterization of dual Nano delivery systems containing vitamin e-Various characterization techniques used Orthopaedic implant-Conventional types of Orthopaedic implant-Orthopaedic implant titanium rods-Advantages of Orthopaedic implant of titanium rods-Preparation of keratin coatings for orthopaedic implant titanium rods-Characterization of keratin coatings-Nanotherapeutics as a treatment for inflammation-Cosmetic repair and restoration-Moisturization of skin-Fortification of the skin barrier-Contact lenses types-Beauty from contact lenses beyond vision correction	

Learning Resources	1. New Cosmetic Science, Mitsui T. , Elsevier,1998 2. Cosmetic Nanotechnology: Polymers and Colloids in Cosmetics, Sarah E.M., Kathleen O.H., Robert Y.L., American Chemical Society,2006	3. Delivery System Handbook for Personal Care and Cosmetic Products, Meyer R.R., William Andrew ASP, 2005. 4. Nanotechnology for the Preparation of Cosmetics Using Plant-Based Extracts, Siti Hamidah Mohd Setapar, Akil Ahmad, Mohammad Jawaid, Elsevier Science, 2022
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Solomon Jonnes,Bengaluru,solomon@terracarb.com	1. Dr. Amit Kumar Mishra , IIT Jodhpur, amit@iitj.ac.in	1. Dr. Mani Rahulan, SRMIST
2. Dr. Nagesh Kini,Thermax,Pune,Maharashtra,nagesh.kini@gmail.com	2. Dr. Sampath Kumar T.S, IIT Madras, tssk@iitm.ac.in	2. Dr. C. Siva, SRMIST

Course Code	21NTO312T	Course Name	SOCIETAL IMPLICATIONS OF NANOTECHNOLOGY	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Provide an insight into the fundamentals of socio-economic implications of nanotechnology	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Provide an insight into knowledge of technology needs, social, political and economic implications pertaining to nanotechnology															
CLR-3:	Understand the impact of nanotechnology, challenges, ethical issues															
CLR-4:	Understand the societal implications, economics, policy regulations to Improve the quality of life															
CLR-5:	Understand the issues of public awareness and risks associated with nanotechnology															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Address the socioeconomic implications of nanotechnology	2	-	-	-	-	-	-	3	-	-	-	-	2	-	-
CO-2:	Apply the knowledge of technology needs, social, political and economic implications pertaining to nanotechnology	2	-	-	-	-	-	-	3	-	-	-	-	3	-	-
CO-3:	Address the impact of nanotechnology, challenges, ethical issues	2	-	-	-	-	-	-	2	-	-	-	-	-	3	-
CO-4:	Address the societal implications, economics, policy regulations to Improve the quality of life	3	-	-	-	-	-	-	3	-	-	-	-	-	2	-
CO-5:	Handle the issues of public awareness and risks associated with nanotechnology	2	-	-	-	-	-	-	3	-	-	-	-	-	-	2

Unit-1 - Implications of nanotechnology	9 Hour
Knowledge and Scientific Understanding of Nature - Industrial Manufacturing, Materials and Products - Medicine and the Human Body - Sustainability: Agriculture, Water, Energy, Materials, and Clean Environment - Space Exploration – National Security- Moving into the Market - Ethical Issues and Public Involvement in Decision Making - Education of Nanoscientists, Nanotechnologists, and Nanofabrication Technicians - Education of Social Scientists - Social Science Research Approaches and Methodologies - Institutional Infrastructure for Societal Implications Research	
Unit-2 - Nanotechnology in various societal applications	9 Hour
National Nanotechnology Initiative - The Age of Transitions - Technological Implications of Nanotechnology- National Needs Drivers for Nanotechnology - Nanotechnology and Societal Transformation - Focus on Economic and Political Implications of Potential Technology - Impact of Nanotechnology on the Chemical and Automotive Industries Information Technology – Societal Implications - Societal Implications of Scaling to Nanoelectronics - Future Implications of Nanoscale Science and Technology: - Implications of Nanotechnology in the Pharmaceuticals and Medical Fields - An Economist's Approach to Analyzing the Societal Impacts of Nanoscience and Nanotechnology	
Unit-3 - Security and ethical aspects	9 Hour
Nanotechnology, Education, and the Fear of Nanobots - Focus on Medical, Environmental, Space Exploration and National Security – Implications - Challenges and Vision for Nanoscience and Nanotechnology in Medicine: Cancer as a Model -Nanotechnology in Medicine - Lifecycle/Sustainability Implications of Nanotechnology - Implications of Nanotechnology for Space Exploration - Security Aspects of Nanotechnology - Focus on Social, Ethical, Legal, and Cultural Implications - Social Science Research Methods for Assessing Societal Implications of Nanotechnology - Ethical Issues in Nanotechnology - Social Acceptance of Nanotechnology	

Unit-4 - Economic policy regulations	9 Hour
Societal Implications of Nanotechnology - Socio-economic Research on Nanoscale Science and Technology: A European Overview and Illustration - Nanotechnology and Unintended Consequences - A Cultural Ecology of Nanotechnology Envisioning and Communicating Nanotechnology to the Public Vision, innovation, and policy Challenges for government and universities - Nanoparticle Toxicity and risk - Social impacts of nano biotechnology – issues; Problems of governance of nanotechnology - Regulatory structures and society - Nanotechnology and social trends - Engagement - Nano revolution implications for the Environmental Impacts of nanomaterials	

Unit-5 - Public awareness and risk assessment	9 Hour
Public Perceptions of Nanotechnology - Public Awareness of Nanotechnology - Public interaction research - Nanotechnological risks - Assessment of nanotechnological risks - Importance of Risk communication - Problems in Risk communication - Nanotechnology's social impacts - Public engagement - Fear of Nanotechnology - Public Engagement with nanotechnology - Nanotechnology: moving beyond risk - Communication streams and nanotechnology: interpretation of a nanotechnology - Individual perspectives of nanotechnology - Historical comparisons - for anticipating public reactions to nanotechnology	

Learning Resources	1. Mihail C.R., and William S.B., "Nanotechnology: societal implications", Springer publication, 2011 (978-1-4020- 5432-7 (e-book)) 2. Ronald sandler, "Nanotechnology the Social & Ethical Issues", Woodrow Wilson, 2009	3. Mihail C. Roco and William Sims Bainbridge, " Societal Implications of Nanoscience and Nanotechnology", National Science Foundation, 2001 (978-0-7923-7178-6) 4. Fritz Allhoff, Patrick Lin, James H. Moor, John Weckert, "Nanoethics: The Ethical and Social Implications of Nanotechnology", John Wiley & Sons, 2007
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Ajay Kumar, Avansa Technology and services, India ajaykumar@avansa.co.in	1. Dr. Hirendra N Ghosh, Institute of Nanoscience and Technology, Punjab, hngghosh@inst.ac.in	1. Dr. R. Ajay Rakkesh, SRMIST
2. Dr.Tanvi Sharma, Nanoshel LLC, Chandigarh, India, tanvisharma@nanoshel.com	2. Dr. Asish Pal, Institute of Nanoscience and Technology, Punjab, apal@inst.ac.in	2. Dr. C.Gopalakrishnan, , SRMIST

Course Code	21NTO313T	Course Name	NANOTECHNOLOGY IN FOOD SCIENCE AND PACKAGING	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	Know the various types of interactions at molecular scale												
CLR-2:	Understand the effect of nanoparticles on agricultural methodology and food technology												
CLR-3:	Gain knowledge on the types of diagnostic tools using nanotechnology												
CLR-4:	Acquire knowledge about the newer technologies in the food production												
CLR-5:	Get familiarized with the new concepts of Nano Science in the packaging industries and food production												
Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	Apply the concept of interactions within the supramolecular structures at molecular scale												
CO-2:	Utilize the assay techniques in agricultural and food diagnostics												
CO-3:	Apply the concepts of nanotechnology in food products												
CO-4:	Engineer food ingredients which are capable to improve the bioavailability												
CO-5:	Assess the toxic effects of the nanomaterials used in the food processing and technology												

Program Outcomes (PO)												Program Specific outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3

Unit-1 - Supramolecular structures	9 Hour
Intermolecular interactions and supermolecular structures – Introduction. .Water - hydrophobic and hydrophilic interactions dispersion interaction, electrostatic interactions Atoms and small molecules, Polymers, particles, and surfaces. Introduction to Steric interactions. Steric interactions involving soluble polymers Aggregation, Depletion, aggregation of particles by non- adsorbing polymers, Bridging aggregation of particles by adsorbing polymers. Stabilization of dispersed particles by adsorbing polymers. Polymer brushes to prevent particle aggregation and particle deposition at surfaces. Self-Assembly, Organized self-assembled structures, Langmuir layers, Lipid bilayers, .Solid-supported lipid bilayers Micelles, Vesicles	
Unit-2 - Nanotechnology in agriculture and food science	9 Hour
Nanotechnology in Agriculture and Food diagnostics. Nanodiagnostic approaches in detecting microbial agents, Biosensors, Enzyme biosensors and diagnostics. DNA-based biosensors and diagnostics. Radiofrequency identification, Integrated nanosensor networks: Detection and Response. .Electrochemical biosensors – Gold Nanoparticles, Magnetic Nanoparticles in diagnostics, Fluorescent Nanoparticles in diagnostics, Silica Nanoparticles in diagnostics. Safety of nanotechnology in food and the impact in consumer health. Transduction Principles. Microfluidic Assays, Lateral flow (immuno) assay, Nucleic acid lateral flow (immuno) assay, Flow-through (immuno) assays, Antibody microarrays Surface plasmon resonance spectroscopy	
Unit-3 - Nanotechnology in food products	9 Hour
Food products and its production – Introduction. Food and new ways of food production. Need for new food processing methods. Efficient fractionation of crops Efficient product structuring, Optimizing Nutritional value. Nanotechnology in Food Production. Applications of nanotechnology in foods, Sensing, packaging Encapsulation, Nano Engineering food ingredients to improve bioavailability Nanocrystalline food ingredients. Nano-engineered protein fibrils as ingredient building blocks. Preparation of food matrices. Risks of Nanotechnology. Concerns about using nanotechnology in food production. Rational argumentation versus Human feelings, Nano-emulsions	

Unit-4 - Risk assessment of nanotechnology in food science	9 Hour
Nanotechnology in Crop management - Introduction. Crop improvement - reasons to package food products. Physical properties of packaging materials, Strength, Barrier properties light absorption, structuring of interior surfaces, Antimicrobial functionality. Visual indicators, Quality assessment, Food safety indication. Product properties, Information and communication technology Sensors, Radiofrequency identification technology. Health Risks, Environmental Risks, Consumer and societal acceptance	
Unit-5 - Toxicology studies	9 Hour
Toxicology of Nanomaterials in food - Introduction. Characterization of engineered nanomaterials. Unique issues for characterization of engineered nanomaterials for food applications Safety assessment of oral exposure engineered nanomaterials for food application Experimental design considerations for toxicology studies. Life cycle of nanotechnology food products Environmental behavior of nanoparticles - Toxicology of nanoparticles, Molecules in foods involved in triggering allergies. Impact of nanoscale structures on allergenic potential of foods Toxicokinetics Adme (absorption), Adme (distribution) Adme (metabolism) Adme (excretion) Toxicodynamics. In vivo toxicity, In vitro toxicity, Study Reliability	

Learning Resources	1. Nicholas A. Kotov, "Nanoparticle Assemblies and Superstructures", CRC, September, 2019 (ISBN 9780367392284) 2. Lynn J. Frewer, Willem Norde, Arnout Fischer, and Rans Kampers, "Nanotechnology in the Agri- Food Sector", Wiley VCH, 2011 (ISBN:9783527330607)	3. David S Goodsell, "Bionanotechnology", John Wiley & Sons, 2004 (ISBN 0-471-41719-X) 4. Jennifer Kuzma and Peter VerHage, "Nanotechnology in agriculture and food production", Woodrow Wilson International, 2006 Espresso and Page 300-307 (VASP)
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Rajendra Moorthy Rajendran, Kemin Industries, Chennai, India rajendramoorthy.r@kemin.com	1. Dr. V Geethalakshmi, TNAU, Coimbatore, directorscms@tnau.ac.in	1. Dr. C. Gopalakrishnan, SRMIST
2. Mr. Saravanan Lokasundaram, Agro Crops, Chennai, India, sara@agrocrops.com	2. Dr. A Lakshmanan, TNAU, Coimbatore, microlaxman@yahoo.com	2. Dr. E. Senthilkumar, SRMIST

Course Code	21PYO301T	Course Name	ASTROPHYSICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Learn the fundamental knowledge about the astronomical units and geometrical coordinate of solar and planetary systems and related events	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-2:	Define and interpret the observational properties of astronomical objects																											
CLR-3:	Understand the laws, their utilization and classification of the sequences of the Staller objects																											
CLR-4:	Understand the different components of the Solar System and its core structure																											
CLR-5:	Interpret the concepts of Universe expansion and characteristics of the Galaxies in the universe																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Perceive the basics of astronomy and Astrophysical systems	3	-	3	-	-	-	-	-	-	-	-	-	-	3	-												
CO-2:	Account for laws, properties and concepts of all astronomical events	3	-	3	3	-	-	-	-	-	-	-	-	-	3	-												
CO-3:	Relate the acquired knowledge to the Sun, stars and celestial systems	3	-	3	3	-	-	-	-	-	-	-	-	-	3	-												
CO-4:	Apply the concepts in modern astronomy related to Solar System and Milky Way	3	-	2	-	-	-	3	-	-	-	-	-	-	3	-												
CO-5:	Infer advances in Modern Astronomy and Astrophysics	3	-	3	-	-	-	3	-	-	-	-	-	-	3	-												

Unit-5 - Advances in Astronomy	9 Hour
A Universe of Galaxies: Early Observations, Distances of Galaxies, Standard Candles (Cepheids and SNe Type1a), Cosmic Distance Ladder, Gravitational redshift: Hubble's Law, Classification of Galaxies (Qualitative); Concepts and Definitions: Galaxy Clusters, Super Clusters, Active Galaxies, Quasars, Dark Matter; Dark matter in Cluster of Galaxies (qualitative overview); Introductory Cosmology- Concept of Evolution of universe, Meaning of Red Shift and Age of Universe, Olber's Paradox, Visible Universe; Concepts and Definitions: the Big Bang, Cosmic Microwave Background, Beginning of the universe and various stages, Radiation Matter-Antimatter, fusion, galaxy formation and present; Idea of Epoch of Inflation.	

Learning Resources	1. Pathways to Astronomy, Thomas T Arny, Stephen E Schneider, (McGraw-Hill College, 2008) 2. Universe, Freedman and Kaufmann, (W. H. Freeman; 8th edition, 2008) 3. An Introduction to Modern Astrophysics, Bradley W Carroll and Dale A Ostlie (Addison-Wesley Publishing, 1996)	4. Introduction to Stellar Astrophysics, Bohm, Erika. (3 Vols. Cambridge University Press, 1989) 5. Astrophysical Concepts, Martin Harwit (Springer Science & Business Media, Science2000)
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. R Seshadri, Titan Company Limited, seshadri@titan.co.in	1. Dr. Ranjit Kumar Nanda, IIT Madras, nandab@iitm.ac.in	1. Dr. Rohit Dhir, SRMIST
2. Dr. DK Aswal, NPL, dkaswal@nplindia.org	2. Prof. C Vijayan, IIT Madras, cvijayan@iitm.ac.in	2. Dr. Tushar Rana, SRMIST

Course Code	21PYO302T	Course Name	PHOTONICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	acquire the knowledge on light matter interaction	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	acquire knowledge for solving problems in laser physics															
CLR-3:	analyze Fabry-Perot cavity to understand laser resonator															
CLR-4:	gain knowledge on Q-switched and mode-locked lasers															
CLR-5:	enable the student for pursuing research in photonics related fields															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	understand the basic processes involved in the interaction between atom and light	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	learn the theory for laser amplification	3	-	3	-	-	-	-	-	-	-	-	-	2	-	2
CO-3:	gain the knowledge on the nonlinearity associated with a laser amplifier	3	-	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	understand on tuning the properties of a laser	3	-	3	-	-	-	-	-	-	-	-	-	-	2	-
CO-5:	acquire the knowledge on optical properties of metals	-	-	3	3	-	-	-	-	-	-	-	-	-	2	-

Unit-1 - Light Matter Interaction	9 Hour
Energy levels, Occupation of energy levels, Boltzmann distribution, Fermi-Dirac distribution, Interaction between an atom and electromagnetic mode, Spontaneous emission, Transition cross section, Line shape function and transition strength, Relation between transition cross section and spontaneous life time, Stimulated emission and absorption, Transition induced by monochromatic light and broadband light, Einstein A and B coefficients, Line broadening, Life time broadening, Collision broadening, Inhomogeneous broadening, Enhanced spontaneous emission, Purcell factor	
Unit-2 - Laser Physics	9 Hour
Thermal equilibrium between photons and atoms, Photon gas, Blackbody radiation spectrum, Thermography, Forms of luminescence: Cathodeluminescence, Chemiluminescence, Electroluminescence, Pholuminescence, Fluorescence and Phosporescence, Theory of laser amplification, Gain and bandwidth, Gain coefficient, Phase shift coefficient for Lorentzian line shape, Amplifier pumping: Rate equations, Rate equations in the absence of amplifier radiation (Steady state population difference), Rate equations in the presence of amplifier radiation, Four level pumping, Comparison of three and four level pumping	
Unit-3 - Laser Resonator	9 Hour
Amplifier nonlinearity: Saturated gain in homogeneously broadened media and inhomogeneously broadened media, Hole burning, Amplifier noise (Amplified spontaneous emission), Fabry-Perot cavity, Coefficient of finesse/Quality factor (Qualitative description)	
Unit-4 - Tuning of Laser	9 Hour
Theory of laser oscillation: Laser amplification, Feedback and loss in a resonator, Gain condition: laser threshold, Phase condition: Laser frequencies, Frequency pulling, Steady state internal photon flux density, Output photon flux density, Optimization of photon flux density, Properties of a Gaussian beam, Selection of the laser line, polarization, transverse and longitudinal modes, Pulsed lasers, Q-switching, Modelocking	

Unit-5 - Optical Properties of Metals **9 Hour**

Effective permittivity of metals, Drude Model, Plasma frequency, Metal dielectric boundary-Surface plasmon polariton, Generation and detection of surface plasmon polaritons, Metallic nanospheres: Localized surface plasmons and applications.

Learning Resources	1. B.E.A. Saleh and M.C. Teich, <i>Fundamentals of Photonics</i> , 2nd Ed., Wiley, 2012.	4. Yariv, <i>Quantum Electronics</i> , 3rd Ed., John Wiley, New York, 1989
	2. K. Thyagarajan and A.K. Ghatak, <i>Lasers Theory and Applications</i> , 1st Ed., Macmillan Publishers, 2010.	5. Seigman, <i>Lasers</i> , 3rd Ed., Oxford Univ. Press, 1986.
	3. O. Svelto, <i>Principles of lasers</i> , 4th Ed., Springer, 1998.	6. S. A. Maier, <i>Plasmonics: Fundamentals and Applications</i> , Springer, 2007

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N Vijayan, NPL, nvijayan @nplindia.org	1. Prof. V Subramanian, IIT Madras, manianvs@iitm.ac.in	1. Dr. K Shadak Alee, SRMIST
2. Mr. R Seshadri, Titan Company Limited, seshadri@titan.co.in	2. Prof. C Vijayan, IIT Madras, cvijayan@iitm.ac.in	2. Dr. Junaid Masud Laskar, SRMIST

Course Code	21PYO303T	Course Name	QUANTUM OPTICS	Course Category	O	OPEN ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Physics and Nanotechnology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
<i>The purpose of learning this course is to:</i>		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
<i>Emphasize the importance of Quantum optics to quantum information science</i>																
<i>Understand quantum nature of light</i>																
<i>Learn cavity-based light-matter interaction</i>																
<i>Acquire more advanced knowledge on quantum optics</i>																
<i>Learn atom-photon interactions</i>																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
<i>Concepts on Photon statistics</i>		3	-	-	-	-	-	-	-	-	-	-	3	-	-	2
<i>Non-classical behaviour of light: Photon antibunching</i>		3	-	-	-	-	-	-	-	-	-	-	3	2	-	-
<i>Detect and generate squeezed states of light</i>		3	-	-	3	-	-	-	-	-	-	-	-	-	2	-
<i>Formulate the photon number states</i>		3	-	3	-	-	-	-	-	-	-	-	-	-	-	-
<i>Gain knowledge on atom-cavity coupling</i>		3	-	-	-	-	-	-	-	-	-	-	3	-	-	2

Unit-1 - Quantum Optics	9 Hour
Photon Statistics, Coherent light: Poissonian photon statistics, Classification of light by photon statistics, Super-Poissonian light, Sub-Poissonian light, Thermal light, Theory of photodetection, Quantum theory of photodetection, shot noise in photodiodes, Observation of sub-Poissonian photon statistics	
Unit-2 - Quantum Nature of Light	9 Hour
Introduction to the intensity interferometers, Hanbury Brown-Twiss experiments and classical intensity fluctuations, Second order correlation function, Hanbury Brown-Twiss experiments with photons, Photon bunching and antibunching, Experimental demonstration of photon antibunching, Single Photon sources	
Unit-3 - Light Matter Interaction	9 Hour
Light waves as classical harmonic oscillators, Light as a quantum harmonic oscillator, The vacuum field, Coherent states, Shot noise and number-phase uncertainty, Squeezed states, Selection of Squeezed light, Generation of squeezed states	
Unit-4 - Advances in Quantum Optics	9 Hour
Operator solution of the harmonic oscillator, The number state representation, Photon number states, Coherent states, Quantum theory of Hanbury Brown-Twiss experiments, Two-level atom approximation, Coherent superposition states, Density matrix, Time-dependent Schrodinger equation, The weak field limit: Einstein's B coefficient, The strong field limit: Rabi oscillations	
Unit-5 - Optical Cavities	9 Hour
Atom-cavity coupling, Weak coupling: Preliminary considerations, Free-space spontaneous emission, Spontaneous emission in a single mode cavity (Purcell effect), Experimental demonstration, Strong coupling: Cavity quantum electrodynamics, Experimental observations of strong coupling, Applications of cavity effects and quantum information science	

Learning Resources	1. <i>Quantum Optics: An Introduction</i> , Mark Fox, (Oxford University Press)	3. <i>Introduction to Quantum Optics: From Light Quanta to Quantum Teleportation</i> , Harry Paul (Cambridge University Press)
	2. <i>Quantum Optics</i> , M.O. Scully, M.S. Zubairy, (Cambridge University Press)	4. <i>Quantum Optics for Beginners</i> , Z. Ficek, M. R. Wahiddin (Pan Stanford Publishing)

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N Vijayan, NPL, nvijayan@nplindia.org	1. Prof. V Subramanian, IIT Madras, manianvs@iitm.ac.in	1. Dr. Shadak Alee, SRMIST
2. Mr. R Seshadri, Titan Company Limited, seshadri@titan.co.in	2. Prof. C Vijayan, IIT Madras, cvijayan@iitm.ac.in	2. Dr. Junaid M. Laskar, SRMIST

ACADEMIC CURRICULA

Engineering Science Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21DCS201P	Course Name	DESIGN THINKING AND METHODOLOGY	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							1	0	4	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	SRM Innovation and Design Centre		Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Designed to explores mindset, skill set and toolset associated with design	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2 :	Designed to work with guided applications to framing and solving problems from the perspectives of both business and engineering writing	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3 :	Exposing students diverging to generate solutions and converging to select among them															
CLR-4 :	Design methods to create concept generation methods, concept selection methods, imagining alternative futures															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	learn and understand technology design concepts	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	learning mindset, skillset and toolset associated with design	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-3:	identify the best solutions and converging to select among them.	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	understand concept generation methods, concept selection methods, imagining alternative futures	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-

Unit-1 -Introduction to Design Methodology	15 Hour
Design Frameworks - Engineering Design Problem Solving - Developing Design Solutions - Making Design Solutions - Evaluating Design Solutions - Project Introduction and Team formation -Stakeholder Map - Brainstorming	
Unit-2-Prototyping	15 Hour
Prototyping Planning - Concept Refinement and Storyboard - Envisioning Future - Conceptual design - Creative Matrix, Morphological Synthesis, Concept Poster - Basic Presentation - Project Discussion with Teaching Team – Usability Test Demo	
Unit-3- User Assessment	15 Hour
Usability Test - Understanding Users - Learning about Customer - Clustering & Abstract Laddering - User Testing - Project Discussion with Teaching Team	
Unit-4 – Value Proposition Design	15 Hour
Value Proposition Design and Mapping, - Prototyping & Competitor Study - Competitors / Complementor's Map - Design Methodologies - Capital Budgeting: Risk Analysis with Scenarios - Project Discussion with Teaching Team - Project Mini-showcase - Project Discussion with Teaching Team	
Unit-5– Business Model	15 Hour
Business Model Canvas - Business pitch - Pitching strategies - IP and Partnerships - Forecasting Financial Statements - Project Discussion with Teaching Team - Final Project Presentation - Design Showcase	

Learning Resources	1. Dr. R. Thomas Wright, Dr. Greg J. Strimel, and Dr.Michael E. Grubbs Foundations of Engineering & Technology, 7th Edition	2. Ikhlaqsidhu , Innovation Engineering; a practical guide to creating anything new
--------------------	---	---

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	-	-	10%	-	10%	-	-
Level 2	Understand	20%	-	-	20%	-	20%	-	-
Level 3	Apply	20%	-	-	20%	-	20%	-	-
Level 4	Analyze	20%	-	-	20%	-	20%	-	-
Level 5	Evaluate	20%	-	-	20%	-	20%	-	-
Level 6	Create	10%	-	-	10%	-	10%	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.Ramakrishnan R,CDOO,Intellect Design Arena, Chennai	1.	1. Dr Shantanu Patil, SRMIST.
2. Mr Ramakrishnan, CDOO,Intellect Design Arena, Chennai	2.	2. Dr. Ananth Kumar R, SRMIST
3. Mr Anirban Chowdhury, Co-Founder & Director, Frugal Labs,Bengaluru	3.	3. Dr.M.B Mukesh Krishnan, SRMIST

Course Code	21CSS303T	Course Name	DATA SCIENCE	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							2	0	0	2

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Data Science and Business Systems	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1 :	Understand the basics of data	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CLR-2 :	Learn the Pandas library to analyze data frames	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CLR-3 :	Utilize different methods of data acquisition and data cleaning	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CLR-4 :	Explore the visualization tools for different kinds of input data formats	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CLR-5 :	Apply supervised and unsupervised learning to learn the hidden patterns from the data and predict the output	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the relationship between data	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO-2:	Identify the different data structures to represent data	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO-3:	Identify data manipulation and cleaning techniques using pandas	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO-4:	Constructs the Graphs and plots to represent the data using python packages	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply the principles of the data science techniques to predict and forecast the outcome of real-world problem.	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Data Science, Numpy & Pandas	10 Hour
Introduction to Data science: Facets of data, Data Science Process Introduction to Numpy: Numpy, creating array, attributes, Numpy Arrays objects: Creating Arrays, basic operations (Array Join, split, search, sort), Indexing, Slicing and iterating, copying arrays, Arrays shape manipulation, Identity array, eye function Pandas: Exploring Data using Series, Exploring Data using DataFrames, Index objects, Re index, Drop Entry, Selecting Entries, Data Alignment, Rank and Sort, Summary Statistics, Index Hierarchy Data Acquisition: Gather information from different sources, Web APIs, Open Data Sources, Web Scrapping.	
Unit-2- Data Wrangling, Data Cleaning and Preparation	10 Hour
Data Handling: Problem faced when handling large data-General techniques for handling large volume of data- General programming tips for dealing large data sets Data Wrangling: Clean, Transform, Merge, Reshape: Combining and Merging Datasets, Merging on Index, Concatenate, Combining with overlap, Reshaping, Pivoting Data Cleaning and Preparation: Handling Missing Data, Data Transformation, String Manipulation, summarizing, Binning, classing and Standardization, outlier/Noise& Anomalies.	
Unit-3- Visualization	10 Hour
Customizing Plots: Introduction to Matplotlib, Plots, making subplots, controlling axes, Ticks, Labels & legends; annotations and Drawing on subplots, saving plots to files, matplotlib configuration using different plot styles, Seaborn library. Making sense of data through advanced visualization : Controlling line properties of chart, creating multiple plots, Scatter plot, Line plot, bar plot, Histogram, Box plot, Pair plot, playing with text, styling your plot, 3d plot of surface	

Learning Resources	1. Grus, J. (2019). <i>Data Science from Scratch</i> , 2nd Edition. O'Reilly Media, Inc.	5. Vanderplas, J. T. (2017). <i>Python data science handbook: Essential tools for working with data</i> . O'Reilly Media, Inc.
	2. Jiawei Han, Micheline Kamber and Jian Pei (2012), <i>Data Mining Concepts and Techniques</i> , Third Edition, Elsevier.	6. Jeffrey S. Saltz and Jeffrey M. Stanton (2018), <i>An Introduction to Data Science</i> , Sage Publication.
	3. Davy Cielen, Arno D. B. Meysman, and Mohamed Ali (2016), <i>Introducing Data Science: Big data, machine learning, and more, using Python tools</i> , Manning Publications.	7. Shai Vaingast (2014), <i>"Beginning Python Visualization Crafting Visual Transformation Scripts"</i> , Second Edition, Apress.
	4. McKinney, W. (2018). <i>Python for data analysis: Data wrangling with pandas, NumPy, and IPython</i> . O'Reilly Media, Inc.	8. Wes Mc Kinney (2012). <i>"Python for Data Analysis"</i> , O'Reilly Media.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Veeramanickam. M.R.M, Associate Professor Chitkara University Institute of Engineering and Technology	1. Mr. Snehith Allam Raju Senior Manager Advanced Analytics & Architecture Envista Holdings Corporation, Hyderabad.	1. Dr.V.Kalpna, SRMIST
		2. Dr.G.Vadivu, SRMIST

ACADEMIC CURRICULA

Mandatory Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21PDM201L	Course Name	VERBAL REASONING	Course Category	M	NON CREDIT	L	T	P	C										
							0	0	2	0										
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil													
Course Offering Department		Career Development Centre		Data Book / Codes / Standards		Nil														
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the structure, organization, tone, and main idea of the passage.					1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3		
CLR-2:	Determine the grammatical, syntactical, and logical accuracy of sentences.																			
CLR-3:	Comprehend an argument's line of reasoning and recognize the logical coherence of ideas in a text.																			
CLR-4:	Enable students understand subtle meanings of words used in academic texts.																			
CLR-5:																				
Course Outcomes (CO):		At the end of this course, learners will be able to:																		
CO-1:	Build vocabulary through methodical approaches and nurture passion for vocabulary enrichment.					-	-	-	-	-	-	-	-	2	3	-	3	-	-	-
CO-2:	Detect and correct grammatical, syntactical, and logical fallacies.					-	-	-	-	-	-	-	-	2	3	-	3	-	-	-
CO-3:	Hone critical thinking skills by analyzing arguments with explicit and implicit premises to validate the author's point of view.					-	-	-	-	-	-	-	-	2	3	-	3	-	-	-
CO-4:	Analyze and evaluate texts critically in multifarious ways and identify relationships between sentences based on their function, use and characteristics.					-	-	-	-	-	-	-	-	2	3	-	3	-	-	-
Unit-1 - Sentence Correction																		10 Hour		
Subject Verb Agreement, Pronouns, Tense, Comparisons, Modifiers, parallelism, Subjunctive Mood																				
Unit-2 - Sentence Completion																		10 Hour		
Single Blank, Double and Triple blanks, Sentence Completion- Grammar, Synonyms and Antonyms																				
Unit-3 – Critical Reading																		10 Hour		
Critical Reasoning – Facts, Inference, Judgement, Strengthening and Weakening an Argument, Para jumble, Para Completion																				
Learning Resources	1. Charles Harrington Elstor, Verbal Advantage: Ten Easy Steps to a Powerful Vocabulary, Random House Reference, 2002																	3. Franklin GRE Word List, 3861 GRE Words, Franklin Vocab System, 2014Wiley's GMAT Reading Comprehension Grail, Wiley, 2016		
	2. Norman Lewis, How to Read Better and Faster, Goyal, 4 th Edition																	4. Manhattan Prep GRE : Reading Comprehension and Essays, 5th Edition		

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 (30%)		Formative CLA-2 (30%)		Summative (40%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	30%	-	30%	-	30%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	30%	-	30%	-	30%	-	-
Level 4	Analyze	-	20%	-	20%	-	20%	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Pratap Iyer, Study Abroad Mentors, pratap.iyer30@gmail.com	1. Mr Nishiith Sinha, dueNorth India Academics LLP, nsinha.alexander@gmail.com	1. Dr. P. Madhusoodhanan, SRMIST
2. Mr. Ajay Zener, Director, Gradsquare ajayzenner@gmail.com	2. Dr. Dinesh Khattar, Delhi University, dinesh.khattar31@gmail.com	2. Dr. M. Snehalatha, SRMIST
		3. Dr. Jayapragash J, SRMIST
		4. Ms. I. Jerlina John, SRMIST

Course Code	21PDM202L	Course Name	CRITICAL AND CREATIVE THINKING SKILLS	Course Category	M	NON CREDIT										L	T	P	C	
																0	0	2	0	
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil													
Course Offering Department		Career Development Centre		Data Book / Codes / Standards		Nil														
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Enable to solve problems using fundamental principles and recognize the logical coherence of ideas.					1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Interpret the structure, organization, tone, and main idea of the content.					Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Arrive at solutions to mathematical problems with requisite speed & accuracy.																			
CLR-4:	Provide the right knowledge, skill and aptitude to face any competitive examination.																			
CLR-5:																				
Course Outcomes (CO):		At the end of this course, learners will be able to:																		
CO-1:	Analyze and evaluate contents critically in multifarious ways.					-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
CO-2:	Grasp the approaches and strategies to enhance logical reasoning ability.					-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
CO-3:	Acquire requisite skill to conceptualize & solve aptitude questions quickly.					-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
CO-4:	Gain appropriate skills to succeed in preliminary selection process for recruitment.					-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
Unit-1 – Sentence Completion and Arithmetic-I																		10 Hour		
Sentence Equivalence and Text completion - Time and Work- Pipes & Cisterns - AP /GP (Progressions)																				
Unit-2 – Reasoning																		10 Hour		
Critical Thinking Skills – Assumption, Paradox, Logical Conclusion – Venn Diagram – Syllogism - Operator Based Questions (Quantitative Reasoning) - Ordering and Sequencing.																				
Unit-3 – Sentence Rearrangement and Arithmetic-II																		10 Hour		
Reading Comprehension – Para Jumble - Time and Distance- Problems on Trains- Boats & Streams- Races- Escalators-Circular Tracks – Quadratic Equations.																				
Learning Resources	1. Nishit K. Sinha, The Pearson Guide to Quantitative Aptitude and Data Interpretation for the CAT 2. Dinesh Khattar-The Pearson Guide to Quantitative Aptitude for competitive examinations 3. Charles Harrington Elstor, Verbal Advantage: Ten Easy Steps to a Powerful Vocabulary, Random House Reference, 2002										4. Norman Lewis, How to Read Better and Faster, Goyal, 4 th Edition 5. Franklin GRE Word List, 3861 GRE Words, Franklin Vocab System, 6. 2014Wiley's GMAT Reading Comprehension Grail, Wiley, 2016 7. Manhattan Prep GRE : Reading Comprehension and Essays, 5th Edition									

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 (30%)		Formative CLA-2 (30%)		Summative (40%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	30%	-	30%	-	30%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	30%	-	30%	-	30%	-	-
Level 4	Analyze	-	20%	-	20%	-	20%	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Pratap Iyer, Study Abroad Mentors, pratap.iyer30@gmail.com	1. Mr Nishith Sinha, dueNorth India Academics LLP, nsinha.alexander@gmail.com	1. Dr. P. Madhusoodhanan, SRMIST
2. Mr. Ajay Zener, Director, Gradsquare ajayzenner@gmail.com	2. Dr. Dinesh Khattar, Delhi University, dinesh.khattar31@gmail.com	2. Dr. M. Snehalatha, SRMIST
		3. Dr. Jayapragash J, SRMIST
		4. Ms. I. Jerlina John, SRMIST

Course Code	21PDM301L	Course Name	ANALYTICAL AND LOGICAL THINKING SKILLS				Course Category	M	NON CREDIT				L	T	P	C														
																0	0	2	0											
Pre-requisite Courses	Nil			Co- requisite Courses	Nil				Progressive Courses	Nil																				
Course Offering Department		Career Development Centre				Data Book / Codes / Standards				Nil																				
Course Learning Rationale (CLR):		The purpose of learning this course is to:								Program Outcomes (PO)												Program Specific outcomes								
CLR-1:	Recapitulate fundamental mathematical concepts and skills.															1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3		
CLR-2:	Arrive at solutions to mathematical problems with requisite speed & accuracy.																													
CLR-3:	Sharpen logical reasoning through skillful conceptualization, hone analytical thinking skills.																													
CLR-4:	understand and master the mathematical concepts to solve types of problem tested in competitive examinations.																													
CLR-5:																														
Course Outcomes (CO):		At the end of this course, learners will be able to:																												
CO-1:	Build a strong base in the fundamental mathematical concepts.															-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
CO-2:	Identify the approaches and strategies to solve problems with speed and accuracy.															-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
CO-3:	Understand, comprehend and provide logical conclusions to solve problems in teams, groups and individually.															-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
CO-4:	Gain appropriate skills to succeed in preliminary selection process for recruitment.															-	-	-	-	-	-	-	-	3	3	-	3	-	-	-
Unit-1 - Numbers																10 Hour														
Numbers – Logarithm																														
Unit-2 – Modern Mathematics																10 Hour														
Permutation and Combination – Probability - Clock and Calendars – Crypt Arithmetic																														
Unit-3 – Analytical Ability																10 Hour														
Number, Word Series – Coding Decoding – Cubes – Geometry, Mensuration – Trigonometry - Data Interpretation – Data Sufficiency																														
Learning Resources	1. Nishit K. Sinha, The Pearson Guide to Quantitative Aptitude and Data Interpretation for the CAT 2. Dinesh Khattar-The Pearson Guide to Quantitative Aptitude for competitive examinations															3. Arun Sharma, How to Prepare for Quantitative Aptitude for CAT, Tata McGraw Hill														

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 (30%)		Formative CLA-2 (30%)		Summative (40%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	30%	-	30%	-	30%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	30%	-	30%	-	30%	-	-
Level 4	Analyze	-	20%	-	20%	-	20%	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100%		100%		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Pratap Iyer, Study Abroad Mentors, pratap.iyer30@gmail.com	1. Mr Nishith Sinha, dueNorth India Academics LLP, nsinha.alexander@gmail.com	1. Dr. P. Madhusoodhanan, SRMIST
2. Mr Ajay Zenner, Career Launcher, ajay.z@careerlauncher.com	2. Dr. Dinesh Khattar, Delhi University, dinesh.khattar31@gmail.com	2. Dr. M. Sneha Latha, SRMIST
		3. Dr. Jayapragash J, SRMIST
		4. Ms. I. Jerlina John, SRMIST

Course Code	21PDM302L	Course Name	EMPLOYABILITY SKILLS AND PRACTICES				Course Category	M	NON CREDIT				<table><tr><td>L</td><td>T</td><td>P</td><td>C</td></tr><tr><td>0</td><td>0</td><td>2</td><td>0</td></tr></table>				L	T	P	C	0	0	2	0
L	T	P	C																					
0	0	2	0																					
Pre-requisite Courses	Nil		Co- requisite Courses	Nil				Progressive Courses	Nil															
Course Offering Department		Career Development Centre				Data Book / Codes / Standards			Nil															
Course Learning Rationale (CLR):		The purpose of learning this course is to:						Program Outcomes (PO)												Program Specific outcomes				
CLR-1:	Equip the students to build their profile and understand the nuances of resume building						Engineering Knowledge	2	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-2:	Utilize the group discussion activity to exhibit their knowledge and skills																							
CLR-3:	Get exposure on the interview techniques and get practical experience of attending an interview																							
CLR-4:	Enhance presentation skills along with exploration of opportunities																							
CLR-5:																								
Course Outcomes (CO):		At the end of this course, learners will be able to:						-	-	-	-	-	-	-	2	-	2	-	-	-	-			
CO-1:	Create a personal brand and prepare an effective and powerful resume						-	-	-	-	-	-	-	-	-	2	-	3	-	-	-			
CO-2:	Participate and perform in group discussion with an objective of getting the best out of group discussion						-	-	-	-	-	-	-	-	-	-	3	3	-	-	-			
CO-3:	Approach personal and technical interviews with clarity and confidence						-	-	-	-	-	-	-	-	-	2	-	3	-	-	-			
CO-4:	Present views and ideas in an organized way and get an understanding of the industrial expectations and career opportunities.						-	-	-	-	-	-	-	-	-	3	3	-	-	-	-			
Unit-1 - Profile Building																						10 Hour		
Personal profiling – Psychometric Tests – Competency Mapping – Personal Branding – Role of social media in profiling – Resume Building – SoP – Video Profile																								
Unit-2 - Group Discussion																						10 Hour		
Purpose and Role of GD in recruitment – GD preparation - Types of GD topics – Roles played in GD – Mock GDs – Case study-based GD																								
Unit-3 - Personal Interview																						10 Hour		
Introduction to personal interview – Types of interview – PI preparation – Mock Interviews – Group interviews – High order challenging questions – Discussion - Ethics at workplace																								
Learning Resources	1. Anukul Varshney, I'm not afraid of GDPI, India, PEARSON Publication, 2016.						4. Edgar Thorpe, Winning at Interviews, 5 th Edition, PEARSON Publication, 2013.																	
	2. Ramachandran and Karthik, From Campus to Corporate, India, PEARSON Publication, 2016.						5. William F. Roth, Ethics in the Workplace, PEARSON Publication, 2004.																	
	3. Michele Gilbert, Listening skills, Createspace Independent Publishing Platform, New York, 2015.						6. Dorie Clarke, Reinvent you, Harvard Business Review Press, 2013.																	
							7. Tran Le Hue Nghi, Building Soft skills for Employability, Routledge, 2020																	

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 (30%)		Formative CLA-2 (30%)		Summative (40%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	-	30%	-	30%	-	30%	-	-
Level 2	Understand	-	20%	-	20%	-	20%	-	-
Level 3	Apply	-	30%	-	30%	-	30%	-	-
Level 4	Analyze	-	20%	-	20%	-	20%	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ms. Sudha Mahadevan, Career Launcher, sudha.m@careerlauncher.com	1. Mr. Nishith Sinha, dueNorth India Academics LLP, nsinha.alexander@gmail.com	1. Dr. P. Madhusoodhanan SRMIST
2. Mr Ajay Zenner, Career Launcher, ajay.z@careerlauncher.com	2. Dr.Dinesh Khattar, Delhi University, dinesh.khattar31@gmail.com	2. Mr. P. Priyanand, SRMIST
		3. Mrs. M. Kavitha,, SRMIST

Course Code	21LEM201T	Course Name	PROFESSIONAL ETHICS	Course Category	M	NON CREDIT	L	T	P	C
							1	0	0	0

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	English and Foreign Languages	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1 :		connect the learners to their potential - understand moral, professional and personal values.														
CLR-2 :		introduce the learners to professional ethics and to enable them towards decision making skills														
CLR-3 :		draw the learners' attention towards business ethics.														
CLR-4 :		strengthen and enhance professional ethics through psychological approach														
CLR-5 :		cultivate a spirit of working in diverse world by understanding workplace ethics.														
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:		Equip themselves with an understanding of moral, professional and personal values														
CO-2:		Understand the need of ethics in shaping their profession The learners will hone their decision - making skills.														
CO-3:		Refine their business ethics based on psychological and philosophical perspective.														
CO-4:		Have an edge over the ethical systems in workplace.														
CO-5:		assess the need for a balance between ecology, engineering and economy														

Unit-1 - Introduction	3 Hour
Individual and Professional Ethics: Introduction to Professional Ethics, Morals, Values and Ethics - Personal and Professional - Sense of Engineering Ethics - Code of Ethics by NSPE - Making decisions with ethical dimensions - definition - roadmap to ethical decision making - common standards - internal obstacles - bias - empathy.	
Unit-2 - Business Ethics	3 Hour
Philosophical approaches to Business Ethics - ethical reasoning - ethical issues in business - Social Responsibility of Business - conflict of interest - cultural relativism - Ethical leadership - Resisting un - ethical authority and domination - Global Business Ethics.	
Unit-3 - Psychological Approaches	3 Hour
Ethical Theories - Psychological and Philosophical approaches - Myths about Morality - conflict of interest in psychological perspective - Courage - Integrity - ethical dilemma - Emotional Intelligence.	
Unit-4 - Workplace Ethic	3 Hour
Ethics in changing domains of Research - academic integrity - intellectual honesty - Role of Engineers and Managers - Ethical issues in Diverse workplace - competition - free will - Confidentiality - employee rights - Intellectual property rights - discrimination.	
Unit-5 - Safety, Responsibilities and Rights	3 Hour
Ecology, Engineering, Economy - Risk benefit analysis and reducing risk - SDGs - Corporate social responsibility and Corporate Sustainability - CSR in India - Sustainability Case Studies.	

Learning Resources	1. Subramanian. R., <i>Professional Ethics</i> , Oxford Publication, 2013.	5. https://www.nspe.org/resources/ethics/code-ethics
	2. Nagarasan. R.S. <i>Professional Ethics and Human Values</i> . New Age International Publications, 2006.	6. https://www.toolshero.com/tag/ethical-decision-making/
	3. Mike W Martin and Roland Schinzinger, <i>Ethics in Engineering</i> , 4th edition, Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi, 2014	7. https://pagecentertraining.psu.edu/public-relations-ethics/introduction-to-public-relations-ethics/lesson-1/ethical-theories/
	4. https://soaneemrana.org/onewebmedia/Professional%20Ethics%20and%20Human%20Values%20by%20R.S%20NAGARAZAN.pdf	8. https://www.ewh.ieee.org/soc/pes/switchgear/presentations/tp_files/2017_1_Thurs_Shiffbauer_Singer_Engineering_Ethics.pdf
		9. https://peer.asee.org/case-studies-in-engineering-ethics.pdf

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 (30%)		Formative CLA-2 (30%)		Summative (40%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%		-	-
Level 2	Understand	20%	-	20%	-	20%		-	-
Level 3	Apply	30%	-	30%	-	30%		-	-
Level 4	Analyze	20%	-	20%	-	20%		-	-
Level 5	Evaluate	-	-	-	-	-		-	-
Level 6	Create	-	-	-	-	-		-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ms. Woanyuh Zoe Tsou Founder and proprietor, IF Lingua Cultural studio, Hsinchu, Taiwan.	1. Dr. S. Soundiraraj, Professor and Head, Dept. of English, College of Engineering, Anna University Guindy Campus, Chennai.	1. Dr. P. Tamilarasan, SRMIST.
	2. Dr. J. Mangayakarasi, Dean of Academics Affairs & Head, PG and Research, Dept. of English, Ethiraj College for Woman, Chennai.	2. Dr. J. Michael Raj, SRMIST
		3. Dr. S. Ramya, SRMIST
		4. Dr. K.R. Sondaraya SRMIST.

Course Code	21LEM202T	Course Name	UHV-II: UNIVERSAL HUMAN VALUES – UNDERSTANDING HARMONY AND ETHICAL HUMAN CONDUCT	Course Category	M	NON GRADED	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	EFL-Value Education Cell	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes														
CLR-1 :	Help the students to understand need of value education, appreciate the essential complementarity between 'values' and 'skills' and to ensure sustained happiness and prosperity which are the core aspirations of all human beings,													1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2 :	Help students initiate a process of dialog within themselves to know what they really want to be' in their life and profession.																																							
CLR-3 :	Help students to understand the meaning of happiness and prosperity for a human being. Understanding holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.																																							
CLR-4 :	Help students on right understanding of the Human reality and the rest of existence, harmony at all the levels of human living, and live accordingly.																																							
CLR-5 :	Highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.																																							
Course Outcomes (CO):		At the end of this course, learners will be able to:													-	-	-	-	-	-	-	3	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-1:	Evaluate the significance of value inputs in formal education and start applying them in their life and profession													-	-	-	-	-	-	-	3	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-		
CO-2:	Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.													-	-	-	-	-	-	-	3	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-		
CO-3:	Analyze the value of harmonious relationship based on trust and respect in their life and profession													-	-	-	-	-	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
CO-4:	Examine the role of a human being in ensuring harmony in society and nature.													-	-	-	-	-	2	2	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-		
CO-5:	Apply the understanding of ethical conduct to formulate the strategy for ethical life and profession.													-	-	-	-	-	-	-	3	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Unit-1 - Introduction-Basic Human Aspiration, its fulfillment through All- encompassing Resolution	9 Hour
The basic human aspirations and their fulfillment through Right understanding and Resolution, Right understanding and Resolution as the activities of the Self, Self being central to Human Existence; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution	
Unit-2 - Right Understanding (Knowing)- Knower, Known & the Process	9 Hour
The domain of right understanding starting from understanding the human being (the knower, the experiencer and the doer) and extending up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).	
Unit-3 - Understanding Human Being	9 Hour
Understanding the human being comprehensively as the first step and the core theme of this course; human being as co-existence of the self and the body; the activities and potentialities of the self; Basis for harmony/contradiction in the self	

Unit-4 - Understanding Nature and Existence	9 Hour
A comprehensive understanding (knowledge) about the existence, Nature being included; the need and process of inner evolution (through self-exploration, self-awareness and self-evaluation), particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/order leading to comprehensive knowledge about the existence).	
Unit-5 - Understanding Human Conduct, All-encompassing Resolution & Holistic Way of Living	9 Hour
Understanding Human Conduct, different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All- encompassing Resolution covering all four dimensions of human endeavor viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from Self to Nature and entire Existence	

Learning Resources	1. Gaur R.R., Sangal R., Bagaria G.P., 2019 (2nd Revised Edition), A Foundation Course in Human Values and Professional Ethics, Excel Books, New Delhi.	8. A N Tripathy, 2003, Human Values, New Age International Publishers.
	2. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA	9. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati.
	3. E.F. Schumacher, 1973, small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.	10. E G Seebauer & Robert L. Berry, 2000, Fundamentals of Ethics for Scientists & Engineers, Oxford University Press
	4. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991	11. M Govindrajran, S Natrajan & V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
	5. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.	12. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
	6. A Nagraj, 1998, Jeevan Vidya EkParichay, Divya Path Sansthan, Amarkantak.	13. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
	7. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.	

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 (50%)		Formative CLA-2 (30%)		Summative (20%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	-	30%	-	30%	-	-
Level 2	Understand	20%	-	-	20%	-	20%	-	-
Level 3	Apply	30%	-	-	30%	-	30%	-	-
Level 4	Analyze	20%	-	-	20%	-	20%	-	-
Level 5	Evaluate	-	-	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.	1.	1. .Dr.P.Supraja, SRMIST

Course Code	21LEM301T	Course Name	INDIAN ART FORM	Course Category	M	NON CREDIT	L	T	P	C
							1	0	0	0

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	English and Foreign Languages	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:				
CLR-1:	introduce the learners to the changing art forms in different periods of time: richness, variety and significance of various Indian art forms					
CLR-2:	enable the students to recognize and appreciate paintings of different schools prevalent in the different geographical locations					
CLR-3:	draw the learner's attention towards the various types of sculpture based on the materials used and the themes behind them					
CLR-4:	cultivate a sense of appreciation about the aesthetics of drawing as an integral part of our daily life					
CLR-5:	orient the learners about the changing Indian social scenario and the ways they are reflected in the changing facets of Modern Indian Art Forms					

Program Outcomes (PO)												Program Specific outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3

Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Classify with an awareness of the rich cultural heritage of India	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-
CO-2:	Understand the contexts and significance of various Indian art forms	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-
CO-3:	Understand how the confluence of the diverse art forms of India create the mosaic of the Indian nation	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-
CO-4:	Differentiate each artwork from different periods be it an architecture, sculpture, painting or decorative and functional object	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-
CO-5:	Relate with history and development of Art and its historical, social, cultural, religious and political context.	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-

Unit-1 - Indian Art over Ages - An Overview	3 Hour
Ancient India: An Overview, Raj-Ravi Verma: religious stories like mythologies of Hindu gods, Mysore and Tanjore Art: included themes revolving around Hindu epics like, Ramayana and Mahabharata, Indian artists from different fields, Folk Art, Folk art and popular culture: Classical and folk art. Influential factors giving rise to modern art. Concepts and Motifs behind modern art Mughal paintings. Astonishing contemporary paintings by Indian artists. Fairs, festivals and local deities in the development of art forms. Myth, legends, snippets from epic, multitudinous gods born out of dream and fantasy in art forms	
Unit-2 - Indian Painting	3 Hour
Indus Valley civilization paintings on pottery. Cave paintings from different parts of India. The paintings of the Ajanta and Ellora caves. Paintings of North India, South India, East India, West India, Central and Deccan India, Thanjavur, Madhubani paintings, Analyzing the recurrent themes style through selected illustrations. Kalamkari paintings – Features of organic art; obtaining colours from natural sources, Attempting Simple Kalamkari/Madhubani paintings using natural colours, Pattachitra paintings, Students, presenting and sharing their paintings, Moghal paintings, Moghal paintings from the various Moghal dynasties and identification of the common features	
Unit-3 - Indian sculpture	3 Hour
Sculpture during the Harappan period, Terra Cota – What? Where? When? – A discussion, Rock cut sculpture – Differences between rock cut sculpture and stone sculpture ,Sculptures in religious buildings, Buddhism, Hinduism, and Jainism in sculpures,Visit to Mahabalipuram and submitting a report by the students, Bronze sculptures in India, Cultural stonework in India - in the form of primitive cupule art, the Buddhist Pillars of Ashoka of the Mauryan period, The figurative Greco-Buddhist sculpture of the Gandhara and Mathura schools, and the Hindu art of the Gupta period: Brief Introduction, Khajuraho Temples in Madhya Pradesh, Debate on "Religion and Art Today"	

Unit-4 - The Indian Art of Floor Decoration	3 Hour
Kolam - the traditional floor drawing of South India, Daily life and Kolam - Line drawings, geometric designs and natural world - Some examples, Beliefs behind Kolam, Rangoli – Occasions and motifs, Kalamezhuthu in Kerala - Religious significance, Mandana paintings of Rajasthan and Madhya Pradesh by oldest tribal communities, Bengal's floor art-Alpona, Festival specific Floor Art across India, Festival specific Floor Art across India, Pookalam: The Onam Floral Rangoli, Body Art: Traditional Mehendi, Mehendi designs, religious and cultural significances	
Unit-5 - Modern Art	3 Hour
Matching the picture with the artist, Tracing the major ideas through paintings – Going back to Hindu themes, Student presentations on individual artists, Tracing the major ideas through paintings – Indian Village Life and nationalist themes, Student presentations on individual artists, European influences (British) – Trends in, painting – portrait, landscape and realistic, Collection and display of paintings by various artists, British Gothic and Indo Saracenic architecture through examples, Field trip to places in Chennai which have Indo Saracenic, architecture and report submission, Indian Art post-Independence Progressive Artists' Group and their Influence, Fusion of western style and Indian themes	

Learning Resources	1. Ketkar, Anil Rao Sandhya. <i>The History of Indian Art (Paperback)</i> . Jyotsna Prakashan, 2017. 2. Haturvedi, P. N. <i>Encyclopedia of Indian Art and Architecture</i> . M. D. Publications Pvt. Ltd., 2009.
---------------------------	--

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 (30%)		Formative CLA-2 (30%)		Summative (40%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%		-	-
Level 2	Understand	20%	-	20%	-	20%		-	-
Level 3	Apply	30%	-	30%	-	30%		-	-
Level 4	Analyze	20%	-	20%	-	20%		-	-
Level 5	Evaluate	-	-	-	-	-		-	-
Level 6	Create	-	-	-	-	-		-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Usha Kodandaraman, ABK AOTS, Chennai drushsk@gmail.com	1. Dr. S. P.Dhanavel, Professor of English, IIT, Chennai dhanavelsp@iitmac.in	1. Dr. K.Anbazhagan, SRMIST
2. Mr. Durga Prasad Bokka, TCS Chennai durgaprasad@tcs.com	2. Ms. Subashree, Asst. Prof., VIT, Chennai subashree@vit.ac.in	2. Dr. Sukanya Saha, SRMIST

Course Code	21LEM302T	Course Name	INDIAN TRADITIONAL KNOWLEDGE	Course Category	M	NON CREDIT	L	T	P	C
							1	0	0	0

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	English and Foreign Languages	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Introduce the learners to the early and traditional environmental friendly agricultural practices	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Enable the students to recognize and appreciate the contribution of India to astronomical studies																											
CLR-3:	Draw the learner's attention towards the holistic approach behind Indian system of medicine																											
CLR-4:	Cultivate a sense of appreciation about ancient Indian Engineering and Technology as diverse, culture and resource specific																											
CLR-5:	Develop an understanding about the connection of daily life to the environment and a healthy lifestyle through a comparison of the linguistic phrases and sayings and analyzing them from today's science																											
Course Outcomes (CO):		At the end of this course, learners will be able to:												-	-	-	-	-	3	-	-	-	-	-	3	-	-	-
CO-1:	Describe the ancient India's eco consciousness and India's contribution to astronomy and the beliefs associated with it	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	3	-	-	-		
CO-2:	Classify the Indian aesthetic sensibility which is evidenced in the architectural monuments, economic life and religious worship	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	3	-	-	-		
CO-3:	Understand how Indians have had a holistic approach towards human life integrating the body, mind and soul	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	3	-	-	-		
CO-4:	Understand the importance of Traditional knowledge in Agriculture and Medicine.	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	3	-	-	-		
CO-5:	relate the traditional knowledge in different sectors	-	-	-	-	-	3	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	3	-	-	-		

Unit-1 - Agriculture	3 Hour
Early agricultural settlements - Influencing Factors – locale and climate-Locating the early agricultural settlements in the Indian map and indicating the timeline -Crop cultivation - Community based Environment friendly practices -Group presentations on the traditional agricultural practices in selected states-Ancient Indian Water management and irrigation methods -A region-based study of natural water resources and aquifers and types of irrigation	
Unit-2 - Mathematics & Astronomy	3 Hour
Concepts of time and space - Knowledge of the Universe-Quiz based on the Indian concept of time and distance between the planets-Great astronomers and mathematicians of ancient India-The respective contributions of Astronomers and Mathematicians -The planetary system and Indian Astrology: Basic Facts-Discussion on a few sample birth charts and predictions made	
Unit-3 - Medicine	3 Hour
Introduction to the school of Ayurveda, Siddha and Naturopathy: -Compare and Contrast of the methodologies, popular beliefs, myths and truths about medications-Common features - Holistic Therapeutic Approach – Natural elements, individual constitution (Humours), and the balance recommended -Understanding the rationale behind selected sample treatments provided or advised, Case Studies- Yoga and its Universal Appeal -Discussions on worldwide popularity of Yoga and meditation	

Unit-4 - Engineering & Technology	3 Hour
Architecture – Temples, forts, palaces, houses and town planning-Group Discussions through examples from different historical periods and geographical locations Metallurgy – Coins, Traditional Indian Metal Carvings, Discussions on historical periods and their architectural influences- Textile technology – Region / Culture specific Fiber, Fabric and weaving Comparing the Temple Architecture of North and Southern Indian States	
Unit-5 - Customs, Sayings and Life Truths	3 Hour
Regional myths, beliefs, and cultural practices, Noting the idioms, proverbs in mother tongues connected to seasons and festivals, Traditional Foods of India in accordance with the climate and availability of the resources, collecting old sayings in specific regions of India, Translating Regional sayings into English, Traditional sayings about Hygiene and practices pertaining to them	

Learning Resources	1. V. Sivaramakrishnan (Ed.), Cultural Heritage of India-course material, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014. 2. Basham, A.L. Ed. A Cultural History of India. OUP, 1997.
---------------------------	---

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 (30%)		Formative CLA-2 (30%)		Summative (40%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%		-	-
Level 2	Understand	20%	-	20%	-	20%		-	-
Level 3	Apply	30%	-	30%	-	30%		-	-
Level 4	Analyze	20%	-	20%	-	20%		-	-
Level 5	Evaluate	-	-	-	-	-		-	-
Level 6	Create	-	-	-	-	-		-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Usha Kodandaraman, ABK AOTS, Chennai, drushsk@gmail.com	1. Dr. S. P.Dhanavel, Professor of English, IIT, Chennai, dhanavelsp@iitmac.in	1. Dr.K.Anbazhagan, SRMIST
2. Mr. Durga Prasad Bokka, TCS Chennai, durgaprasad@tcs.com	2. Ms. Subashree, Asst. Prof., VIT, Chennai subashree@vit.ac.in	2. Dr.S.Ramya, SRMIST

ACADEMIC CURRICULA

**Humanities & Social Sciences
including Management Courses**

Regulations 2021



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu, Tamil Nadu, India

Course Code	21PDH201T	Course Name	SOCIAL ENGINEERING	Course Category	H	HUMANITIES AND SOCIAL SCIENCES										L	T	P	C												
																2	0	0	2												
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil																								
Course Offering Department		Career Development Centre		Data Book / Codes / Standards		Nil																									
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes													
CLR-1:	Create personal awareness and social responsibility towards the society				1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Equip students on social competencies to be self-reliant, resourceful and industrious																														
CLR-3:	Gain knowledge on social entrepreneurship and design social business plan																														
CLR-4:	Apply knowledge and skills in the pursuit of humanitarian goals																														
Course Outcomes (CO):		At the end of this course, learners will be able to:				-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-1:	Identify and address social problems and the needs of social responsibilities				-	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Understand social responsibility competencies and involve in socially responsible activities				-	-	-	-	-	-	-	-	2	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Build a business plan to meet social needs and gain real time experience				-	-	-	-	-	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Possess an insight of social engineering and cause social change				-	-	-	-	-	-	-	3	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unit-1 – Social Ethics and Responsibilities																10 Hour															
Introduction to Social Engineering – Importance – Social Ethics – Vision & Mission towards society – Social Change – Individual Social Responsibility (ISR), United Nations Sustainable Development Goals (UNSDGs) – Relevance & impact of Sustainable Development Goals (SDGs)																															
Unit-2 – Social Competencies																10 Hour															
Personal Responsibility Competencies (PRC) – Self-determination – Self regulation – Well-being (PERMA) – Volunteerism – Social Responsibility Competencies (SRC) – Contributing to community & environment – Solving problems peacefully, Valuing diversity – Building relationships – Non-Governmental Organizations (NGO) – functions – Types – Approaches – Non-Profit Organizations (NPO) – Corporate Social Responsibility – Evolution - Benefits – Types – Legal Mandate																															
Unit-3 – Social Entrepreneurship																10 Hour															
Social Marketing – Marketing mix - Process - Social Entrepreneurship – History – Impact – Types, Social Entrepreneurs – Social Enterprises – Social Business model canvas																															
Learning Resources	1. Joel Makeower, Beyond The Bottom Line: Putting Social Responsibility to work for your Business and the World, Oct, 1995										5. Nicholls, Alex, ed., Social Entrepreneurship – New Models of Sustainable Social Change, Oxford University Press, 2008																				
	2. Simen Sinek, Start with Why, How great leaders Inspire Everyone to Take Action, Penguin UK, 2011										6. Ronald R. Sims, Ethics and Corporate Social Responsibility: Why Giants fall, 2003																				
	3. Adam Grant, Give and Take: Why Helping others drives our success, Orion Publishing Group, 2014										7. Robert A. Rohm, Positive Personality Profiles, Personality Insights, Inc, 2006																				
	4. David Bornstien, How to change the world, Oxford University Press, 2007										8. Neil Malhotra, Frontiers in Social Innovation. Harvard Business Review Press, 2022																				

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Ajay Zener, Director, Gradsquare	1. Dr.J.Vanitha, Dept. of Sociology, Loyola College.	1. Dr.P.Madhusoodhanan, SRMIST
		2. Mr.P.Priyanand, SRMIST
		3. Ms.M.Kavitha, SRMIST

Course Code	21GNH401T	Course Name	BEHAVIOURAL PSYCHOLOGY	Course Category	H	HUMANITIES AND SOCIAL SCIENCES				L	T	P	C
										2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	College of Engineering and Technology	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
CLR-1:	understand the importance of self and attitude, develop emotion maturity to become a positive individual													1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
CLR-2:	help students move towards problem solving and creative thinking																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
CLR-3:	help students to develop life skill like resilience, communication																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
CLR-4:	explore and assess the perception of stress and their coping strategies																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
CLR-5:	understand the intercorrelation between personality, nationalism, ethics and human values																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
Course Outcomes (CO):		At the end of this course, learners will be able to:													-	2	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Understanding Self for Effectiveness	9 Hour
Self and Competency; Techniques of Self Awareness, Building Positive Attitude; optimism, acceptance and Attitude formation. Self Esteem; Components of Self-esteem, building self-esteem. and Building Emotional Competence; understanding Emotions, Emotional Maturity and emotional intelligence.	
Unit-2 - Problem Solving and Creativity	9 Hour
Thinking; Components of Thinking, nature of thinking, thinking and reasoning. Problem-Solving, Problem-Solving Process, problem solving skills and strategies. and creative thinking, model of creative thinking	
Unit-3 – Life Skills	9 Hour
Life skills development; components of life skills, Interpersonal Skills; Concepts of Resilience; developing resilience. Communication skills, empathy and communication. Importance and application of life skills.	
Unit-4 - Stress and Coping Strategies	9 Hour
Concepts of Stress, Stages of Stress, Models of Stress, Causes and Symptoms of Stress, Strategies of Stress Management	
Unit-5 - Personality, Nationalism and Human Values	9 Hour
Individual difference & Personality; personality types, components of personality development. Socialization; principals of socialization, social skills and interaction Managing Diversity; Psychology of Diversity, strategies to manage diversity, Ethics; ethical framework and moral behaviour.	

Learning Resources	<ol style="list-style-type: none"> 1. Organization Behaviour – Keith Davis, Tata McGraw Hill; Tenth Edition (1 January 2001) 2. Understanding Social Behaviour – Bates Alan P & Joseph Julian, Publisher : Houghton Mifflin School 3. Handbook of Social Psychology – Lindzey G & Borgatta, Publisher : Springer 4. How to be a Better Problem Solver – Michael Stevens, Kogan Page; 1st edition 1996 5. How to be better at Creativity – Geoffrey, Petty, Publisher : Lulu.com 2017 	<ol style="list-style-type: none"> 6. Effective small group and Team communication – Judith D. Hoover, Wadsworth Publishing Co Inc; 2nd edition 2004 7. Sociology : The Study of Human Interaction – David Dressler, Donald E.Carns, Edition, 2 ; Publisher, Knopf, 1973 8. Studies in Stress and its Management – Pestonjee DM, Pareek Udai, Agrawal Rita 9. Coping with Stress in a changing world – Richard Blonna, McGraw-Hill Education; 5th edition 2011
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	-	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Nappinnai Seran, Consultant Psychologist, Professor Dept. Of Psychiatry at Meenakshi Medical College	1. Dr. Ragitha Radhakrishnan, IQAC co-ordinator & Head, Department of Psychology, Dr.MGR Janaki College of Arts & Science for Women, Chennai-600 028.	1. Dr.Emilda Judith Ezhil Rajan, Associate Professor, Clinical Psychology, SRM MCH & RC
2. Prof. (Dr.) S.Srividhya Clinical Psychologist, Wellbeing expert & the soul saviour specialist		

ACADEMIC CURRICULA

**Project Work, Seminar,
Internship in Industry / Higher Technical Institutions
Courses**

Regulations 2021



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu, Tamil Nadu, India

Course Code	21GNP301L	Course Name	COMMUNITY CONNECT		Course Category	P	PROJECT WORK, SEMINAR, INTERNSHIP IN INDUSTRY / HIGHER TECHNICAL INSTITUTIONS		L	T	P	C
									0	0	2	1

Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil					
Course Offering Department					Data Book / Codes / Standards		Nil					

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Specific outcomes		
CLR-1:		Train oneself in finding the aspects in real-time work environment and prepare them to join the workforce in the future												1	2	3
CLR-2:		Gain the exposure to the society including rules, regulations and safety practices												4	5	6
CLR-3:		Enhance social service and skills of the students												7	8	9
CLR-4:		Develop the students in terms of ability, competence and interpersonal relationship												10	11	12
CLR-5:		Enhance students' knowledge in one particular technology												Engineering Knowledge	Problem Analysis	Design/development of solutions
Course Outcomes (CO):		At the end of this course, learners will be able to:												Conduct investigations of complex problems	Modern Tool Usage	The engineer and society
CO-1:		Apply social knowledge in the real world of work and get attached to the community												Environment & Sustainability	Ethics	Individual & Team Work
CO-2:		Demonstrate competency in societal problems and finding solutions												Communication	Project Mgt. & Finance	Life Long Learning
CO-3:		Effectively implement skills in professional communication, technical writing and using multimedia tools												PSO-1	PSO-2	PSO-3
CO-4:		Develop ability to work as an individual and in a group as an effective team member												-	-	-
CO-5:		Master the professional and ethical responsibilities of a social worker												-	-	-

Students shall undergo social service in government recognized NGOs/Hospitals/Service organizations for a duration of 4 to 6 weeks during the IV semester vacation. At the end of the community connect, the student shall submit a report to the department and make a presentation during the 5th semester, which will be assessed by a committee constituted by the department or school.

Learning Assessment	Community Connect Certification and Report Submission (80% weightage)	Final Presentation (20% weightage)
---------------------	---	------------------------------------

Note: Final Presentation Evaluation would be done by the expert Committee formed by the Department.

Course Code	21ASP302L	21AIP302L	21AUP302L	21BTP302L	21BMP302L	21CHP302L	21CEP302L	21CSP302L	Course Name	PROJECT	Course Category	P	PROJECT WORK, SEMINAR, INTERNSHIP IN INDUSTRY / HIGHER TECHNICAL INSTITUTIONS	L	T	P	C
	21ECP302L	21EEP302L	21EVP302L	21EIP302L	21FPP302L	21MEP302L	21MHP302L	21NTP302L						0	0	6	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Data Book / Codes / Standards			Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes						
CLR-1:	Learn responsible and professional way of working	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3				
CLR-2:	Practice development-oriented approach to work																															
CLR-3:	Enhance students' knowledge in one particular technology																															
CLR-4:	Create awareness of the social, cultural, global and environmental responsibility as an engineer																															
CLR-5:	Grow more empathetic, become systems thinkers, become explorers, problem-solvers.																															
Course Outcomes (CO):		At the end of this course, learners will be able to:																														
CO-1:	Develop capability to acquire and apply fundamental principles of engineering	3	3	3	3	3	-	3	3	3	3	3	3																			
CO-2:	Become updated with all the latest changes in technological world	3	3	3	3	3	-	3	3	3	3	3	3																			
CO-3:	Make deep connections between ideas	3	3	3	3	3	-	3	3	3	3	3	3																			
CO-4:	Learn to take creative risks	3	3	3	3	3	-	3	3	3	3	3	3																			
CO-5:	Be ready for the creative economy also engage in iterative thinking and divergent thinking	3	3	3	3	3	-	3	3	3	3	3	3																			

Project Work Selection: Project Work Titles for students would be finalized by the Department Project Work Evaluation Committee.

	Continuous Learning Assessment (100% weightage)				Final Examination (0%)	
	Review - 1	Review - 2	Project Report	Viva-Voce		
Project	30 %	40%	10 %	20 %	-	

Note: Final Presentation Evaluation would be done by the expert Committee formed by the Department.

Course Code	21ASP303T	21AIP303T	21AUP303T	21BTP303T	21BMP303T	21CHP303T	21CEP303T	21CSP303T	Course Name	MOOC	Course Category	P	PROJECT WORK, SEMINAR, INTERNSHIP IN INDUSTRY / HIGHER TECHNICAL INSTITUTIONS	L	T	P	C
	21ECP303T	21EEP303T	21EVP303T	21EIP303T	21FPP303T	21MEP303T	21MHP303T	21NTP303T						3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Data Book / Codes / Standards			Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	Improve Student Academic Characteristics and learning goals through forums, discussion groups, and blogs												
CLR-2:	Improve Student Personal Characteristics through self-learning habits												
CLR-3:	Characterize self-learning environment that includes pedagogy, tools, tasks, duration, feedback and assessments												
CLR-4:	Improve lifelong learning habits and Learning process												
CLR-5:	Characterize learning engagement methods and activities												
Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	Inculcate student characteristics: prior-knowledge, prior-experience, expertise, academic achievement and matriculation												
CO-2:	Inculcate self-motivation, self-confidence, intrinsic motivation, participation, social economic statute, and task-orientation												
CO-3:	Enhance self-learning through peer learning, learning groups, positive collaboration												
CO-4:	Explore different learning styles and activities, identify self-learning pace, difficulties and remedial measures												
CO-5:	Identify ways of students' engagement, achievement, and attrition												

Program Outcomes (PO)												Program Specific outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
3	2	-	-	-	-	-	-	-	-	-	3	-	-	-
3	2	-	-	-	-	-	-	-	-	-	3	-	-	-
3	2	-	-	-	-	-	-	-	-	-	3	-	-	-
3	2	-	-	-	-	-	-	-	-	-	3	-	-	-
3	2	-	-	-	-	-	-	-	-	-	3	-	-	-

MOOC Course Selection: List of MOOC Courses that are Approved to be learned by the student will be displayed by the Department MOOC Committee. Student can pick any course from that list.

Learning Assessment	MOOC Certification Obtained (100% weightage)
---------------------	--

Course Code	21ASP401L	21AIP401L	21AUP401L	21BTP401L	21BMP401L	21CHP401L	21CEP401L	21CSP401L	Course Name	MAJOR PROJECT	Course Category	P	PROJECT WORK, SEMINAR, INTERNSHIP IN INDUSTRY / HIGHER TECHNICAL INSTITUTIONS	L	T	P	C
	21ECP401L	21EEP401L	21EVP401L	21EIP401L	21FPP401L	21MEP401L	21MHP401L	21NTP401L						0	0	30	15

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Data Book / Codes / Standards			Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Learn responsible and professional way of working	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Practice development-oriented approach to work																											
CLR-3:	Enhance students' knowledge in one particular technology																											
CLR-4:	Create awareness of the social, cultural, global and environmental responsibility as an engineer																											
CLR-5:	Grow more empathetic, become systems thinkers, become explorers, problem-solvers.																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Develop capability to acquire and apply fundamental principles of engineering	3	3	3	3	3	-	3	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-	
CO-2:	Become updated with all the latest changes in technological world	3	3	3	3	3	-	3	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-	
CO-3:	Make deep connections between ideas	3	3	3	3	3	-	3	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-	
CO-4:	Learn to take creative risks	3	3	3	3	3	-	3	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-	
CO-5:	Be ready for the creative economy also engage in iterative thinking and divergent thinking	3	3	3	3	3	-	3	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-	

Project Work Selection: Project Work Titles for students would be finalized by the Department Project Work Evaluation Committee.

	Continuous Learning Assessment (100% weightage)				
	Review - 1	Review - 2	Review - 3	Project Report	Viva-Voce
Major Project	10 %	20 %	30 %	10 %	30 %

Note: Final Presentation Evaluation would be done by the expert Committee formed by the Department.

Course Code	21ASP402L	21AIP402L	21AUP402L	21BTP402L	21BMP402L	21CHP402L	21CEP402L	21CSP402L	Course Name	MAJOR PROJECT	Course Category	P	PROJECT WORK, SEMINAR, INTERNSHIP IN INDUSTRY / HIGHER TECHNICAL INSTITUTIONS	L	T	P	C
	21ECP402L	21EEP402L	21EVP402L	21EIP402L	21FPP402L	21MEP402L	21MHP402L	21NTP402L						0	0	20	10

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Data Book / Codes / Standards			Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Learn responsible and professional way of working	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Practice development-oriented approach to work	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	Enhance students' knowledge in one particular technology																											
CLR-4:	Create awareness of the social, cultural, global and environmental responsibility as an engineer																											
CLR-5:	Grow more empathetic, become systems thinkers, become explorers, problem-solvers.																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Develop capability to acquire and apply fundamental principles of engineering	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-												
CO-2:	Become updated with all the latest changes in technological world	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-												
CO-3:	Make deep connections between ideas	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-												
CO-4:	Learn to take creative risks	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-												
CO-5:	Be ready for the creative economy also engage in iterative thinking and divergent thinking	3	3	3	3	3	-	3	3	3	3	3	3	-	-	-												

Project Work Selection: Project Work Titles for students would be finalized by both industry and the Department Project Work Evaluation Committee.

	Continuous Learning Assessment (100% weightage)				
	Review - 1	Review - 2	Review - 3	Project Report	Viva-Voce
Major Project	10 %	20 %	30 %	10 %	30 %

Note: Students register for this industry-based major project also have to register for internship
Final Presentation Evaluation would be done by the expert Committee formed by the Department.

Course Code	21ASP403L	21AIP403L	21AUP403L	21BTP403L	21BMP403L	21CHP403L	21CEP403L	21CSP403L	Course Name	INTERNSHIP	Course Category	P	PROJECT WORK, SEMINAR, INTERNSHIP IN INDUSTRY / HIGHER TECHNICAL INSTITUTIONS	L	T	P	C
	21ECP403L	21EEP403L	21EVP403L	21EIP403L	21FPP403L	21MEP403L	21MHP403L	21NTP403L						0	0	10	5

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		Data Book / Codes / Standards			Nil

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Become job ready along with real corporate exposure	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Increase self-confidence and helps in finding their own proficiency	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Cultivate leadership ability and responsibility to perform or execute the given task															
CLR-4:	Inculcate learners hands on practice within a real job situation															
CLR-5:	Create awareness of the social, cultural, global and environmental responsibility as an engineer															
Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Enhance capability to acquire and apply fundamental principles of engineering	3	2	2	3	3	3	-	3	3	3	3	3	-	-	-
CO-2:	Become master in one's specialized technology	3	2	2	3	3	3	-	3	3	3	3	3	-	-	-
CO-3:	Become updated with all the latest changes in technological world	3	2	2	3	3	3	-	3	3	3	3	3	-	-	-
CO-4:	Demonstrate hands on practice within a real job situation	3	2	2	3	3	3	-	3	3	3	3	3	-	-	-
CO-5:	Inculcate self-improvement through continuous professional development and life-long learning	3	2	2	3	3	3	-	3	3	3	3	3	-	-	-

Internship Training Selection: List of Industries / Research Centre's for Internship Training for students would be finalized by the Department Internship/Industrial Training Committee.

	Continuous Learning Assessment (100% weightage)				
	Review - 1	Review - 2	Review - 3	Project Report	Viva-Voce
Major Project	10 %	20 %	30 %	10 %	30 %

Note: Students register for this internship also have to register for industry-based major project.
Final Presentation Evaluation would be done by the Internship/Industrial Training Committee formed by the Department.

Course Code	21CSP501L 21MEP501L	21ECP501L 21NTP501L	Course Name	SPECIALIZATION PROJECT	Course Category	P	PROJECT WORK, SEMINAR, INTERNSHIP IN INDUSTRY / HIGHER TECHNICAL INSTITUTIONS	L	T	P	C
								0	0	10	5

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department		Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes												
CLR-1:	Become job ready along with real corporate exposure	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Increase self-confidence and helps in finding their own proficiency																											
CLR-3:	Cultivate leadership ability and responsibility to perform or execute the given task																											
CLR-4:	Inculcate learners hands on practice within a real job situation																											
CLR-5:	Create awareness of the social, cultural, global and environmental responsibility as an engineer																											
Course Outcomes (CO):		At the end of this course, learners will be able to:		3	2	2	3	3	3	-	3	3	3	3	3	3	-	-	-									
CO-1:	Enhance capability to acquire and apply fundamental principles of engineering	3	2	2	3	3	3	-	3	3	3	3	3	-	-	-												
CO-2:	Become master in one's specialized technology	3	2	2	3	3	3	-	3	3	3	3	3	-	-	-												
CO-3:	Become updated with all the latest changes in technological world	3	2	2	3	3	3	-	3	3	3	3	3	-	-	-												
CO-4:	Demonstrate hands on practice within a real job situation	3	2	2	3	3	3	-	3	3	3	3	3	-	-	-												
CO-5:	Inculcate self-improvement through continuous professional development and life-long learning	3	2	2	3	3	3	-	3	3	3	3	3	-	-	-												

Internship Training Selection: List of Industries / Research Centre's for Internship Training for students would be finalized by the Department Internship/Industrial Training Committee.

	Continuous Learning Assessment (100% weightage)				
	Review - 1	Review - 2	Review - 3	Project Report	Viva-Voce
Major Project	10 %	20 %	30 %	10 %	30 %

Note: Students register for this internship also have to register for industry-based major project.
Final Presentation Evaluation would be done by the Internship/Industrial Training Committee formed by the Department.



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 11

(Syllabi for School of Computing Programme Courses)



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

Contents (Volume-11)

Syllabi for Higher Semester (3 - 8) CSE Courses

<u>No</u>	<u>Title</u>	<u>Page No</u>
1	Engineering Science Course	10
	21CSS201T Computer Organization and Architecture.....	11
2	Professional Core Courses.....	13
	21CSC201J Data Structures and Algorithms.....	14
	21CSC202J Operating Systems.....	16
	21CSC203P Advanced Programming Practice.....	18
	21CSC204J Design And Analysis of Algorithms.....	20
	21CSC205P Database Management Systems.....	22
	21CSC301T Formal Language and Automata.....	24
	21CSC302J Computer Networks.....	26
	21CSC303J Software Engineering and Project Management.....	28
	21CSC304J Compiler Design.....	30
	21CSC305P Machine Learning.....	32
	Volume-11A – CSE Courses	34
1	Professional Elective Courses.....	35
	21CSE251T Digital Image Processing.....	36
	21CSE252T Biometrics.....	38
	21CSE253T Internet of Things.....	40
	21CSE254T Bio Inspired Computing.....	42
	21CSE255T Computer Graphics and Animation.....	44
	21CSE351T Computational Logic.....	46
	21CSE352T Neuro Fuzzy and Genetic Programming.....	48
	21CSE353T Augmented, Virtual and Mixed Reality.....	50
	21CSE354T Full Stack Web Development.....	52
	21CSE355T Data Mining and Analytics.....	54
	21CSE356T Natural Language Processing.....	56
	21CSE357T Distributed Computing.....	58
	21CSE358T Network Security and Cryptography.....	60
	21CSE359T Information Storage Management.....	62
	21CSE360T High Performance Computing.....	64
	21CSE361T Database Security and Privacy.....	66

21CSE362T	Cloud Computing.....	68
21CSE399T	Advanced Mobile Communications.....	70
21CSE451T	Pattern Recognition Techniques.....	72
21CSE452T	Semantic Web.....	74
21CSE453T	Speech Recognition.....	76
21CSE454T	Computer Vision.....	78
21CSE455T	Social Network Analysis.....	80
21CSE456T	Software Defined Networks.....	82
21CSE457T	Service Oriented Architecture.....	84
21CSE458T	Wireless and Mobile Communication.....	86
21CSE459T	Wireless Sensor Networks.....	88
21CSE460T	Network Protocols and Algorithms.....	90
Volume-11B – CSE (AIML) Courses		92
1 Professional Core Courses.....		93
21CSC401J	Deep Learning Techniques.....	94
21CSC402P	Report Writing.....	96
2 Professional Elective Courses.....		98
21CSE271T	Programming in Java.....	99
21CSE272T	Genetic Algorithm and its Applications.....	101
21CSE291T	Introduction to Cognitive Neuroscience.....	103
21CSE311P	Robot Programming.....	105
21CSE312P	Software Engineering in Artificial Intelligence.....	107
21CSE313P	Accelerated Data Science.....	109
21CSE323T	Marketing Analytics.....	111
21CSE326T	Artificial Neural Networks.....	113
21CSE371T	Advanced Algorithms.....	115
21CSE375T	Computational Neuroscience.....	117
21CSE376T	Nature Inspired Computing Techniques.....	119
21CSE377T	Information Retrieval.....	121
21CSE396T	Design Principles of Smart Space Management.....	123
21CSE397T	Philosophy of Cognitive Science.....	125
21CSE398T	Logic and Knowledge Representation.....	127
21CSE411T	Artificial Intelligence in Genomics and Disease Prediction.....	129
21CSE412T	Machine Learning in Drug Discovery.....	131
21CSE414T	IoT Concepts and Applications.....	133
21CSE415T	Fuzzy Logic and its Applications.....	135
21CSE416T	Robotics: Computational Motion Planning.....	137
21CSE417T	Reinforcement Learning Techniques.....	149

21CSE418T	Cyber Physical Systems.....	141
21CSE421T	Business Intelligence and Analytics.....	143
Volume-11C – CSE (SWE) Courses		145
1 Professional Core Courses.....		146
21CSC309J	Software Architecture and Design.....	147
21CSC403T	Software Measurements and Metrics.....	149
21CSC404T	Software Verification and Validation.....	151
2 Professional Elective Courses.....		153
21CSE275T	Requirements Engineering.....	154
21CSE276T	Software Quality Management.....	156
21CSE277T	Software Process.....	158
21CSE271T	Programming in Java.....	160
21CSE391P	User Interface Design.....	162
21CSE392P	Visual Programming.....	164
21CSE393P	Machine Learning Techniques.....	166
21CSE312P	Software Engineering in Artificial Intelligence.....	168
21CSE391T	Object Oriented Software Engineering.....	170
21CSE392T	Python for Software Engineering.....	172
21CSE393T	Analysis of Software Artifacts.....	174
21CSE396T	Design Principles of Smart Space Management.....	176
21CSE421T	Business Intelligence and Analytics.....	178
21CSE493T	Software Security.....	180
21CSE495T	Artificial Intelligence in Agile Systems.....	182
21CSE496T	Deep Learning.....	184
21CSE497T	Gaming and Virtual Reality.....	186
21CSE498T	Smart Phone Computing and its Applications.....	188
Volume-11D – CSE (CC) Courses		190
1 Professional Core Courses.....		191
21CSC314P	Big Data Essentials	192
21CSC316J	Cloud Architecture and Protocols.....	194
2 Professional Elective Courses.....		196
21CSE261T	Fundamentals of Cloud Computing.....	197
21CSE262T	Communication Systems Engineering.....	199
21CSE263T	Digital Communication Systems.....	201
21CSE330T	Cloud Architecture.....	203
21CSE329T	Service Oriented Architecture and Microservices.....	205
21CSE363T	Aws Solution Architect.....	207

21CSE364T	Data Centric Networking and System Design.....	209
21CSE461T	Cloud Security.....	211
21CSE463T	Cloud Strategy Planning and Management.....	213
21CSE464T	Fog Computing Analytics.....	215
21CSE465T	Cloud Application Development.....	217
21CSE466T	Network Design and Management.....	219
Volume-11E – CSE (CN) Courses		221
1 Professional Core Courses.....		222
21CSC311J	Wireless Networks	223
21CSC312J	Mobile Adhoc Networks.....	225
2 Professional Elective Courses.....		227
21CSE273T	Distributed Operating Systems.....	228
21CSE274T	Pervasive Computing.....	230
21CSE347T	Network Protocols and Programming.....	232
21CSE348T	Network Routing Algorithms.....	234
21CSE349T	Optical Networks.....	236
21CSE350T	Principles Of Cloud Computing.....	238
21CSE450T	Network Security.....	240
21CSE466T	Network Design and Management.....	242
Volume-11F – CSE (CS) Courses		244
1 Professional Core Courses.....		245
21CSC308T	Security Risk Management Principles	246
21CSC310J	Malware Analysis.....	248
2 Professional Elective Courses.....		249
21CSE229J	Check Point System Administration.....	251
21CSE281T	Cryptography and Network Security.....	253
21CSE282T	Information Security.....	255
21CSE283T	Cyber Law.....	257
21CSE381T	Forensics and Incident Response.....	259
21CSE382T	Security Management.....	261
21CSE383T	Security Governance, Risk and Compliance.....	263
21CSE384J	Security Audit and Risk Assessment.....	265
21CSE385J	Advanced Malware Analysis.....	267
21CSE386J	Penetration Testing and Vulnerability Assessment.....	269
21CSE387J	Hacker Techniques, Tools, and Incident Handling.....	271
21CSE399J	Comprehensive Linux for All.....	273

21CSE485T	Database Security.....	275
21CSE486T	Operation System Security.....	277
21CSE487T	Cyber Warfare.....	279
21CSE488T	Hacker Mind: Profiling the it Criminal.....	281
21CSE489T	Mobile and Wireless Security.....	283
21CSE490J	Windows and Linux Internals.....	285
21CSE491T	Cyber Crimes and Digital Forensic.....	287
21CSE492T	Cyber Crimes and Cyber Security.....	289
Volume-11G – CSE (IT) Courses		291
1 Professional Core Courses.....		292
21CSC314P	Big Data Essentials.....	293
21CSC317J	Information Retrieval Techniques.....	295
2 Professional Elective Courses.....		297
21CSE267T	Statistics for Machine Learning.....	298
21CSE310J	Quantum Computation.....	300
21CSE373T	Streaming Analytics.....	302
21CSE475T	Applied Graph Theory.....	304
21CSE476T	Logical Deduction and Non-Verbal Reasoning.....	306
21CSE477T	Cloud Native Architecture for Modern Platforms.....	308
21CSE479T	Fault Tolerant Systems.....	310
21CSE480T	Image and Video Processing.....	312
Volume-11H – CSE (IoT) Courses		314
1 Professional Core Courses.....		315
21CSC313J	Cloud Computing for IoT.....	316
21CSC315J	Fog Computing.....	318
2 Professional Elective Courses.....		320
21CSE264T	Introduction to IoT: Sensors, Actuators and Microcontrollers.....	321
21CSE265T	Introduction to Embedded Programming and Embedded OS.....	323
21CSE266T	Internet of Things Architecture and Protocols.....	325
21CSE365T	Machine Learning for IoT.....	327
21CSE366T	Introduction to Cloud Application Development for IoT.....	329
21CSE367T	IoT Forensics.....	331
21CSE368J	Network Programming for IoT.....	333
21CSE369J	Introduction to Security of Internet of Things and Cyber-Physical Systems.....	335
21CSE370J	Data Visualization for IoT.....	337
21CSE371J	IoT Techniques, Tools and its Application.....	339

21CSE467T	Advanced Database Systems.....	341
21CSE468T	Edge Computing.....	343
21CSE469T	Energy Management for IoT Devices.....	345
21CSE470T	Applied Software Techniques in IoT Engineering.....	347
21CSE471T	Fundamentals of Cyber Security.....	349
21CSE472J	Full Stack Development for IoT.....	351
21CSE473T	Deep Learning for IoT.....	353
21CSE474T	IoT Privacy.....	355
Volume-11I – CSE (BCT) Courses		357
1 Professional Core Courses.....		358
21CSC305T	Blockchain Using Cryptography.....	359
2 Professional Elective Courses.....		361
21CSE231T	Fundamentals of Blockchain.....	362
21CSE232T	IoT And Blockchain.....	364
21CSE233T	Distributed Systems and Applications.....	366
21CSE234T	Principles of Cryptography.....	368
21CSE331T	Cryptocurrencies and Blockchain Technology.....	370
21CSE332T	Fundamentals of Ethereum.....	372
21CSE333T	AI And Blockchain.....	374
21CSE334T	Container Management.....	376
21CSE335T	Advanced Cryptography.....	378
21CSE336T	Cloud Computing with Blockchain.....	380
21CSE337T	Web3 Development.....	382
21CSE338T	Trust Based Computing.....	384
21CSE431T	Building Private Blockchain.....	386
21CSE432T	Blockchain Technology with Hyperledger.....	388
21CSE433T	Blockchain Business Models.....	390
21CSE434T	Distributed Ledger Technology.....	392
21CSE435T	Smart Contracts and Application Development.....	394
21CSE436T	Bitcoin Essentials and Use Cases.....	396
21CSE437T	Decentralized Applications on Block Chain.....	398
21CSE438T	Web Security.....	400
Volume-11J – CSE (GT) Courses		402
1 Professional Core Courses.....		403
21CSC306J	Software Engineering Perspectives in Computer Game Development.....	404
21CSC307T	Deep Learning in Gaming and Application.....	406

2 Professional Elective Courses.....	408
21CSE235T Game Design, Prototyping and Development.....	409
21CSE236T GPU Programming.....	411
21CSE237T Art Creation for Games.....	413
21CSE238T Storytelling for Marketing.....	415
21CSE339T Game Artificial Intelligence.....	417
21CSE340T Analytics and Decision Making.....	419
21CSE341T Computer Graphics.....	421
21CSE342T Gaming Studio for Business.....	423
21CSE343T Web Services Development for Games.....	425
21CSE344T 3D Game Development with Unity.....	427
21CSE345T Game System Integration.....	429
21CSE346T Design Art and Theory.....	431
21CSE439T Virtual Reality and Augmented Reality.....	433
21CSE440T Computer Animation and Simulation.....	435
21CSE441T Mobile Game Development.....	437
21CSE442T Game Monetization Techniques.....	439
21CSE443T Game Production and Publishing.....	441
21CSE444T Applied Gamification.....	443
21CSE445T Metaverse Fundamentals.....	445
21CSE446T Digital Marketing and Publishing.....	447
Volume-11K – CSE (BD & DS) Courses	449
1 Engineering Science Course	450
21CSS202T Fundamentals of Data Science.....	451
21CSS301T Full Stack Development	453
2 Professional Core Courses.....	455
21CSC206P Advanced Object Oriented and Programming.....	456
21CSC307P Machine Learning for Data Analytics.....	458
3 Professional Elective Courses.....	460
21CSE222T Big Data Tools and Techniques.....	461
21CSE224T Computer Architecture.....	463
21CSE321T Data Warehousing and Data Mining.....	465
21CSE322T Multivariate Techniques for Data Analytics.....	467
21CSE323T Marketing Analytics.....	469
21CSE325T Applied Social Network Analysis.....	471
21CSE326T Artificial Neural Networks.....	473
21CSE327T Cloud Computing for Data Analytics.....	475

21CSE373T	Streaming Analytics.....	477
21CSE421T	Business Intelligence and Analytics.....	479
21CSE422T	Convolutional Neural Networks.....	481
21CSE423T	Big Data Visualization.....	483
21CSE424T	Deep Learning for Data Analytics.....	485
21CSE425T	Advanced Machine Learning.....	487
21CSE426T	Financial Machine Learning.....	489
21CSE427T	Augmented and Virtual Reality.....	491
21CSE428T	Healthcare Analytics.....	493
21CSE429T	Data Science for Internet of Things.....	495
21CSE430T	Automatic Speech Recognition.....	497
21CSE447T	Robotics: Computational Motion Planning.....	499
21CSE448T	Bio-Inspired Computing and Fuzzy Logic.....	501
21CSE449T	Risk Analytics.....	503
Volume-11L – M.Tech(Int) CSE (CC) Courses		504
1	Professional Core Courses.....	505
21CSC505T	Computer Graphics and Vision.....	506
21CSC506J	Computation and Cognition: the Probabilistic Approach.....	508
2	Professional Elective Courses.....	510
21CSE541T	Probabilistic Graphical Models: Principles and Techniques.....	512
21CSE542T	Deep Generative Models.....	514
21CSE543T	Brain Machine Interface: Science, Technology and Application.....	516
21CSE544T	Data Analysis and Visualization.....	518
21CSE545T	Computational Perception and Cognition.....	520
21CSE546T	Medical Signal Processing.....	522
21CSE547T	Deep Multitask and Meta Learning.....	524
21CSE548T	Spatial and Temporal Computing.....	526
21CSE549T	Decision Making Under Uncertainty.....	528
21CSE553T	Neural Network Models of Cognition.....	530
21CSE552T	Computational Linguistics.....	532
21AIE536T	Artificial Intelligence Engines.....	534
21AIE538T	Artificial Intelligence for Industrial Applications.....	536
21AIE539T	Artificial Intelligence in Medical Imaging.....	538
21AIE541T	Multimodal Machine Learning.....	540

Volume-11M – M.Tech(Int) CSE (CS & DF) Courses	542
1 Professional Core Courses.....	543
21CSC503T Security Service Management.....	544
21CSC504J Android Malware Analysis.....	546
2 Professional Elective Courses.....	548
21CSE531T Cyber Security Operations.....	549
21CSE532T Network Management and Protocols.....	551
21CSE533T Firewalls and Access Controls.....	553
21CSE534T Network Programming and Management.....	555
21CSE535T Network Intrusions and Computer Forensics.....	557
21CSE536T Mobile Forensics.....	559
21CSE537T Digital Forensics.....	561
21CSE538T Security Scripting and Analysis.....	563
21CSE539T Principles of Secure Coding Principles.....	565
21CSE540T Android Security and Design Internals.....	567
 Volume-11N – M.Tech(Int) CSE (DS) Courses	 569
1 Professional Core Courses.....	570
21CSC501T Natural Language Processing Techniques.....	571
21CSC502J Applied Deep Learning.....	573
2 Professional Elective Courses.....	575
21CSE521T Advanced Algorithms Analysis.....	576
21CSE522T Functional Programming.....	578
21CSE524T Computer Vision Techniques.....	580
21CSE527T Text Mining and Analytics.....	582
21CSE529T Web Intelligence.....	584

ACADEMIC CURRICULA

Engineering Science Course

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSS201T	Course Name	COMPUTER ORGANIZATION AND ARCHITECTURE	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the Fundamentals of computers, Memory operations and Addressing Modes	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Know about Functions of Arithmetic and Logic unit															
CLR-3:	Explore the Operations of Control Unit, Execution of Instruction and Pipelining															
CLR-4:	Classify the Need for Parallelism, Multicore and Multiprocessor Systems															
CLR-5:	Understand the Concepts and functions of Memory unit, I/O unit															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Identify the computer hardware and how software interacts with computer hardware	3	2	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Apply Boolean algebra as related to designing computer logic, through simple combinational and sequential logic circuits	3	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Examine the detailed operation of Basic Processing units and the performance of Pipelining	3	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-4:	Analyze concepts of parallelism and multi-core processors.	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-5:	Classify the memory technologies, input-output systems and evaluate the performance of memory system	3	2	-	-	-	-	-	-	-	-	-	-	-	3	-

Unit-1 – Introduction to Number System	12 Hour
Introduction to Number System and Logic Gates: Number Systems- Binary, Decimal, Octal, Hexadecimal; Codes- Grey, BCD, Excess-3, ASCII, Parity; Binary Arithmetic- Addition, Subtraction, Multiplication, Division using Sign Magnitude, 1's compliment, 2's compliment, BCD Arithmetic; Logic Gates-AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR.	
Unit-2 - Architectures	12 Hour
Basic structure of computers: Functional Units of a computer, Operational concepts, Bus structures, Memory addresses and operations, assembly language, Instructions, Instruction sequencing, Addressing modes. Case study: 8086.	
Unit-3 - Design of ALU	12 Hour
De Morgan's Theorem, Adders, Multiplier – Unsigned, Signed, Fast, Carry Save Addition of summands; Division–Restoring and Non-Restoring; IEEE 754 Floating point numbers and operations	
Unit-4 - Control Unit	12 Hour
Basic processing unit, ALU operations, Instruction execution, Branch instruction, Multiple bus organization, Hardwired control, Generation of control signals, Micro-programmed control; Pipelining: Basic concepts of pipelining, Performance, Hazards-Data, Instruction and Control, Influence on instruction sets.	
Unit-5 - Parallelism	12Hour
Need, types, applications and challenges, Architecture of Parallel Systems-Flynn's classification; ARM Processor: The thumb instruction set, Processor and CPU cores, Instruction Encoding format, Memory load and Store instruction, Basics of I/O operations. Case study: ARM 5 and ARM 7 Architecture.	

Learning Resources	1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Computer Organization, 5th ed., McGraw-Hill, 2015	5. William Stallings, Computer Organization and Architecture – Designing for Performance, 10th ed., Pearson Education, 2015
	2. Kai Hwang, Faye A. Briggs, Computer Architecture and Parallel Processing, 3rd ed., McGraw Hill, 2016	6. David A. Patterson and John L. Hennessy Computer Organization and Design – A Hardware/Software Interface, 5th ed., Morgan Kaufmann, 2014
	3. Ghosh T. K., Computer Organization and Architecture, 3rd ed., Tata McGraw-Hill, 2011	
	4. P. Hayes, Computer Architecture and Organization, 3rd ed., McGraw Hill, 2015.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Saminath Sanjai, Borqs Technologies, Inc. Bengaluru		1. Dr. K. Vijaya, SRMIST
		2. Dr. Anitha D, SRMIST

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC201J	Course Name	DATA STRUCTURES AND ALGORITHMS	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing		Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Know about searching and sorting techniques used to handle a set of data along with time and space complexity		1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Utilize various categories of list structures to develop solutions																
CLR-3:	Explore usage of Stack and Queues in processing data for real time applications																
CLR-4:	Understand tree structure and its applications																
CLR-5:	Utilize hash tables for data storage and use graphs to solve real time problems																
			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
Course Outcomes (CO):		At the end of this course, learners will be able to:	1	2	3	-	-	-	-	-	-	-	-	3	3	-	-
CO-1:	Devise algorithms to arrange the data in required order and retrieve a specific datum in efficient manner		2	3	3	-	-	-	-	-	-	-	-	3	3	-	-
CO-2:	Determine the type of list structure that could be used for solving a problem and implement it using C programming language		2	3	3	-	-	-	-	-	-	-	-	3	3	-	-
CO-3:	Devise solutions using linear structures Stack and Queue		2	3	3	-	-	-	-	-	-	-	-	3	3	-	-
CO-4:	Express proficiency in usage of tree for solving problems		2	3	3	-	-	-	-	-	-	-	-	3	3	-	-
CO-5:	Implement Hash tables for storing data and algorithms to find shortest path between nodes in a graph		3	2	3	-	-	-	-	-	-	-	-	3	3	-	-

Unit-1 - Introduction	15 Hour
Programming in C - Primitive data types, Structures, Self-referential structures, Pointers and structures, Dynamic memory allocation, Matrix multiplication; Data Structure – Definition, Types, ADT, Operations; Mathematical notations - Big O, Omega and Theta, Complexity – Time, Space, Trade off.	
Unit-2 - List Structure	15 Hour
Operations on List ADT – Create, Insert, Search, Delete, Display elements; Implementation of List ADT– Array, Cursor based and Linked; Types – Singly, Doubly, Circular; Applications - Sparse Matrix, Polynomial Arithmetic, Joseph Problem	
Unit-3 - Stack and Queue	15 Hour
Operations on Stack ADT – Create, Push, Pop, Top; Implementation of Stack ADT – Array and Linked; Applications - Infix to Postfix Conversion, Postfix Evaluation, Balancing symbols, Function Calls, Tower of Hanoi; Operations on Queue ADT - Create, Enqueue and Dequeue; Implementation of Queue ADT – Array and Linked; Types of Queue - Circular, Double ended and Priority Queue, Applications – Scheduling	
Unit-4 - Trees and Hashing	15 Hour
Introduction to Trees, Tree traversals, Complete Binary Tree and its height, Binary Search Trees, Need for Balance, Rotation, AVL trees, B Trees, Heaps, trees and array implementations and applications; Hash functions - Introduction, functions, Collision avoidance, Separate chaining, Open Addressing, Linear Probing, Quadratic probing.	
Unit-5 - Graph	15 Hour
Introduction to Graph, Graph Traversal, Topological sorting, Minimum spanning tree – Prims Algorithm, Kruskal's Algorithm, Shortest Path Algorithm - Dijkstra's Algorithm	

Lab Experiments
Lab 1: Implementation of Structures Lab 2: Implementation of Structures using Pointers Lab 3: Implementation of Matrix Multiplication – Dynamic Memory allocation Lab 4: Array Implementation of List Lab 5: Implementation of Linked List Lab 6: Implementation of Doubly linked List Lab 7: Implementation of Stack using array and Linked List Lab 8: Implementation of Queue using array and Linked list Lab 9: Applications of Stack, Queue Lab 10: Implementation of Tree using array Lab 11: Implementation of BST using linked list Lab 12: Implementation of B-Trees Lab 13: Implementation of Graph using Array Lab 14: Implementation of Shortest path Algorithm Lab 15: Implementation of Minimal Spanning Tree

Learning Resources	1. Seymour Lipschutz, Data Structures with C, McGraw Hill, 2014 2. R.F.Gilberg, B.A.Forouzan, Data Structures, 2nd ed., Thomson India, 2005 3. A.V.Aho, J.E Hopcroft, J.D.Ullman, Data structures and Algorithms, Pearson Education, 2003	4. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd ed., Pearson Education, 2015 5. Reema Thareja, Data Structures Using C, 1st ed., Oxford Higher Education, 2011, 6. Thomas H Cormen, Charles E Leiserson, Ronald L Revest, Clifford Stein, Introduction to Algorithms 3 rd ed., The MIT Press Cambridge, 2014
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	25%	-	-	10%	25%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	20%	-	-	30%	20%	-
Level 4	Analyze	20%	-	-	30%	20%	-
Level 5	Evaluate	10%	-	-	10%	10%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Mariappan Vaithilingam, Senior Engineering Manager, Uber India Research and Development Pvt Centre, Bangalore.	1. Dr. Venkatesh Raman, Professor, Mathematical Institute of Science	1. Dr. K. Vijaya, SRMIST
		2. Dr. S. Poornima, SRMIST
		3. Dr. P. Saranya, SRMIST

Course Code	21CSC202J	Course Name	OPERATING SYSTEMS	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										3	0	2	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Outline the structure of OS and basic architectural components involved in OS design	1	2	3	4	5	6	7	8	9	10	11	12							
CLR-2:	Introduce the concept of deadlock and various memory management mechanism	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3				
CLR-3:	Familiarize the scheduling algorithms, file systems, and I/O schemes																			
CLR-4:	Identify and tell the various embedded operating systems and computer security concepts																			
CLR-5:	Name the various computer security techniques in windows and Linux																			
Course Outcomes (CO):		At the end of this course, learners will be able to:																		
CO-1:	Use the appropriate concepts of operating system for resource utilization	3	3	2	2	-	-	-	-	-	-	-	3	2	-	-				
CO-2:	Choose the relevant process and thread concepts for solving synchronization problems	3	3	3	2	-	-	-	-	-	-	-	3	2	-	-				
CO-3:	Exemplify different types of scheduling algorithms and deadlock mechanism.	3	3	3	2	-	-	-	-	-	-	-	3	2	-	-				
CO-4:	Experiment the performance of different algorithms used in management of memory, file and I/O and select the appropriate one.	3	3	3	2	-	-	-	-	-	-	-	3	2	-	-				
CO-5:	Demonstrate different device and resource management techniques for memory utilization with security mechanisms	3	2	3	2	-	-	-	-	-	-	-	3	2	-	-				

Unit-1 - Introduction	15 Hour
Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management, Protection and Security, Kernel Data Structures, Computing Environments, Open-Source Operating Systems, Operating-System Services, User and Operating-System Interface, System Calls, Types of System Calls, System Programs, Operating-System Design and Implementation, Operating-System Structure, Operating-System Debugging, Operating-System Generation, System Boot.	
Unit-2 - Process Management	15 Hour
Process Concept, Process Scheduling, Operations on Processes, Interprocess Communication, Communication in Client– Server Systems, Threads: Multicore Programming, Multithreading Models, Thread Libraries, Implicit Threading, Threading Issues. Process Synchronization: The Critical-Section Problem, Peterson's Solution, Synchronization Hardware, Mutex Locks, Semaphores, Classic Problems of Synchronization, Monitors	
Unit-3 - CPU Scheduling:	15 Hour
Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Thread Scheduling, Multiple-Processor Scheduling, Real-Time CPU Scheduling. Deadlocks: System Model, Deadlock Characterization, Methods for Handling Deadlocks, Deadlock Prevention, Deadlock Avoidance, Deadlock Detection, Recovery from Deadlock	
Unit-4 - Memory Management	15 Hour
Main Memory, Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table. Virtual Memory: Introduction, Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing, Memory-Mapped Files, Allocating Kernel Memory. STORAGE MANAGEMENT: Disk Structure, Disk Attachment, Disk Scheduling, Disk Management, Swap-Space Management, RAID Structure. File-System Interface: File Concept, Access Methods, Directory and Disk Structure, File-System Mounting, File Sharing, Protection. .	

Unit-5 - Protection and Security			15 Hour
Goals of Protection, Principles of Protection, Domain of Protection, Access Matrix, Implementation of the Access Matrix, Access Control, Revocation of Access Rights, Capability-Based Systems, Language-Based Protection, The Security Problem, Program Threats, System and Network Threats, Cryptography as a Security Tool, User Authentication, Implementing Security Defenses, Firewalling to Protect Systems and Networks, Computer-Security Classifications.			
Lab Experiments			
Lab 1: Operating system Installation, Basic Linux commands	Lab 6: Dining Philosopher problem	Lab 11: LRU and LFU Page Replacement Algorithm	
Lab 2: Process Creation using fork() and Usage of getpid(), getppid(), wait() functions	Lab 7: Bankers Algorithm for Deadlock avoidance	Lab 12: Best fit and Worst fit memory management policies	
Lab 3: Multithreading	Lab 8: FCFS and SJF Scheduling	Lab 13: Disk Scheduling algorithm	
Lab 4: Mutual Exclusion using semaphore and monitor	Lab 9: Priority and Round robin scheduling	Lab 14: Sequential and Indexed file Allocation	
Lab 5: Reader-Writer problem	Lab 10: FIFO Page Replacement Algorithm	Lab 15: File organization schemes for single level and two-level directory	

Learning Resources	1. Abraham Silberschatz, Peter Baer Galvin, and Greg Gagne, "Operating System Concepts", John Wiley & Sons (Asia) Pvt. Ltd, Tenth Edition, 2018	6. Charles Crowley, "Operating Systems: A Design-Oriented Approach", Tata McGraw Hill Education, 2017
	2. RamazElmasri, A. Gil Carrick, David Levine, "Operating Systems – A Spiral Approach ", Tata McGraw Hill Edition, 2010	7. https://nptel.ac.in/courses/106/105/106105214/
	3. Dhananjay M. Dhamdhere, "Operating Systems – A Concept Based Approach", Third Edition, Tata McGraw Hill Edition, 2019	8. https://nptel.ac.in/courses/106/106/106106144/
	4. Andrew S. Tanenbaum, "Modern Operating Systems", Fourth Edition, Global Edition, Pearson, 2015.	9. https://nptel.ac.in/courses/106/102/106102132/
	5. William Stallings, "Operating Systems: Internals and Design Principles", Pearson Education, Sixth Edition, 2018.	10. https://onlinecourses.nptel.ac.in/noc21_cs44/preview
		11. https://nptel.ac.in/courses/106/105/106105172/

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	0%	20%	-
Level 2	Understand	40%	-	-	40%	40%	-
Level 3	Apply	20%	-	-	40%	20%	-
Level 4	Analyze	20%	-	-	10%	10%	-
Level 5	Evaluate	-	-	-	10%	10%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.T.Madhan, Team Leader, Tata Consultancy Services, siruseri Campus, Chennai, madhan.tk@gmail.com	1. Dr. S. Janakiraman, Associate Professor, Pondicherry University, sj.dbt@pondiuni.edu.in	1. Dr. N. Prasath, SRMIST
2. Mrs.K.Saranya, IT Analyst, Tata Consultancy Services, siruseri Campus, Chennai, saranya.k6@gmail.com	2. Dr. R. Shyamala, Associate Professor, Anna University College of Engineering Tindivanam, vasuchaaru@gmail.com	2. Dr. M. Eliazer, SRMIST

[illegible]

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing		Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the paradigm functionalities and their hierarchy	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Deploy structural, procedural, and Object-Oriented Programming Paradigm	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	Demonstrate the event, Graphical User Interface, and declarative Paradigm with a java application.																											
CLR-4:	Extended knowledge on logic, functional, network and concurrent Paradigm																											
CLR-5:	Symbolic, Automata-based, and Event with a python application.																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Devise solutions to the various programming paradigm	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-												
CO-2:	Express proficiency in the usage of structural, procedural, and Object-Oriented Program	3	2	-	1	-	-	-	-	-	-	-	-	2	-	-												
CO-3:	Determine the Java application using declarative, event, and graphical user interface paradigm	3	-	2	1	2	-	-	-	1	-	-	-	2	-	-												
CO-4:	Express proficiency in the usage of logic, functional, network, and concurrent Paradigm	3	2	-	1	-	-	-	-	-	-	-	-	2	-	-												
CO-5:	Determine the Python application using symbolic, automata-based, and graphical user interface programming paradigms	3	-	2	1	2	-	-	-	1	-	-	-	2	-	-												

Unit-1 - Introduction to Programming Paradigm	12 Hour
Programming Languages – Elements of Programming languages - Programming Language Theory - Bohm- Jacopini structured program theorem - Multiple Programming Paradigm – Programming Paradigm hierarchy – Imperative Paradigm: Procedural, Object-Oriented and Parallel processing – Declarative programming paradigm: Logic, Functional and Database processing - Machine Codes – Procedural and Object-Oriented Programming – Suitability of Multiple paradigms in the programming language - Subroutine, method call overhead and Dynamic memory allocation for message and object storage - Dynamically dispatched message calls and direct procedure call overheads – Object Serialization – parallel Computing	
Unit-2 - Java Programming Paradigms	12 Hour
Object and Classes; Constructor; Data types; Variables; Modifier and Operators - Structural Programming Paradigm: Branching, Iteration, Decision making, and Arrays - Procedural Programming Paradigm: Characteristics; Function Definition; Function Declaration and Calling; Function Arguments - Object-Oriented Programming Paradigm: Abstraction; Encapsulation; Inheritance; Polymorphism; Overriding - Interfaces: Declaring, implementing; Extended and Tagging - Package: Package Creation.	
Unit-3 - Advanced Java Programming Paradigms	12 Hour
Concurrent Programming Paradigm: Multithreading and Multitasking; Thread classes and methods - Declarative Programming Paradigm: Java Database Connectivity (JDBC); Connectivity with MySQL – Query Execution; - Graphical User Interface Based Programming Paradigm: Java Applet: Basics and Java Swing: Model View Controller (MVC) and Widgets; Develop a java project dissertation based on the programming paradigm.	
Unit-4 - Pythonic Programming Paradigm	12 Hour
Functional Programming Paradigm: Concepts; Pure Function and Built-in Higher-Order Functions; Logic Programming Paradigm: Structures, Logic, and Control; Parallel Programming Paradigm: Shared and Distributed memory; Multi-Processing – Ipython; Network Programming Paradigm: Socket; Socket Types: Creation and Configuration of Sockets in TCP / UDP – Client / Server Model.	

Unit-5 - Formal and Symbolic Programming Paradigm	12 Hour
Automata Based programming Paradigm: Finite Automata – DFA and NFA; Implementing using Automaton Library - Symbolic Programming Paradigm: Algebraic manipulations and calculus; Sympy Library - Event Programming Paradigm: Event Handler; Trigger functions and Events – Tkinter Library. Develop a python-based project dissertation based on the programming paradigm.	

Learning Resources	1. Elad Shalom, A Review of Programming Paradigms throughout the History: With a suggestion Toward a Future Approach, Kindle Edition, 2018 2. Maurizio Gabbrielli, Simone Martini, Programming Languages: Principles and Paradigms, 2010.	3. Herbert Schildt, Java: The Complete Reference Seventh Edition, 2016. 4. Mark Lutz, Programming Python: Powerful Object-Oriented Programming, 2011.
---------------------------	--	--

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	--	20%	-	10%	-	-
Level 2	Understand	30%	-	-	20%	-	10%	-	-
Level 3	Apply	20%	-	-	20%	-	10%	-	-
Level 4	Analyze	20%	-	-	20%	-	10%	-	-
Level 5	Evaluate	-	-	-	10%	-	30%	-	-
Level 6	Create	-	-	-	10%	-	30%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. N. Venkatesh, Tech Lead, Honeywell, Bengaluru, Karnataka, India	1. Dr. Sudeepta Mishra, Assistant Professor, Computer Science and Engineering, Indian Institute of Information Technology, Ropar, Punjab.	1. Dr Ramkumar J, SRMIST

Course Code	21CSC204J	Course Name	DESIGN AND ANALYSIS OF ALGORITHMS	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										3	0	2	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Design efficient algorithms in solving complex real time problems	CLR-2:	Analyze various algorithm design techniques to solve real time problems in polynomial time	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-3:	Utilize various approaches to solve greedy and dynamic algorithms	CLR-4:	Utilize back tracking and branch and bound paradigms to solve exponential time problems	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-5:	Analyze the need of approximation and randomization algorithms, utilize the importance Non polynomial algorithms																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Apply efficient algorithms to reduce space and time complexity of both recurrent and non-recurrent relations	CO-2:	Solve problems using divide and conquer approaches	2	1	2	1	-	-	-	-	-	3	-	3	3	1	-
CO-3:	Apply greedy and dynamic programming type's techniques to solve polynomial time problems.	CO-4:	Create exponential problems using backtracking and branch and bound approaches.	2	1	2	1	-	-	-	-	-	3	-	3	3	1	-
CO-5:	Interpret various approximation algorithms and interpret solutions to evaluate P type, NP Type, NPC, NP Hard problems			2	1	2	1	-	-	-	-	-	3	-	3	3	1	-

Unit-1 - Introduction to Algorithm Design	15 Hour
Fundamentals of Algorithms- Correctness of algorithm - Time complexity analysis - Insertion sort-Line count, Operation count Algorithm Design paradigms - Designing an algorithm And its analysis-Best, Worst and Average case - Asymptotic notations Based on growth functions. $O, O(\theta), \omega, \Omega$ - Mathematical analysis - Induction, Recurrence relations -Solution of recurrence relations - Substitution method - Solution of recurrence relations - Recursion tree - Solution of recurrence relations - examples.	
Unit-2 - Divide and Conquer	15 Hour
Maximum Subarray Problem Binary Search - Complexity of binary search Merge sort - Time complexity analysis -Quick sort and its Time complexity analysis Best case, Worst case, Average case analysis - Strassen's Matrix multiplication and its recurrence relation - Time complexity analysis of Merge sort - Largest sub-array sum - Time complexity analysis of Largest sub- array sum - Master Theorem Proof - Master theorem examples - Finding Maximum and Minimum in an array - Time complexity analysis-Examples - Algorithm for finding closest pair problem - Convex Hull problem	
Unit-3 - Greedy and Dynamic Programming	15 Hour
- Examples of problems that can be solved by using greedy and dynamic approach Huffman coding using greedy approach Comparison of brute force and Huffman method of encoding - Knapsack problem using greedy approach Complexity derivation of knapsack using greedy - Tree traversals - Minimum spanning tree – greedy Kruskal's algorithm - greedy - Minimum spanning tree - Prims algorithm Introduction to dynamic programming - 0/1 knapsack problem - Complexity calculation of knapsack problem - Matrix chain multiplication using dynamic programming - Complexity of matrix chain multiplication - Longest common subsequence using dynamic programming - Explanation of LCS with an example - Optimal binary search tree (OBST)using dynamic programming - Explanation of OBST with an example.	

Unit-4 - Backtracking	15 Hour
branch and bound - N queen's problem – backtracking - Sum of subsets using backtracking Complexity calculation of sum of subsets Graph introduction Hamiltonian circuit - backtracking - Branch and bound - Knapsack problem Example and complexity calculation. Differentiate with dynamic and greedy Travelling salesman problem using branch and bound - Travelling salesman problem using branch and bound example - Travelling salesman problem using branch and bound example - Time complexity calculation with an example - Graph algorithms - Depth first search and Breadth first search - Shortest path introduction - Floyd-Warshall Introduction - Floyd-Warshall with sample graph - Floyd-Warshall complexity	

Unit-5 - Randomized and Approximation Algorithm	15 Hour
Randomized hiring problem Randomized quick sort Complexity analysis String matching algorithm Examples - Rabin Karp algorithm for string matching Example discussion - Approximation algorithm - Vertex covering - Introduction Complexity classes - P type problems - Introduction to NP type problems - Hamiltonian cycle problem - NP complete problem introduction - Satisfiability problem - NP hard problems – Examples	

Lab Experiments	
Lab 1: Simple Algorithm-Insertion sort Lab 2: Bubble Sort Lab 3: Recurrence Type-Merge sort, Linear search Lab 4: Quicksort, Binary search Lab 5: Strassen Matrix multiplication Lab 6: Finding Maximum and Minimum in an array, Convex Hull problem Lab 7: Huffman coding, knapsack and using greedy Lab 8: Various tree traversals,	Lab 9: Longest common subsequence Lab 10: N queen's problem Lab 11: Travelling salesman problem Lab 12: BFS and DFS implementation with array Lab 13: Randomized quick sort Lab 14: String matching algorithms Lab 15: Discussion over analyzing a real time problem

Learning Resources	1. Thomas H Cormen, Charles E Leiserson, Ronald L Revest, Clifford Stein, Introduction to Algorithms, 3rd ed., The MIT Press Cambridge, 2014	3. Ellis Horowitz, Sartaj Sahni, Sanguthevar, Rajesekaran, Fundamentals of Computer Algorithms, Galgotia Publication, 2010
	2. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2nd ed., Pearson Education, 2006	4. S. Sridhar, Design and Analysis of Algorithms, Oxford University Press, 2015

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	-	30%	30%	-
Level 2	Understand	70%	-	-	30%	30%	-
Level 3	Apply	-	-	-	40%	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. G. Venkateswaran, Wipro Technologies, gvenki@pilani.bits-pilani.ac.in	1. Mitesh Khapra, IITM Chennai, miteshk@cse.iitm.ac.in	1. Dr. K.Senthil Kumar, SRMIST
2. Dr. Sainarayanan Gopalakrishnan, HCL Technologies, sai.jgk@gmail.com	2. V. Masilamani, IIITDM, masila@iiitdm.ac.in	2. Dr. V. Sivakumar, SRMIST
		3. Dr. R. Vidhya, SRMIST

Course Code	21CSC205P	Course Name	DATABASE MANAGEMENT SYSTEMS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the fundamentals and need of Database systems, Architecture, Languages			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Conceive database design through Relational model, Relational Algebra																	
CLR-3:	Design Logical schema with constraints, Familiarize SQL Queries																	
CLR-4:	Standardization of Database through Normalization																	
CLR-5:	Understand Storage Management, the practical problems of Concurrency control, Failures and recovery, NoSQL database																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Acquire knowledge on DBMS architecture and languages			-	2	-	-	-	-	-	-	-	-	-	-	2	1	-
CO-2:	Acquire knowledge on Relational languages and design a database			1	2	-	-	-	-	-	-	-	-	-	-	2	1	-
CO-3:	Implement the Database structure with SQL			1	-	2	-	-	-	-	-	-	-	-	-	2	1	-
CO-4:	Removal of anomalies using Normalization concepts			1	-	-	-	-	-	-	-	-	-	-	-	2	1	-
CO-5:	Visualizing storage structure, handling concurrency, Failure and recovery principles, NoSQL concept			1	2	-	-	-	-	-	-	-	-	-	-	2	1	-

Unit-1 - Introduction	12 Hour
Issues in File Processing System, Need for DBMS, Basic terminologies of Database, Database system Architecture, Various Data models, ER diagram basics and extensions, Case study: Construction of Database design using Entity Relationship diagram for an application such as University Database, Banking System, Information System	
Unit-2 – Relational DBMS	12 Hour
Conversion of ER model to Relational Table, Case study: Apply conversion concept. Discussion of various design issues. Pitfalls in Relational Database systems, Understanding various Relational languages such as Tuple Relational calculus, Domain relational calculus, Calculus Vs Algebra, Computational capabilities. Case Study: Applying Relational Algebra for all the queries of application Designed.	
Unit-3 – SQL	12 Hour
SQL commands, Constraints, Joins, set operations, Sub queries, Views, PL – SQL, Triggers, and Cursors. Case Study: Implement all the queries using SQL, PL-SQL, Cursor and Triggers	
Unit-4 - Normalization	12 Hour
Normalization, Need for Normalization, NF1, NF2, NF3, NF4, NF5. Case study: Apply Conversion rules and normalize the Database	
Unit-5 – Concurrency Control	12 Hour
Storage Structure, Transaction control, Concurrency control algorithms, Issues in Concurrent execution, Failures and Recovery algorithms Case study: Demonstration of Entire project by applying all the concepts learnt with minimum Front end requirements, NoSQL Databases-Documents Oriented, Key value pairs, Column Oriented and Graph	

Learning Resources	1. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, Database System ConceptsII, Seventh Edition, Tata McGraw Hill, 2019. 2. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database SystemsII, Sixth Edition, Pearson Education, 2011. 3. CJ Date, A Kannan, S Swamynathan, An Introduction to Database Systems, Eight Edition, Pearson Education, 2006.	4. RaghuramaKrishnan, Johannes Gehrke, Database Management Systems, 3rdEdition, McGrawHill Education, 2003. 5. Principles of Database Systems, J.D. Ullman, Galgoti, 1982 6. NoSQL Distilled, A brief guide to the emerging world of Polygot persistence, First Edition, Promod J, Sadalage Martin Fowler, 2012
---------------------------	---	---

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	-	-	-	-	-
Level 2	Understand	40%	-	-	-	-	-	-	-
Level 3	Apply	40%	-	-	30%	-	-	-	-
Level 4	Analyze	-	-	-	30%	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	50%	-	-
Level 6	Create	-	-	-	40%	-	50%	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ms.Sangeetha Jayaprakash, Database Architect, BOSCH India	1. Dr.J.Sheeba Rani, Indian Institute of Space Science and Technology, Trivandrum	1. Dr.M.Thenmozhi,NWC
2. Dr.Manipoonchelvi, Senior Technical Manager, HCL Technologies	2. Dr.K.Nandhini, Central University of Thiruvavur	2. Ms.K.Srividya, DSBS

Course Code	21CSC301T	Course Name	FORMAL LANGUAGE AND AUTOMATA	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:		Construct automata for any equivalent regular expressions	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:		Acquire brief knowledge about automata languages	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:		Analyze about context free grammars and its implementation in Push down automata															
CLR-4:		Interpret the power of Turing machine and the decidable nature of a problem															
CLR-5:		Categorize undecidable problems and NP class problems															
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:		Summarize the basic concepts of deterministic and non-deterministic finite automata and its applications.	-	1	1	-	-	-	-	-	-	-	-	-	1	3	-
CO-2:		Analyze the formal relationships among machines, languages and Context free grammars and its normalization	-	3	3	-	-	-	-	-	-	-	-	-	1	3	-
CO-3:		Construct the Push down stack machine and its context free language acceptance and its equivalence with CFG	-	2	2	-	-	-	-	-	-	-	-	-	1	3	-
CO-4:		Analyze the techniques for Turing machine construction and its recursive languages and functions	-	2	2	-	-	-	-	-	-	-	-	-	1	3	-
CO-5:		Evaluate the computational complexity of various problems	-	3	3	-	-	-	-	-	-	-	-	-	1	3	-

Unit-1 - Finite Automata and Regular Expressions	9 Hour
Deterministic and Non-Deterministic Finite Automata, Finite Automata with ϵ -moves, regular expressions – equivalence of NFA and DFA, two-way finite automata, Moore and Mealy machines, Equivalence of Moore and Mealy machines, applications of finite automata.	
Unit-2 - Regular Sets and Context Free Grammars	9 Hour
Properties of regular sets, context-Free Grammars, and Languages – derivation trees, Simplification of CFG: Elimination of Useless Symbols Simplification of CFG: Unit productions, Null productions - Chomsky Normal Forms and Greibach Normal Forms, ambiguous and unambiguous grammars; minimization of finite automata	
Unit-3 - Pushdown Automata and Parsing Algorithms	9 Hour
Deterministic Push Down Automata – Non-Deterministic Push Down Automata – Equivalence of Pushdown Automata and context-free languages; Properties of CFL; Applications of pumping lemma – closure properties of CFL and decision algorithms; Overview of Top-down parsing and Bottom-up parsing	
Unit-4 - Turing machines	9 Hour
Turing machines (TM) – computable languages and functions – Turing machine constructions – storage in finite control – variations of TMs – Church-Turing thesis – Universal Turing machine– recursive and recursively enumerable languages	
Unit-5 - Introduction to Computational Complexity	9 Hour
Time and Space complexity of TMs – complexity classes – introduction to NP-Hardness and NP-Completeness Post Correspondence Problems (PCP) – Modified PCP – Halting Problems – Undecidability Problems	

Learning Resources	1. Hopcroft J.E., Motwani R. and Ullman J.D, "Introduction to Automata Theory, Languages and Computations", Second Edition, Pearson Education, 2008.	3. John.C. Martin, "Introduction to Languages and the Theory of Computation" McGraw-Hill Education, 01- May-2010.
	2. Michael Sipser, "Introduction to the Theory of Computation" Cengage Learning, 2012	4. Peter Linz, "An introduction to formal languages and automata", Jones & Bartlett Learning, Sixth Edition, 2017

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Santhosh Muniswami, Cisco Systems, Inc.	1. Dr. P. Victor Paul, Indian Institute of Information Technology Kottayam	1. Dr. N. Arunachalam
2. B. Divya, TCS	2. Dr.C. Punitha Devi, Pondicherry University,	2. Dr. K. Vijaya

Course Code	21CSC302J	Course Name	COMPUTER NETWORKS				Course Category	C	PROFESSIONAL CORE					L	T	P	C					
																	3	0	2	4		
Pre-requisite Courses	Nil		Co- requisite Courses	Nil				Progressive Courses	Nil													
Course Offering Department		School of Computing				Data Book / Codes / Standards				Nil												
Course Learning Rationale (CLR):		The purpose of learning this course is to:						Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Define the layered network architecture						1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3			
CLR-2:	Produce knowledge in IP addressing																					
CLR-3:	Identify suitable routing algorithms based on geographical location of the devices																					
CLR-4:	Apply the concept of Error detection to identify the errors in data.																					
CLR-5:	Exploring reliable and unreliable protocols																					
Course Outcomes (CO):		At the end of this course, learners will be able to:																				
CO-1:	Apply the knowledge of communication						3	-	-	-	3	-	-	-	-	-	-	-	1	-	-	
CO-2:	Construct the network using addressing schemes						3	-	-	2	-	-	-	-	-	-	-	-	1	-	-	
CO-3:	Design and implement the various Routing Protocols						3	-	-	2	3	-	-	-	-	-	-	-	1	-	-	
CO-4:	Identify and correct the errors in transmission						3	-	-	-	-	-	-	-	-	-	-	-	1	-	-	
CO-5:	Analyze the services provided by Transport and Application layers						3	-	-	-	-	-	-	-	-	-	-	-	1	-	-	
Unit-1 - Introduction to Networks																	15 Hour					
Network Types: LAN, MAN, PAN, WAN - Network Topology : BUS, STAR, RING, MESH, HYBRID - Switching : Circuit Switching, Packet Switching - OSI Layered Architecture - TCP/IP Model - Physical Layer Overview - Latency, Bandwidth, Delay - Guided Media : Twisted pair, Coaxial cable, Fiber optic cable - Unguided Media : Radio waves, Microwaves, Infrared.																						
Lab 1: Introduction to Packet Tracer, Peer to Peer communication, study of cables and its colour codes																						
Lab 2: Implementation of Network Topologies																						
Lab 3: Router Configuration (Creating Passwords, Configuring Interfaces)																						
Unit-2 - Addressing																	15 Hour					
IPv4 Addressing - Address space - Classful addressing - Subnet mask - FLSM - Classless Addressing - VLSM – NAT – Super netting - Network Devices: Hub, Repeaters, Switch, Bridge, Router																						
Lab 4: IP addressing and Sub netting (VLSM)																						
Lab 5: Static and Default Routing																						
Lab 6: NAT Configuration																						
Unit-3 - Routing																	15 Hour					
Forwarding of IP Packets — Static and Default Routing — Unicast Routing Algorithms: Distance Vector Routing, Link State Routing, Path Vector Routing — Protocols: RIP V1, RIP V2, OSPF, BGP, EIGRP — Multicasting Basics — IPV6 Addressing Basics																						
Lab 7: Implementation of RIP version 1																						
Lab 8: Implementation of RIP version 2																						
Lab 9: Implementation of Single Area OSPF																						

Unit-4 – Medium Access Control	15 Hour
ALOHA ,CSMA/CD, CSMA/CA, Ethernet, Token Ring - Flow Control :Stop and Wait, Sliding Window - Error Control: Stop and Wait ARQ, Sliding Window ARQ - Error Detection : Parity Check, Checksum, CRC - Error Correction: Hamming codes - Data-Link Layer Protocols : HDLC, PPP. Lab 10: Implementation of Multi Area OSPF Lab 11: PPP Configuration Lab 12: HDLC Configuration	
Unit-5 – Transport and Application Layer Protocols	15 Hour
Port Numbers — User Datagram Protocol — Transmission Control Protocol — WWW and HTTP — FTP — Email –Telnet – DNS. Lab 13: Implementation of BGP Lab 14: Implementation of EIGRP Lab 15: Telnet Configuration	

Learning Resources	1. Behrouz A. Forouzan, "Data Communication and Networking", 5th ed., 2010 2. Bhushan Trivedi, "Data Communication and Networks" 2016	3. William Stallings, "Data and Computer Communications", 9th ed., 2010 4. Todd Lammle, "CCNA Study Guide", 7th ed., 2011
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	20%	20%	-
Level 2	Understand	40%	-	-	40%	40%	-
Level 3	Apply	40%	-	-	40%	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Srinivasan Varadarajan, Senior Principal Software Engineer, Manhattan Associates, Atlanta, United States	1. Dr. I.Joe Louis Paul, Associate Professor, SSN College of Engineering, TamilNadu	1. Dr. S. Metilda Florence, SRMIST

Course Code	21CSC303J	Course Name	SOFTWARE ENGINEERING AND PROJECT MANAGEMENT	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Familiarize the software life cycle models and software development process		1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Illustrate the various techniques for requirements, planning and managing a technology project		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Examine basic methodologies for software design, development, testing, and implementation																
CLR-4:	Understand manage user's expectations and the software development team																
CLR-5:	Apply the project management and analysis principles to software project development																
Course Outcomes (CO):		At the end of this course, learners will be able to:	-	-	-	-	-	-	-	-	2	-	2	-	3	-	-
CO-1:	Identify the process of project life cycle model and process		-	3	-	-	-	-	-	-	2	-	2	-	3	-	-
CO-2:	Analyze and translate end-user requirements into system and software requirements		-	-	2	-	-	-	-	-	2	-	2	-	3	-	-
CO-3:	Identify and apply appropriate software architectures and patterns to carry out high level design of a system		-	-	-	-	-	-	-	-	2	-	2	-	3	-	-
CO-4:	Develop Test plans and incorporate suitable testing strategies		-	-	-	-	-	-	-	-	2	-	2	-	3	-	-
CO-5:	Examine the risk strategies and maintenance measures		-	-	-	-	-	-	-	-	2	-	3	-	3	-	-

Unit-1 - Introduction to Software Engineering	12 Hour
The evolving role of software, changing nature of software, Generic view of process: Software engineering- a layered technology, a process framework, Software Project Management - life cycle activities, Process models: The waterfall model, incremental process models, evolutionary process models, the unified process, Conventional- Agile, XP, Scrum, Project Initiation management – Project Charter, Project Scope, Project Objectives, Practical considerations.	
Unit-2 - Software Requirements	12 Hour
Functional and non-functional requirements, user requirements, system requirements, interface specification, the software requirements document. Requirements engineering process: Feasibility studies, requirements elicitation and analysis, requirements validation, requirements management, Software project effort and cost estimation – Cocomo model I, Cocomo Model II, LOC, Function point metrics	
Unit-3 - Software Design	12 Hour
Software Design Fundamentals, Design process – Design Concepts-Design Model– Design Heuristic , Design techniques– Architectural Design - Architectural styles, Creating an architectural design- software architecture, data design, architectural styles and patterns, architectural design, conceptual model of UML, basic structural modeling, class diagrams, sequence diagrams, collaboration diagrams, use case diagrams, component diagrams, Design of User Interface design Elements of good design, Design issues Features of modern GUI - Menus, Scroll bars, windows, Buttons, icons, panels, error Messages etc.	
Unit-4 - Software Construction	12 Hour
Coding Standards, Coding Frameworks. Reviews: Deskchecks, Walkthroughs, Code Reviews, Inspections, Coding Methods, Testing Strategies: A strategic approach to software testing, test strategies for conventional software, black-box and white-box testing, validation testing, system testing, Unit Testing – Integration Testing – Validation Testing – System Testing and Debugging	
Unit-5 – Product Management	12 Hour
Product Release Management, Risk management: Reactive Vs proactive risk strategies, software risks, risk identification, risk projection, risk refinement, RMMM, RMMM plan, Maintenance and Reengineering	

Lab Experiments	
<p>Lab 1: Identify the Software Project, Create Business Case, Arrive at a Problem Statement</p> <p>Lab 2: Analyse Stakeholder and User Description and Identify the appropriate Process Model</p> <p>Lab 3: Identify the Requirements, System Requirements, Functional Requirements, Non-Functional Requirements and develop a SRS Document</p> <p>Lab 4: Prepare Project Plan based on scope, Find Job roles and responsibilities, Calculate Project effort based on resources</p> <p>Lab 5: Prepare the Work, Breakdown Structure based on timelines, Risk Identification and Plan</p> <p>Lab 6: Design a System Architecture, Use Case Diagram, ER Diagram (Database)</p> <p>Lab 7: DFD Diagram (process) (Upto Level 1), Class Diagram (Applied For OOPS based Project),</p> <p>Lab 8: Interaction Diagrams, State chart and Activity Diagrams</p> <p>Lab 9: State and Sequence Diagram, Deployment Diagram,</p> <p>Lab 10: Sample Frontend Design (UI/UX)</p> <p>Lab 11: Sample code implementation</p> <p>Lab 12: Master Test Plan, Test Case Design (Phase 1)</p> <p>Lab 13: Manual Testing</p> <p>Lab 14: User Manual, Analysis of Costing, Effort and Resource</p> <p>Lab 15: Project Demo and Report Submission with the team</p>	

Learning Resources	1. Roger S. Pressman, Software Engineering – A Practitioner Approach, 6th ed., McGraw Hill, 2005	4. Ramesh, Gopalaswamy, Managing Global Projects, Tata McGraw Hill, 2005
	2. Ian Sommerville, Software Engineering, 8th ed., Pearson Education, 2010	5. Ashfaque Ahmed, Software Project Management: a process-driven approach, Boca Raton, Fla: CRC Press, 2012
	3. Rajib Mall, Fundamentals of Software Engineering, 4th ed., PHI Learning Private Limited, 2014	6. Walker Royce, Software Project Management, Pearson Education, 1999
		7. Jim Smith Agile Project Management: Creating Innovative Products, Pearson 2008

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	20%	20%	-
Level 2	Understand	20%	-	-	20%	20%	-
Level 3	Apply	40%	-	-	40%	40%	-
Level 4	Analyze	20%	-	-	20%	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. DHINAKAR JACOB SELWYN, CAP GEMINI TECHNOLOGY		1. Mrs. Anupama C G
2. Mr. Girish Raghavan, Wipro Technologies		

Course Code	21CSC304J	Course Name	COMPILER DESIGN	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Outline the implementation of Lexical Analyzer	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	To learn the various parsing techniques	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Familiarize the intermediate code generation and run-time environment																	
CLR-4:	To learn the implementation of code generator																	
CLR-5:	Identify the various methods for Code Optimizer																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Acquire knowledge of Lexical Analyzer from a specification of a language's lexical rules	3	2	-	-	2	-	-	-	-	-	-	-	-	1	-		
CO-2:	Apply different parsing algorithms to develop the parsers for a given grammar	3	3	-	-	2	-	-	-	-	-	-	-	-	1	-		
CO-3:	Gain knowledge to translate a system into various intermediate codes	3	2	-	-	2	-	-	-	-	-	-	-	-	1	-		
CO-4:	Analyze the methods of implementing a Code Generator for compilers	3	2	-	3	-	-	-	-	-	-	-	-	-	1	-		
CO-5:	Design the methods of developing a Code Optimizer	3	-	2	3	-	-	-	-	-	-	-	-	-	1	-		

Unit-1 - Introduction	12 Hour
Compilers-Phases of Compiler-Cousins of the Compiler-Grouping of Phases-Compiler construction tools- Lexical Analysis-Role of Lexical Analyzer-Input Buffering -Specification of Tokens -LEX -Finite Automata-Regular Expressions to Automata -Minimizing DFA.	
Unit-2 – Top Down Parsing	12 Hour
Role of Parser-Grammars-Error Handling-Context-Free Grammars-Writing a grammar- Elimination of Ambiguity-Left Recursion- Left Factoring-Top Down Parsing — Recursive Descent Parser- Predictive Parser-LL(1) Parser- Computation of FIRST-Computation of FOLLOW-Construction of a predictive parsing table-Predictive Parsers LL(1) Grammars- Predictive Parsing Algorithm- Problems related to Predictive Parser - Error Recovery in Predictive Parsing-.	
Unit-3 – Bottom-Up Parsing	12 Hour
Bottom Up Parsing-Reductions-Handle Pruning-Shift Reduce Parser-Problems related to Shift Reduce Parsing-Operator Precedence Parser, LEADING, TRAILING -LR Parser- LR Parsers- Need of LR Parsers-LR (0)Item-Closure of Item Sets- Construction of SLR Parsing Table -Problems related to SLR-Construction of Canonical LR(1)- Problems related to CLR - LALR Parser — Problems related to LALR-YACC.	
Unit-4 – Code Generation	12 Hour
Intermediate Code Generation- prefix – postfix notation- Quadruple - triple - indirect triples Representation- Syntax tree- Evaluation of expression - Three-address code- Synthesized attributes – Inherited attributes - Intermediate languages – Declarations- Assignment Statements- Boolean Expressions- Case Statements- Back patching – Procedure calls- Code Generation- Issues in the design of code generator- The target machine – Runtime Storage management- A simple Code generator- Code Generation Algorithm- Register and Address Descriptors.	
Unit-5 – Code Optimization	12 Hour
Code optimization -Principal Sources of Optimization- Function Preserving Transformation- Loop Optimization- Peephole optimization — DAG- Basic Blocks- Flow Graphs- Global Data Flow Analysis — Efficient Data Flow Algorithm- Runtime Environments- Source Language issues- Storage Organization- Activation Records- Storage Allocation strategies.	

Lab Experiments	
Lab 1 - Implementation of Lexical Analyzer Lab 2 conversion from Regular Expression to NFA Lab 3 Conversion from NFA to DFA Lab 4 Elimination of Ambiguity, Left Recursion and Left Factoring Lab 5 -FIRST AND FOLLOW computation Lab 6 Predictive Parsing Table Lab 7 - Shift Reduce Parsing Lab 8- Computation of LEADING AND TRAILING	Lab9 Computation of LR (0) items Lab 10-Intermediate code generation – Postfix, Prefix Lab 11 Intermediate code generation – Quadruple, Triple, Indirect triple Lab 12: A simple code Generator Lab 13 Implementation of DAG Lab 14: Implementation of Global Data Flow Analysis Lab 15: Implement any one storage allocation strategies (heap, stack, static)

Learning Resources	1. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, <i>Compilers: Principles, Techniques and Tools</i> , Second Edition, Pearson Education, 2011.	4. David Galles, <i>Modern Compiler Design</i> , Pearson Education, Reprint 2012.
	2. S. Godfrey Winster, S. Aruna Devi, R.Sujatha, <i>Compiler Design</i> , Yesdee Publishing Pvt.Ltd, 2016. 3. K.Muneeswaran, <i>CompilerDesign</i> , Oxford Higher Education, Fourth Edition, 2015.	5. Raghavan V., <i>Principles of CompilerDesign</i> , Tata McGraw Hill Education Pvt. Ltd., 2010.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Saranya Baskar, Lead Software Testing Engineer, EPAM Systems India Private Limited, Hyderabad. saranya_baskar@epam.com	1. Dr. E. Ilavarasan, Professor, Department of Computer Science and Engineering, Puducherry Technological University, Puducherry.	1. Dr. M. Baskar, SRMIST
	2. Dr. M. Shyamala Devi, Professor, Department of Computer Science and Engineering, Vel Tech Rangarajan Dr. Sagunthala R & D Institute of Science and Technology, Chennai.	2. Dr. Godfrey Winster S SRMIST

Course Code	21CSC305P	Course Name	MACHINE LEARNING	Course Category	C	PROFESSIONAL CORE										L	T	P	C				
																2	1	0	3				
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil																
Course Offering Department		School of Computing			Data Book / Codes / Standards			Nil															
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes					
CLR-1:	Explore the fundamental mathematical concepts of machine learning algorithms					1	2	3	4	5	6	7	8	9	10	11	12						
CLR-2:	Apply linear machine learning model to perform regression and classification					Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3			
CLR-3:	Utilize mixture models to group similar data items																						
CLR-4:	Develop machine learning models for time –series data prediction																						
CLR-5:	Design ensemble learning models using various machine learning algorithms																						
Course Outcomes (CO):		At the end of this course, learners will be able to:																					
CO-1:	Understand the basics of machine learning using probability theory					-	2	-	-	-	-	-	-	-	-	-	-	1	-	-			
CO-2:	Implement machine learning models using supervised learning algorithms					-	2	-	2	-	-	-	-	-	-	-	-	-	-	2			
CO-3:	Implement machine learning models using unsupervised learning algorithms					-	3	-	3	-	-	-	-	-	-	-	-	-	-	2			
CO-4:	Implement machine learning models for sequential data analysis and prediction					-	3	-	3	-	-	-	-	-	-	-	-	-	-	3			
CO-5:	Develop ensemble learning models for supervised and unsupervised learning					-	3		3	-	-	-	-	-	-	-	-	-	-	3			
Unit-1 - Introduction																				9 Hour			
machine learning what and why?, supervised and unsupervised learning, polynomial curve fitting, probability theory- discrete random variables, fundamental rules,Bayes rule, Independence and conditional independence, continuous random variables, Quantiles, Mean and variance, probability densities, Expectation and covariance.																							
Practice:																							
1. Devise a program to import, load and view dataset																							
2. Create a program to display the summary and statistics of the dataset																							
Unit-2 - Linear models for regression																				9 Hour			
Maximum likelihood estimation – least squares, robust linear expression, ridge regression, Bayesian linear regression. Linear models for classification: Discriminant function – Probabilistic generative models, Probabilistic discriminative models, Laplacian approximation, Bayesian logistic regression, Kernels functions, using kernels in GLMs, Kernel trick, SVMs.																							
Practice:																							
1. Implement linear regression to perform prediction																							
2. Implement Bayesian logistic regression and SVM for classification																							
Unit-3 - Mixture models and EM																				9 Hour			
K-means clustering, mixtures of Gaussians, An alternative view of EM, Factor analysis, PCA, choosing the number of latent dimensions. Clustering – measuring dissimilarity, evaluating the output of clustering methods, Hierarchical clustering.																							
Practice:																							
1. Implement K-means clustering, mixtures of Gaussians and Hierarchical clustering algorithm to categorize data.																							
2. Create a program to perform PCA																							

Unit-4 – Hidden Markov Models	9 Hour
Sequential data – Markov models, HMM – maximum likelihood for the HMM, The forward and Backward algorithm, the sum-product algorithm, scaling factors, Viterbi algorithm, linear dynamical systems.	
Practice:	
1. Implement HMM to predict the sequential data	
Unit-5 – Combining Models	9 Hour
Bayesian model averaging, Boosting, Adaptive basis function models, CART, generalized additive models, Ensemble learning.	
Practice:	
1. Implement CART learning algorithms to perform categorization	
2. Implement Ensemble learning models to perform classification	

Learning Resources	1. Pattern Recognition and Machine Learning, Christopher M Bishop, Springer, 2006. 2. Machine Learning- A probabilistic perspective, Kevin P.Murphy, The MIT Press, 2012.
---------------------------	--

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	-	15%	-	-
Level 2	Understand	25%	-	-	20%	-	20%	-	-
Level 3	Apply	30%	-	-	25%	-	25%	-	-
Level 4	Analyze	30%	-	-	25%	-	25%	-	-
Level 5	Evaluate	-	-	-	10%	-	10%	-	-
Level 6	Create	-	-	-	5%	-	5%	-	-
Total		100 %		100 %		100 %		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Vaisakh. P.S, Assistant executive manager, Samsung Electronics, Bangalore vaishakhps@samsung.com	1. Dr.C.Oswald, Assistant professor, NIT, Trichy,Oswald.mecse@gmail.com	1. A.Jackulin Mahariba, SRMIST

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

**Volume - 11A
(Syllabi for CSE Programme Courses)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSE251T	Course Name	DIGITAL IMAGE PROCESSING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:		CLR-2:		1	2	3	4	5	6	7	8	9	10	11	12	PO-1	PO-2	PO-3
CLR-1:	Outline the fundamentals of various image processing concepts	CLR-2:	Familiarize on multiple image enhancement techniques and methodologies	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	Learn different image segmentation methodologies	CLR-4:	Learn the art of on feature extraction and compression															
CLR-5:	Master various Deep learning algorithms for Image processing																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Apply various Fundamental techniques and methodologies image processing systems	CO-2:	Apply the image quality through different image enhancement algorithms	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Gain knowledge on image segmentation algorithms	CO-4:	Apply feature extraction and compression models	3	-	2	3	-	-	-	-	-	-	-	-	2	-	-
CO-5:	Apply Deep learning principles for image processing			3	3	-	-	-	-	-	-	-	-	-	-	-	3	-

Unit-1 - Fundamentals of Digital Image Processing	9 Hour
Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization. Relationships between pixels - Color image fundamentals - RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms - DFT, DCT.	
Unit-2 - Image Enhancement (Spatial and Frequency Domain)	9 Hour
Spatial Domain: Basic relationship between pixels- Basic Gray level Transformations – Histogram Processing – Smoothing spatial filters- Sharpening spatial filters. Frequency Domain: Smoothing frequency domain filters- sharpening frequency domain filters Homomorphic filtering.	
Unit-3 - Image Restoration Techniques	9 Hour
Introduction to Image Restoration- degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering	
Unit-4 - Concepts on Image Segmentation	9 Hour
Region of interest (ROI) selection - Feature extraction: Histogram based features - Intensity Features-Color, Shape Features-Local Binary Patterns (LBP), Texture descriptors- Grey Level Occurrence Matrix (GLCM). Fundamentals of Image Compression models – Error Free Compression – Variable Length Coding –Bit – Plane Coding – Lossless Predictive Coding – Lossy Compression – Lossy Predictive Coding.	
Unit-5 - Feature Extraction	9 Hour
Extracting Interest Points and Their Descriptors (with Harris, SIFT and SURF) in Image Pairs, Principal Component Analysis (PCA) and Linear Discriminant Analysis for Image Recognition- Image Classification using SVM-ANN- Feedforward and Back propagation-Object Detection using CNN-RCNN.	

Learning Resources	1. Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Pearson Education, Third Edition, 2010.	4. Kumar, "Digital Image Processing", Tata McGraw Hill Pvt. Ltd., Second Reprint, 2010.
	2. S. Sridhar, "Digital Image Processing", Second Edition, Oxford University, 2016.	5. Bhabatosh Chanda, Dwejesh Dutta Majumder, "Digital Image Processing and analysis", PHI Learning Pvt. Ltd., Second Edition, 2011.
	3. Anil Jain K. "Fundamentals of Digital Image Processing", PHI Learning Pvt. Ltd., 2011. 3. Jayaraman S., Esaki Rajan S., T.Veera	6. Malay K.Pakhira, "Digital Image Processing and Pattern Recognition", PHI Learning Pvt. Ltd., First Edition, 2011.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	30%	-	30%	-
Level 3	Apply	30%	-	50%	-	50%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. SheebaBackiamary Huawei, Sweden. Sheeba.backia.mary@huawei.com	1. Dr.Venningstun NIT, J&K, India veningstonk@gmail.com	1. Dr.Kottilingam, SRMIST kottilik@srmist.edu.in
2. Dr. Gopal, Ceri, CHENNAI agopalceeri@gmail.com	2. Dr. Jayashree P, Anna University, India pjshree@annauniv.edu	2. Dr.Arivazhagan, SRMIST arivazhn@srmist.edu.in

Course Code	21CSE252T	Course Name	BIOMETRICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basic concept of biometrics.			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Gain knowledge on the basics of biometric traits, sensors, data acquisition and finger print process																	
CLR-3:	Introduce the process of Multibiometric system																	
CLR-4:	Acquire knowledge on biometric system authentication																	
CLR-5:	Understand the real time application of biometrics																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Acquire the knowledge on basics of biometric traits			3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-2:	Ability to identify pattern recognition system and its features			3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Understand about multi model biometric traits			3	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO-4:	Apply the knowledge of biometrics on developing authentication system			3	-	1	2	-	-	-	-	-	-	-	-	-	1	-
CO-5:	Apply the knowledge for designing biometric systems			3	-	-	1	-	-	-	-	2	-	-	-	-	1	-

Unit-1 - Introduction	9 Hour
Basics of biometric systems, Biometric functionalities: verification, identification- Introduction to unimodal system, Introduction to multimodal system, what is image, acquisition, type, point operations, Geometric transformations-First and Second Derivatives- steps in edge detection, smoothening, enhancement, thresholding, localization, Low level feature extraction, Describing image motion- High level feature extraction, Template matching	
Unit-2 - Process of Biometric System	9 Hour
Biometrics Sensors, Data Acquisition and Database, Biometrics Pre-processing Techniques-Image restoration and segmentation, Pattern Extraction and Classification, Fingerprint Identification Technology- Fingerprint Patterns, Fingerprint Features, Fingerprint Image, width between two ridges -Fingerprint Image Processing – Minutiae Determination – Fingerprint Matching: Fingerprint Classification, Matching policies.	
Unit-3 - Multibiometric System	9 Hour
Introduction to Multibiometric – Information Fusion in Biometrics – Issues in Designing a Multibiometric System – Sources of Multiple Evidence – Levels of Fusion in Biometrics – Sensor level, Feature level, Rank level, Decision level fusion – Score level Fusion. Introduction to various matching methods – LDA, PCA, Eigen Vectors and Values-Covariance, Correlation- Introduction to decision theory and their examples	
Unit-4 - Authentication Procedure	9 Hour
physiological and behavioral properties of biometric system, Software biometrics systems, Hardware biometrics systems, Security of biometric systems- Advisory, insider, infrastructure attacks- Attacks at the user interface- impersonation ,obfuscation, spoofing Attacks on system module and interconnections- Counter measure: Biometric template security- Challenges in biometric systems like fool proofing, false positives	
Unit-5 - Applications	9 Hour
access control like a lock or an airport check-in area- immigration and naturalization- welfare distribution- military application- banking, e.g., check cashing, credit card, ATM- computer login; intruder detection; smart card- multi-media Communication; WWW and an electronic purse- sensor fusion; decision fusion- categorization: e.g., age and gender- industrial automation - efficient enrollment gesture interpretation; on-line shopping- other commercialized service: Fingerprint, Face detection, Irish Recognition.	

Learning Resources	1. James Wayman, Anil Jain, DavideMaltoni, Dario Maio, Biometric Systems, Technology Design and Performance Evaluation, Springer, 2005.	4. Digital Image Processing using MATLAB, By: Rafael C. Gonzalez, Richard Eugene Woods, 2nd Edition, Tata McGraw-Hill Education 2019
	2. James wayman, Anilk.Jain, ArunA.Ross, Karthik Nandakumar, –Introduction to. BiometricsII, Springer, 2011	5. Guide to Biometrics, By: Ruud M. Bolle, SharathPankanti, Nalini K. Ratha, Andrew W. Senior, Jonathan H. Connell, Springer 2009
	3. Mark S.Nixon, Alberto S.Aguado, Feature Extraction and image processing for computer vision, Third Edition, , Elsevier 2012	6. Pattern Classification, By: Richard O. Duda, David G.Stork, Peter E. Hart, Wiley 2007
		7. Shimon K.Modi , –Biometrics in Identity Management :concepts to applicationsII, Artech House 2011

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	30%	-	30%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	30%	-	30%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.L.Parthiban, Exceillity Technologies	1. Dr.S.P.Raja, Associate Professor, VIT, Vellore,	1. Dr.E.Poongothai, SRMIST

Course Code	21CSE253T	Course Name	INTERNET OF THINGS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand Smart Objects and IoT Architectures	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Learn about various IOT-related protocols	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	Build simple IoT Systems using Arduino and Raspberry Pi.																											
CLR-4:	Understand data analytics and cloud in the context of IoT																											
CLR-5:	Develop IoT infrastructure for popular applications																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Explain the concept of IoT.	1	-	-	-	-	2	-	-	-	-	-	-	-	-	2												
CO-2:	Analyze various protocols for IoT.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2												
CO-3:	Design a PoC of an IoT system using Rasperry Pi/Arduino	2	-	1	-	-	-	-	-	-	-	-	-	-	-	2												
CO-4:	Apply data analytics and use cloud offerings related to IoT.	-	3	-	-	1	-	-	-	-	-	-	-	-	-	2												
CO-5:	Analyze applications of IoT in real time scenario	-	1	-	3	-	-	-	-	-	-	-	-	-	-	2												

Learning Resources	<ol style="list-style-type: none"> David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, –IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017 ArshdeepBahga, Vijay Madiseti, –Internet of Things – A hands-on approach, Universities Press, 2015 Olivier Hersent, David Boswarthick, Omar Elloumi, – The Internet of Things – Key applications and Protocols, Wiley, 2012 (for Unit 2). 	<ol style="list-style-type: none"> An Ho"ller, VlasiosTsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), –Architecting the Internet of Things, Springer, 2011. Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011.
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Shreyas Lakshminarayanan, Systems Engineer Tata Consultancy Services Pvt Ltd, Chennai	1. Dr. G.R. Sakthidharan, Professor/GRIET, Hyderabad	1. M. Arulprakash, SRMIST
2. Shaishav Tayde, IT Analyst Tata Consultancy Services Pvt Ltd, Ahmedabad	2. Dr. Arunraj, Associate Prof./Crescent University, Chennai	2. J. Ramaprabha, SRMIST

Course Code	21CSE254T	Course Name	BIO INSPIRED COMPUTING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the basics of biological systems	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Acquire knowledge on working of Evolutionary algorithms	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Gain the knowledge on the fundamentals and topological working of Artificial Neural Networks																	
CLR-4:	Conceive the the fundamentals and working of Swarm Intelligence																	
CLR-5:	Explore the working of Immuno Computing Techniques																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Exhibit knowledge on fundamental concepts of bio inspired computing	3	2	-	2	-	-	-	-	-	-	-	-	-	3	2		
CO-2:	Apply evolutionary algorithms and perform computing	2	2	-	-	-	-	-	-	-	-	-	-	-	3	2		
CO-3:	Design and develop simple neural network models	3	-	3	2	-	-	-	-	-	-	-	-	-	3	2		
CO-4:	Recommend appropriate swarm algorithm for building an AI model	2	2	2	-	-	-	-	-	-	-	-	-	-	3	2		
CO-5:	Apply suitable Immuno Computing algorithm for a given problem	2	-	2	-	-	-	-	-	-	-	-	-	-	3	2		

Unit-1 - Introduction	9 Hour
Models of Life and Intelligence - Fundamentals of bio-inspired models and bio-inspired computing. Evolutionary models and techniques, Swarm models and its self-Organization, swarm, and evolutionary algorithms. Optimization problems – single and multi-objective optimization, heuristic, meta-heuristic, and hyper heuristic functions	
Unit-2 - Evolutionary Computing	9 Hour
Evolutionary Computing, Hill Climbing and Simulated Annealing, Darwin's Dangerous Idea, Genetics Principles, Standard Evolutionary Algorithm -Genetic Algorithms, Reproduction-Crossover, Mutation, Evolutionary Programming, Genetic Programming	
Unit-3 - Neural Models	9 Hour
Biological nervous systems, artificial neural networks, evolution of neural networks,neuron models, architecture, unsupervised learning, supervised learning, reinforcement learning,Linear separability problem,signal encoding, synaptic plasticity, hybrid neural systems	
Unit-4 - Swarm Intelligence	9 Hour
Introduction - Ant Colonies, Ant Foraging Behavior, Ant Colony Optimization, SACO, and scope of ACO algorithms, Ant Colony Algorithm (ACA), Swarm Robotics, Foraging for food, Social Adaptation of Knowledge, Particle Swarm Optimization (PSO)	
Unit-5 - Immuno Computing Systems	9 Hour
Introduction- Immune System, Physiology and main components, Pattern Recognition and Binding, biological immune systems, lessons for artificial immune systems, algorithms and applications, shape space, negative selection algorithm, clonal selection algorithm, Bone Marrow Models, Forest's Algorithm	

Learning Resources	1. Leandro Nunes de Castro - " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor, and Francis Group, 2007 2. Floreano, D. and C. Mattiussi - "Bio-Inspired Artificial Intelligence: Theories, methods, and Technologies" IT Press, 2008 3. Albert Y. Zomaya - "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006	4. Marco Dorigo, Thomas Stutzle - "Ant Colony Optimization", Prentice Hall of India, New Delhi, 2005 5. D. E. Goldberg, "Genetic algorithms in search, optimization, and machine learning", Addison-Wesley, 1989. 6. Simon O. Haykin, "Neural Networks and Learning Machines", Third Edition, Prentice Hall, 2008.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Muthukumarasamy S, Capgemini India Pvt Ltd, Chennai	1. Deivamani Mallaya, College of Engineering, Guindy, Chennai.	1. Ms.S.Kiruthika devi, SRMIST
		2. Dr. K. Deeba, SRMIST

Course Code	21CSE255T	Course Name	COMPUTER GRAPHICS AND ANIMATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Identify various computer graphics drawing algorithms	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Provide understanding of 2D transformations and viewing methods	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Learn 3D transformations and viewing methods																
CLR-4:	Explore Visible surface detection methods																
CLR-5:	Acquire the knowledge of animation and image processing methods																
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	Accrue the basic knowledge of computer graphics and various algorithms	3	2	3	-	-	-	-	-	-	-	-	-	-	3	-	
CO-2:	Implement 2D transformations and viewing methods	3	3	3	-	-	-	-	-	-	-	-	-	-	3	-	
CO-3:	Demonstrate various 3D transformations and viewing methods	3	3	3	-	-	-	-	-	-	-	-	-	-	3	-	
CO-4:	Apply various visible surface detection methods	3	2	3	-	-	-	-	-	-	-	-	-	-	3	-	
CO-5:	Develop various computer animations	3	-	3	-	2	-	-	-	-	-	-	-	-	3	2	

Unit-1 - Introduction to Computer Graphics	9 Hour
Overview of Computer Graphics, Computer Graphics Application and Software - Video Display devices - Raster scan systems - Random Scan systems - Graphics Monitors and Workstations - Input Devices - Hard-Copy Devices - Graphics Software - Output Primitives - Points and Lines - Line-Drawing Algorithms - Circle-Generating Algorithms - Ellipse-Generating Algorithms - Parallel Curve Algorithms - Curve Functions -Pixel Addressing - Filled-Area Primitives - Scan-Line Polygon Fill Algorithm Inside-Outside Tests Scan -Line Fill of Curved Boundary Areas - Boundary-Fill Algorithm - Flood-Fill Algorithm - Overview of various attributes	
Unit-2 - 2D Transformations	9 Hour
Introduction to 2D transformations Basic transformations - Matrix representations - Composite Transformations -Transformations - Shear- Affine- Reflection - 2D viewing - The Viewing Pipeline-viewing functions - Clipping operations - Point clipping - Line Clipping -Cohen-Sutherland -Liang-Barsky- Nicholl-Lee-Nicholl - Line Clipping Using Nonrectangular Clip Windows - Splitting Concave Polygons - Polygon Clipping - Other Clipping methods	
Unit-3 - 3D Transformations	9 Hour
Introduction to 3D transformations Translations - Rotations - Reflections- shearing - Scaling - other transformations - Matrix Representation of 3D Transformations - 3D Viewing - Viewing Pipeline- Coordinates - Projections -Parallel- Perspective -View Volumes and General Projection Transformations-General Parallel-Projection Transformations- Clipping-Hardware Implementations Three-Dimensional Viewing-Functions	
Unit-4 - Visible-Surface Detection Methods	9 Hour
Introduction- Classification of Visible-Surface Detection Algorithms -Back-Face Detection-Depth-Buffer Method-Buffer Methods-Scan-Line Method-Depth-Sorting Method BSP-Tree Method-Area-Subdivision Method-Octree Methods Ray-Casting Method-Curved Surfaces-Wireframe Methods-Visibility-Detection Functions- Illumination Models and Surface-Rendering Methods-Light Sources Basic Illumination Models-Displaying Light Intensities-Half-tone Patterns and Dithering Techniques -Polygon-Rendering Methods-Ray-Tracing Methods -comparison of the methods.	

Unit-5 - Computer Animation and Color Models	9 Hour
Principles of Animation, Key framing, Deformations- Motion Specifications S3- Color models - Properties of light- types - Color model conversion - applications - Mathematics for computer Graphics - Coordinate-Reference Frames-Points and Vectors - Basis Vectors and the Metric Tensor- Matrices - Digital Image- File formats - Compression standard - JPEG- Enhancement and Contrast stretching- Practices on open source image processing software	

Learning Resources	1. Donald Hearn and Pauline Baker M, —Computer Graphics", Prentice Hall, 2nd Edition, New Delhi, 2007 2. Fundamentals of Computer Graphics by Steve Marschner and Peter Shirley, 4th Edition, A K Peters/CRC Press, 2018 ISBN: 9781315360201	3. Computer Graphics Principles and Practice Third Edition by John F. Hughes, Andries Van Dam, Morgan McGuire, David F. Sklar, James D. Foley, Steven K. Feiner Kurt Akeley, Addison- Wesley, 3rd Edition, 2008 4. Andleigh, P. K and Kiran Thakrar, —Multimedia Systems and Design, Pearson Education, 2015
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. N. Madhu, Senior Analyst, Tata Eleksi, Siruseri.	1. Dr. N. Brindha, Associate Professor, Department of Computer Science and Engineering, NIT, Trichy 2. Dr. Asha, Associate Professor, Department of Computer Science and Engineering, VIT, Chennai	1. Dr. P. Murali, Associate Professor, Department of Computing Technologies, School of computing, SRMIST, Kattankulathur

Course Code	21CSE351T	Course Name	COMPUTATIONAL LOGIC	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes						
CLR-1:	Explore the basics of Propositional logic	CLR-2:	Provide skills on rules to handle Propositional logic and various deduction rules	CLR-3:	Learn the First order Logic and its applications	CLR-4:	Acquire the art of. applying various inference rules in First Order Logic	CLR-5:	Introduce Modal logic and its Inference rules	1	2	3	4	5				6	7	8	9
			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3				
Course Outcomes (CO):			At the end of this course, learners will be able to:																		
CO-1:	Apply the skills acquired on propositional logic to solve examples at hand		3	3	-	-	-	-	-	-	-	-	-	-	-	-	-				
CO-2:	Analyze the rules learnt towards problem solving		3	3	-	-	-	-	-	-	-	-	-	-	-	-	-				
CO-3:	Acquire mastery over FOL and Meta theorems and apply the same with confidence		3	3	-	-	-	-	-	-	-	-	-	-	-	-	-				
CO-4:	Distinguish the acquired knowledge on AI under appropriate problem-solving contexts		3	3	-	-	-	-	-	-	-	-	-	-	-	-	-				
CO-5:	Attempt to apply the acquired knowledge on modal logics under appropriate problem-solving contexts		3	3	-	-	-	-	-	-	-	-	-	-	-	-	-				

Unit-1 -	9 Hour
Propositional Logic-Introduction-Syntax of PL-Is It a Proposition? - Interpretations-Models-Interpretations-Equivalences and Consequences-More About Consequence-A Propositional Calculus-Axiomatic System PC-Five Theorems about PC-Using the Metatheorems-Adequacy of PC to PL-Compactness of PL	
Unit-2 -	9 Hour
Normal Forms and Resolution-Truth Functions-CNF and DNF-Logic Gates-Satisfiability Problem-Resolution in PL-Resolution Strategies-Other Proof Systems for PL-Natural Deduction-Gentzen Sequent Calculus-Analytic Tableaux	
Unit-3 -	9 Hour
First Order Logic-Syntax of FL-Scope and Binding-Substitutions-Semantics of FL-Translating into FL-Satisfiability and Validity-Some Metatheorems-A First Order Calculus-Axiomatic System FC-Six Theorems about FC-Adequacy of FC to FL-Compactness of FL	
Unit-4 -	9 Hour
First Order Logic-Syntax of FL-Scope and Binding-Substitutions-Semantics of FL-Translating into FL-Satisfiability and Validity-Some Metatheorems-A First Order Calculus-Axiomatic System FC-Six Theorems about FC-Adequacy of FC to FL-Compactness of FL	
Unit-5 -	9 Hour
Modal Logic K—Introduction-Syntax and Semantics of K-Validity and Consequence in K-Axiomatic System KC-Adequacy of KC to K-Natural Deduction in K-Analytic Tableau for K-Other Modal Logics-Various Modalities-Computation Tree Logic	

Learning Resources	1. Arindama Singh, "Logics for Computer Science", PHI Learning Private Ltd, 2nd Edition, 2018	4. Dana Richards & Henry Hamburger, "Logic And Language Models For Computer Science", Third Edition, World Scientific Publishing Co. Pte. Ltd, 2018.
	2. Wasilewska & Anita, "Logics for computer science: classical and non-classical", Springer, 2018	6. https://www.cs.cornell.edu/courses/cs3110/2012sp/lectures/lec15-logic-contd/lec15.html
	3. Huth M and Ryan M, "Logic in Computer Science : Modeling and Reasoning about systems", Cambridge University Press, 2005	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Dr.Masilamani, IITKD Kancheepuram	1. Dr.K.Senthil Kumar, CTech, SRMIST
	2. Dr.G.Venkateswaran, BITS Pilani	

Course Code	21CSE352T	Course Name	NEURO FUZZY AND GENETIC PROGRAMMING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the core concepts and architectures of Neural Networks	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Recognize Associative Memory and Adaptive Resonance Theory in Neural Networks																											
CLR-3:	Articulate the fundamentals and various models of Fuzzy Systems																											
CLR-4:	Illustrate the concepts of Genetic Algorithms																											
CLR-5:	Integrate Neural Network, Fuzzy Logic, and Genetic Algorithm techniques																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Apply the concepts of Neural Network for building intelligent systems	2	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-		
CO-2:	Correlate Associative Memory and Adaptive Resonance Theory in Neural Networks	2	3	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-		
CO-3:	Devise a framework for building Fuzzy Logic Systems	1	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-		
CO-4:	Examine the modelling of Genetic Algorithms	1	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-		
CO-5:	Apply the concepts of Neural Network, Fuzzy Logic, and Genetic Algorithm for developing a framework for hybrid systems	3	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-		

Unit-1 - Neural Networks	9 Hour
Introduction to Artificial Intelligence Systems, Fundamentals of Neural Networks- Basic concepts, Human brain, Model of an Artificial Neuron, Neural Network Architectures, Characteristics of Neural Networks, Learning Methods, Taxonomy of Neural Network Architectures, History of Neural Network Research, Early Neural Network Architectures, McCulloch-Pitts Neuron Model; Back Propagation Networks - Architecture, Backpropagation Learning, Illustration, Applications, Effect of Turning Parameters of the Backpropagation Neural Network, Selection of various parameters in BPN, Variations of Standard Backpropagation Algorithms; Practice of Neural Network Tool - XOR Problem	
Unit-2 - Associative Memory & Adaptive Resonance Theory	9 Hour
Associative Memory - Autocorrelators, Heterocorrelators, Wang et al.'s Multiple Training Encoding Strategy, Exponential BAM, Associative Memory for Real-coded Pattern Paris, Applications; Adaptive Resonance Theory - Introduction, ART1, ART2, Applications, Sensitivities of Ordering of Data; Practice of Neural Network Tool- Delta Rule	
Unit-3 - Fuzzy Logic	9 Hour
Fuzzification; Fuzzy Set Theory- Fuzzy versus Crisp, Crisp Sets, Fuzzy Sets, Crisp Relations, Fuzzy Relations; Fuzzy Systems- Crisp Logic, Predicate Logic, Fuzzy Logic, Fuzzy Rule Based System, Defuzzification Methods, Practice of Fuzzy Logic Tool- Fuzzy Functions	
Unit-4 - Genetic Algorithms	9 Hour
Genetic Algorithms- Basic Concepts, Creation of Offspring, Working Principle, Encoding, Fitness Function, Reproduction; Genetic Modelling - Inheritance Operators, Crossover, Inversion and Deletion, Mutation Operator, Bitwise Operators used in GA, Generation Cycle, Conversion of Genetic Algorithm, Applications, Multilevel Optimization, Advances in GA, Practice of Optimization in Genetic Algorithm Tool	

Unit-5 - Hybrid Systems	9 Hour
Introduction, Neural Networks, Fuzzy Logic, and Genetic Algorithms Hybrids; Genetic Algorithm based Back Propagation Networks - GA Based Weight Determination; Fuzzy Backpropagation Networks- LR Type Fuzzy Numbers, Fuzzy Neuron, Fuzzy BP Architecture, Learning in Fuzzy BP; Fuzzy Logic Controlled Genetic Algorithms- GA in Fuzzy Logic Controller Design, Fuzzy Logic Controller, FLC-GA Based Structural Optimization.	

Learning Resources	<ol style="list-style-type: none"> 1. S. Rajasekaran, G. A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic, and Genetic Algorithms, Synthesis and Applications", PHI Learning Private Limited, 15th Printing, 2011. 2. S. Rajasekaran, G. A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Systems and Evolutionary Algorithms" PHI Learning Private Limited, Second Edition, 2017. 3. L. Fortuna, G. Rizzotto, M. Lavorgna, G. Nunnari, M. G. Xibilia, and R. Caponetto, "Soft Computing, New Trends and Applications", Springer, 2001. 4. S. N. Sivanandam, S. N. Deepa, "Principles of Soft Computing", Wiley, 3rd edition. 5. Dilip K. Prathihar, "Soft Computing - Fundamentals and Applications", Alpha Science International Limited, 2014. 6. Simon Hawkins, "Neural Networks", Pearson Education, 3rd edition, 2008. 7. Lone, Y. A., Singh, H. (2019). Deep Neuro-Fuzzy Systems with Python: With Case Studies and Applications from the Industry. Germany: Apress.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Vinay Ramanath, Principal Key Expert cientist, Simulations and Digital Twins Siemens Technology.	1. Dr. Y. Nancy Jane, Assistant Professor, Madras Institute of Technology, Anna University.	1. Dr. Sindhuja M, Assistant Professor
2. Prabakaran, Aerothermal Engineer - India Defence Rolls Royce India Pvt Ltd.		

Course Code	21CSE353T	Course Name	AUGMENTED, VIRTUAL AND MIXED REALITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the concepts of Augmented, Virtual and Mixed Realities	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Apply the concepts to develop real world scenarios and components	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Practical understanding of concepts of Unity software																	
CLR-4:	Apply AR concepts to develop unreal use cases																	
CLR-5:	Develop UI model using oculus quest																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Describe the similarities and differences between the Mixed Reality Technologies	3	-	2	-	-	-	-	-	-	-	-	-	-	-	2		
CO-2:	Demonstrate ability to develop applications using AR / VR technologies	3	-	2	-	-	-	-	-	-	-	-	-	-	-	2		
CO-3:	Build applications using unity	-	-	3	-	2	-	-	-	-	-	-	-	-	-	2		
CO-4:	Develop use cases using unreal	-	-	3	-	2	-	-	-	-	-	-	-	-	-	2		
CO-5:	Create user interface for VR applications	-	-	3	-	2	-	-	-	-	-	-	-	-	-	2		

Unit-1 – Introduction to Mixed Reality	9 Hour
VR, AR, MR, xR: similarities and differences, Current trends, and state of the art in immersive technologies, The future of human experience - Human Perception and Cognition, Technology on Stereoscopic Display: Immersion and Presence, Developing platforms and consumer devices, Physiology, Psychology and the Human Experience, Adaptation and Artefacts, Ergonomics, Ethics, Guidelines for Proper VR Usage, User-Centered Design, User Experience: Scientific Concerns, VR Health and Safety Issues, Effects of VR Simulations on Users, Cyber sickness, before and now, Ethical Code of Conduct.	
Unit-2 - AR components and Techniques	9 Hour
AR Frameworks, Practical understanding of real world AR application development, AR methodologies and project types, VR components and techniques, VR frameworks, Practical Understanding of real world VR application development, VR methodologies and project types, Navigation and Manipulation Interface techniques in Blender	
Unit-3 – Application Using Unity	9 Hour
AR advanced SDKs, AR core & Kit, AR spark studio, Vuforia engine, perform preliminary data quality and formatting, Hands on Unity Software and Use case applications, Purpose of Wikitude and 8 th wall tools	
Unit-4 – Unreal Engine and Techniques	9 Hour
Specific aspects of Unreal engine, Unreal engine vs unity, Unreal/Unity engine Physics & optimization techniques, Application demos, The present and the future of MR/xR	
Unit-5 – Modeling the Physical World	9 Hour
Geometric Modeling- Kinematics Modeling- Physical Modeling-, Locomotion tools, Oculus setup and environment for object interaction, User Interface/Experience developed through Oculus Quest – Audio/video in Immersive Environments, Introduction to Metaverse and applications, Behavior Modeling the functionalities of Metaverse applications through a Real-World Example	

Learning Resources	1. David Rose, "Super sight: What Augmented Reality Means for our lives, our work, and the way we imagine our future", Nov 2021	4. Jonathan Linowes, "Augmented Reality with Unity AR Foundation- a practical guide to cross platform AR development with Unity and later versions, 2021
	2. Lily Sayter, Brain Solis, The augmented Workforce, 2020	5. Kenneth J.Varnum, Beyond Reality- Augmented Virtual and Mixed Reality in the library, 2020
	3. Hevin W Allen, Meta Verse- A beginner's guide to the new digital revolution	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Jagatheeswaran Senthilvelan, Head - IoT and Robotics, Auxo Labs	1. Prof Thuong Hoang Associate Head of School, Research Faculty of Sci Eng & Built Env School of Info Technology Deakin University,Melbourne Burwood Campus, Australia	1. Dr.M.Pushpalatha, Professor
2. Mr.Gowtham, Head - Innovation and Technology, ProtoHubs.io		2. Dr.Vaishnavi Moorthy, Assistant Professor

Course Code	21CSE354T	Course Name	FULL STACK WEB DEVELOPMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Introduce the Web Fundamentals	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Introduce the Client-side scripting with react.js	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Introduce the Database Connectivity																
CLR-4:	Introduce the Spring Framework with Basic Concepts																
CLR-5:	Introduce the Spring Boot and Micro-Services																
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	Understand the Static Web Page Application	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-	
CO-2:	Apply scripting at client side.	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-	
CO-3:	Connect with Database to do CRUD operations.	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-	
CO-4:	Develop, Maintain and applications using Spring Boot Framework.	3	2	3	-	-	-	-	-	-	-	-	-	2	-	-	
CO-5:	Ability to use Microservices	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-	

Unit-1 - HTML, CSS Overview	9 Hour
HTML Overview: Structuring an HTML Document, Validating and debugging your code, Working with Fonts, Text Blocks, Lists and Tables, Using External and Internal Links, Working with Colors, Images, and Multimedia. CSS Overview: Understanding Cascading Style Sheets, Working with Margins, Padding, Alignment and Floating, Understanding the CSS Box Model and Positioning, Using CSS to do more with Lists, Text, and Navigation, Creating Layouts Using modern CSS Techniques, Taking Control of Backgrounds and Borders, Using CSS Transformations and Transitions, Animating with CSS and the Canvas.	
Unit-2 - JavaScript, React JS Overview	9 Hour
JavaScript Overview: Understanding JavaScript, Understanding Dynamic Websites and HTML5 Applications, Getting Started with JavaScript Programming, working with the Document Object Model (DOM), Using JavaScript Variables, Strings, and Arrays, Controlling Flow with Conditions and Loops, Responding to Events and Using Windows, JavaScript Best Practices., Using Third-Party JavaScript Libraries and Frameworks. React JS: The Foundation of React, JSX, All About Components of React, Events, Forms, Refs, Styling React, Routing, Hooks: Rules of Hooks, The Built-in Hooks (useState, useEffect, useContext, useMemo, useRef), Writing Custom Hooks, Labeling Custom Hooks with useDebugValue, Finding and Using Custom Hooks.	
Unit-3 - SQL, JDBC Overview	9 Hour
SQL Overview: Basics of SQL: Data basics, Retrieval: Basic Selection, Joins, Set Queries: UNION, INTERSECT, and EXCEPT, Subqueries, Modifying Data: Insert, Delete, Update, Creating, Deleting, and Altering Tables, JDBC: Introduction to JDBC: Setting up the database, connecting to a Database: The Connection Interface, connecting to the database using Driver Manager, Querying and Updating the Database: Statement Interface, Result Set Interface, Querying and Updating the Database.	
Unit-4 - Spring Boot Framework-Part-1	9 Hour
Spring Boot Framework-Part-1: Basic concepts: Spring, Spring Boot, Testing Basics, Testing in Spring Boot. A Basic Spring Boot Application: Setting up the Development Environment, The Skeleton Web App, and Spring Boot Auto configuration, Three-Tier, Three-Layer Architecture, Modeling our Domain, Business Logic, and Presentation Layer.	

Unit-5 - Spring Boot Framework-Part-2 **9 Hour**

Spring Boot Framework-Part-2: The Data Layer: The Data Model, choosing a Database, Spring Boot Data JPA, Entities, Repositories, Storing Users and Attempts. Microservices: Moving to Microservices, Architecture Overview, Designing and Implementing the New Service, User Interface UI

Learning Resources	<ol style="list-style-type: none"> 1. Sams Teach Yourself HTML, CSS, and JavaScript All in One, Julie Meloni, First Edition 2019, Pearson. (Unit - I, Unit - II) 2. BEGINNING ReactJS Foundations Building User Interfaces with ReactJS: AN APPROACHABLE GUIDE, Chris Minnick, First Edition 2022, Published by John Wiley & Sons. (Unit - II) 3. SQL Practical Guide for Developers, Michael J. Donahoo & Gregory D. Speegle, 2005, Morgan Kaufmann Publishers an Imprint of Elsevier. (Unit - III) 4. Oracle Certified Professional JavaSE 8 Programmer, Exam 1Z0-809 A Comprehensive OCPJP 8 Certification Guide, by S G Ganesh, Hari Kiran & Tushar Sharma, 2016, APress publisher. (Unit - III) 5. Learn Microservices with Spring Boot: A Practical Approach to RESTful Services Using an Event-Driven Architecture, Cloud-Native Patterns, and Containerization, Moisés Macero Garcia, Second Edition – 2020, APress Publisher. 	<ol style="list-style-type: none"> 6. Programming the World Wide Web, by Robert W. Sebesta, Eighth Edition - 2014, Published by Pearson. 7. Internet and World Wide Web How to Program, Paul Deitel, Harvey Deitel, and Abbey Deitel, Fifth Edition - 2011, Published by Prentice Hall. 8. Database Programming with JDBC and Java, by George Reese, Second Edition - 2000, Published by O'Reilly Media. 9. Expert Oracle JDBC Programming, by R. M. Menon, First Edition - 2005, Published by Apress. 10. Pro Spring MVC with WebFlux: Web Development in Spring Framework 5 and Spring Boot 2, by Marten Deinum and Iuliana Cosmina, Second Edition - 2022, Published by Apress. 11. Full stack development with Spring Boot and React: build modern and scalable full stack applications using the power of Spring Boot and React, by Juha Hinkula, Third Edition - 2022, Published by 12. Spring Boot in Practice, Somnath Musib, First Edition - 2022, Manning Publications.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr.Mariappan, Uber		1. Mr.Suresh Anand
		2. Ms. N.Anbarasi

Course Code	21CSE355T	Course Name	DATA MINING AND ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Introduce the basic concepts of pattern discovery and data preparation	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Understand the importance of Association and Correlation Algorithms	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Comprehend and apply various Classifiers																
CLR-4:	Work with the foundation for Clustering																
CLR-5:	Perform Outlier Analysis and Explore a data mining tool																
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	Do the preprocessing of data before mining of data for patterns	1	2	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO-2:	Make use of Association and Correlations Algorithms for framing association rules	1	2	-	-	3	-	-	-	-	-	-	-	2	-	-	
CO-3:	Apply as well as Compare the performance of various classifiers	1	2	-	-	3	-	-	-	-	-	-	-	2	-	-	
CO-4:	Utilize different Clustering algorithms for generalization	1	-	-	-	3	-	-	-	-	-	-	-	2	-	-	
CO-5:	Identify Outliers in the data given	1	2	-	-	3	-	-	-	-	-	-	-	2	-	-	

Unit-1 - Data Mining Introduction	9 Hour
Introduction: Kinds of Data- Kinds of Patterns-Data Objects and Attribute Type- Data Visualization -Data Preprocessing: Data cleaning, Data Integration, Data Transformation, Data Discretization and Data Reduction: Attribute Subset Selection-Histograms, Clustering, Sampling	
Unit-2 - Associations and Correlations	9 Hour
Market Basket Analysis – Apriori Algorithm – Mining Frequent Itemsets without Candidate Generation – Mining Frequent Itemsets Using Vertical Data Format – Mining Closed Frequent Itemsets – Mining Multilevel Association Rules – Mining Multidimensional Association Rules – Correlation Analysis – Constraint-Based Association Mining	
Unit-3 - Classification and Prediction	9 Hour
Basic Concepts- Decision Tree Induction-Attribute selection Measures-ID3 and CART algorithms, Tree Pruning-Bayes Classification Methods: Bayes’ Theorem, Naive Bayesian Classification - Classification by Backpropagation- Support Vector Machines-Lazy learners: KNN-Metrics for evaluating classifier performance-Techniques to improve classification accuracy-Prediction: Regression Analysis	
Unit-4 - Cluster Analysis	9 Hour
Cluster Analysis: Partitioning Methods- Hierarchical Methods: Agglomerative versus Divisive Hierarchical Clustering-Probabilistic Model based Clustering - BIRCH, DBSCAN, STING, CLIQUE Techniques- Evaluation of clustering Techniques	
Unit-5 - Outliers and Statistical Approaches in Data Mining	9 Hour
Introduction to outliers, Challenges in detecting Outliers, Outlier Detection Methods - Supervised, Semisupervised, Unsupervised- Statistical Data Mining approaches - Data mining in Recommender Systems, Data mining for Intrusion Detection, Data Mining for Financial Analysis	

Learning Resources	1. Jiawei Han and Micheline Kamber, "Data Mining Concepts and Techniques", Third Edition, Elsevier, 2012 2. Ian H. Witten, Eibe Frank and Mark A. Hall "Data Mining: Practical Machine Learning Tools and Techniques", Fourth Edition, Elsevier, 2017.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. T. Ruso, Senior Project Lead, HCL Technologies, Chennai	1. Khanna Nehemiah, Associate Professor, Anna University Chennai	

Course Code	21CSE356T	Course Name	NATURAL LANGUAGE PROCESSING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PO-1	PO-2	PO-3
CLR-1:	Understand the fundamentals behind the Language processing and perform word level analysis.			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the syntactic processing and probabilistic context-free grammars.																	
CLR-3:	Conceive the basics of the knowledge representation, inference, and discourse analysis.																	
CLR-4:	Recognize the significance of transformer-based models.																	
CLR-5:	Understand the natural language processing applications and to learn how to apply basic algorithms in this field.																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Exhibit knowledge on text preprocessing techniques and perform word level analysis.			3	3	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Illustrate approaches to syntax analysis including probabilistic context-free grammars			3	3	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Apply approaches to semantics and discourse analysis in NLP.			3	3	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Develop models using transfer learning approaches.			3	-	-	3	3	-	-	-	-	-	-	-	2	-	-
CO-5:	Implement applications that use Natural Language Processing approaches.			-	-	2	3	3	-	-	-	-	-	-	-	-	-	-

Unit-1 - Overview and Word Level Analysis	9 Hour
Introduction to Natural Language Processing, Applications of NLP, Levels of NLP, Regular Expressions, Morphological Analysis, Tokenization, Stemming, Lemmatization, Feature extraction: Term Frequency (TF), Inverse Document Frequency (IDF), Modeling using TF-IDF, Parts of Speech Tagging, Named Entity Recognition, N-grams, Smoothing.	
Unit-2 - Syntax Analysis	9 Hour
Context Free Grammars, Grammar Rules for English, Top-Down Parsing, Bottom-Up Parsing, Ambiguity, CKY Parsing, Dependency Parsing, Earley Parsing - Probabilistic Context-Free Grammars	
Unit-3 - Semantic and Discourse Analysis	9 Hour
Representing Meaning, Lexical Semantics, Word Senses, Relation between Senses, Word Sense Disambiguation, Word Embeddings, Word2Vec, CBOW, Skip-gram and GloVe, Discourse Segmentation, Text Coherence, Discourse Structure, Reference Resolution, Pronominal Anaphora Resolution, Coreference Resolution	
Unit-4 - Language Models	9 Hour
Recurrent Neural Networks (RNN), Long Short-Term Memory (LSTM), Attention mechanism, Transformer Based Models, Self-attention, multi-headed attention, BERT, RoBERTa, Fine Tuning for downstream tasks, Text classification and Text generation.	
Unit-5 - NLP Applications	9 Hour
Introduction to Chatbot Applications, Retrieval based- Conversation based, Information Extraction and its approaches, Information Retrieval, Semantic Search and Evaluation, Question Answering, Summarization, Extractive Vs Abstractive Summarization, Machine Translation.	

Learning Resources	1. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, 2nd Edition, 2018.	4. Rothman, Denis. Transformers for Natural Language Processing: Build innovative deep neural network architectures for NLP with Python, PyTorch, TensorFlow, BERT, RoBERTa, and more. Packt Publishing Ltd, 2021.
	2. C.Manning and H.Schutze, —Foundations of Statistical Natural Language Processingll, MIT Press. Cambridge, MA, 1999	5. http://mccormickml.com/2106/04/19/word2vec-tutorial-the-skip-gram-model/
	3. JamesAllen, Bejamin/cummings, —NaturalLanguageUnderstandingll, 2ndedition, 1995	6. https://nlp.stanford.edu/pubs/glove.pdf

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. J.Balaji, Associate Manager, Allstate Solutions Pvt Ltd, jagank.balaji@gmail.com	1. Dr. Vani. V, Assistant Professor, National Institute of Technology Puducherry	1. Dr. R. Anita, SRMIST.
		2. Dr.Subalalitha C.N , SRMIST
		3. Ms.Viji D , SRMIST

Course Code	21CSE357T	Course Name	DISTRIBUTED COMPUTING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Infer knowledge in distributed computing	1	2	3	4	5	6	7	8	9	10	11	12							
CLR-2:	Introduce about snapshot recording and graph algorithm	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3				
CLR-3:	Demonstrate about various distributed mutual exclusion algorithms																			
CLR-4:	Understanding about various Deadlock Detection																			
CLR-5:	Outline the knowledge about Checkpointing and rollback recovery																			
Course Outcomes (CO):		At the end of this course, learners will be able to:																		
CO-1:	Use the appropriate concepts of Distributed computing for resource utilization	-	-	2	2	2	-	-	-	-	-	-	-	1	-	-				
CO-2:	Formulate various Snapshot Recording and Graph Algorithms	-	-	2	2	2	-	-	-	-	-	-	-	2	-	-				
CO-3:	Apply appropriate Distributed mutual exclusion algorithms	-	-	3	3	3	-	-	-	-	-	-	-	2	-	-				
CO-4:	Design a deadlock system to implement various deadlock detection algorithms	-	-	3	3	3	-	-	-	-	-	-	-	2	-	-				
CO-5:	Develop and implement various Checkpointing and rollback recovery	-	-	2	2	2	-	-	-	-	-	-	-	2	-	-				

Unit-1 - Introduction to distributed computing	9 Hour
Primitives for distributed communication, Synchronous versus asynchronous executions, Design issues and challenges, A model of distributed executions, Global state of a distributed system, Cuts of a distributed computation, A framework for a system of logical clocks, Jard-Jourdan's adaptive technique, Physical clock synchronization: NTP, Classifications and basic concepts, Complexity measures and metrics	
Unit-2 - Snapshot Recording and Graph Algorithms	9 Hour
Snapshot algorithms for FIFO channels, Variations of the Chandy-Lamport algorithm, Snapshot algorithms for non-FIFO channels Snapshots in a causal delivery system, monitoring global state, Necessary and sufficient conditions for consistent global Snapshots, Finding consistent global snapshots in a distributed computation, Elementary graph algorithms. A spanning-tree-based termination detection algorithm	
Unit-3 - Distributed mutual exclusion algorithms	9 Hour
Lamport's algorithm, Ricart-Agrawala algorithm, Singhal's dynamic information-structure algorithm, Lodha and Kshemkalyani's fair mutual exclusion algorithm, Quorum-based mutual exclusion algorithms, Maekawa's algorithm, Agarwal-EI Abbadi quorum-based algorithm, Token-based algorithms, Suzuki-Kasami's broadcast algorithm, Raymond's tree-based algorithm	
Unit-4 - Deadlock Detection	9 Hour
Models of deadlocks, Knapp's classification of distributed deadlock detection Algorithms, Mitchell and Merritt's algorithm for the single-resource model, Chandy-Misra-Haas algorithm for the AND model, Chandy-Misra-Haas algorithm for the OR model, Kshemkalyani-Singhal algorithm for the P-out-of-Q model	
Unit-5 - Checkpointing and rollback recovery	9 Hour
Background and definitions, Issues in failure recovery, Checkpoint-based recovery, Log-based rollback recovery, Koo-Toueg coordinated checkpointing algorithm, Juang-Venkatesan algorithm for asynchronous checkpointing and recovery, Manivannan-Singhal quasi-synchronous checkpointing algorithm, Peterson-Kearns algorithm based on vector time, Helary-Mostefaoui-Netzer-Raynal communication-induced protocol.	

Learning Resources	1. <i>Distributed Computing: Principles, Algorithms, and Systems</i> Paperback – 3 March 2011 by Ajay D. Kshemkalyani (Author), Mukesh Singhal (Author)	3. Tanenbaum S. Maarten V.S.: <i>Distributed Systems Principles and Paradigms</i> , (Pearson Education)
	2. Tanenbaum S.: <i>Distributed Operating Systems</i> , Pearson Education	4. George Coulouris, Jean Dollimore. Tim Kindberg: <i>Distributed Systems concepts and design</i> .

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. T. Ruso. Senior Project Lead, HCL Technologies, Chennai	1. Dr.T.Sethukarasi, Professor and Head, Dept of CSE, RMK Engineering College	1. Dr.G.Padmapriya

Course Code	21CSE358T	Course Name	NETWORK SECURITY AND CRYPTOGRAPHY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understanding the basic concepts of security services and its mechanisms	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Apply the different symmetric key cryptographic techniques	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Analyze the various asymmetric key cryptographic techniques																	
CLR-4:	Apply the message authentication and hash functions																	
CLR-5:	Develop the security applications in networks																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Acquire the knowledge of security services and techniques	1	2	-	-	-	-	-	-	-	-	-	-	2	-	-		
CO-2:	Analyze the symmetric key algorithms	2	3	1	-	-	-	-	-	-	-	-	-	2	-	-		
CO-3:	Apply the various asymmetric key algorithms	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-		
CO-4:	Evaluate the various MAC and Hash functions	-	3	2	-	-	-	-	-	-	-	-	-	2	-	-		
CO-5:	Analyze the security applications	-	-	3	-	2	-	-	-	-	-	-	-	2	-	-		

Unit-1 - Introduction to security concepts	9 Hour
The need for security- Security approaches- Principles of security- Types of Security attacks- Security services- Security Mechanisms- A model for Network Security- substitution techniques- transposition techniques- steganography.	
Unit-2 - Symmetric Key Cryptography	9 Hour
Algebraic structures – Divisibility and division algorithm - Euclidean algorithm- Modular arithmetic-Prime numbers - Fermats and Eulers theorem - Congruence and matrices - Block Ciphers and operations - Simplified Data Encryption Standard - Data Encryption Standard - Advanced Encryption Standard	
Unit-3 - Asymmetric Key Cryptography	9 Hour
Groups, Rings, Fields- Finite fields - Principles of public key cryptosystems, RSA algorithm, Elgamal Cryptography, Diffie-Hellman Key Exchange- Elliptic Curve Cryptography	
Unit-4 - Message Authentication Algorithms and Hash Functions	9 Hour
Message Authentication, Secure Hash Algorithm (SHA-3) - Authentication requirements, HMAC, CMAC, Digital signatures, Elgamal Digital Signature Scheme- Kerberos, X.509 Authentication Service, Public – Key Infrastructure.	
Unit-5 - Security in networks	9 Hour
Web security considerations-Secure Socket Layer and Transport Layer Security-Secure electronic transaction- Email security - PGP, S/MIME-Intruders-Intrusion detection- password management -virus and related threats- Countermeasures-Firewall design principles- types of firewalls, Case Studies on Cryptography and security: Secure Inter-branch Payment Transactions, Cross site Scripting Vulnerability, Virtual Elections	

Learning Resources	1. <i>Cryptography and Network Security Principles and Practice Seventh Edition, William Stallings, Pearson 2017.</i>	3. <i>Cryptography and Network Security: Atul Kahate, Mc Graw Hill, 3rd Edition, 2013.</i>
	2. <i>Behrouz A. Forouzan, Cryptography and Network Security, Tata McGraw Hill 2010.</i>	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	25%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
<i>Dr. Mariappan, Uber</i>		1. <i>Dr.G.K.Sandhia</i>

Course Code	21CSE359T	Course Name	INFORMATION STORAGE MANAGEMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes						
CLR-1:	Acquire the knowledge on the components of storage infrastructure	CLR-2:	Learn the various types of Storage evolution architecture	CLR-3:	Understand the business continuity, backup and recovery methods.	CLR-4:	Introduce the working principle of storage infrastructure with monitoring principles	CLR-5:	Understand the structure of cloud computing and its techniques	1	2	3	4	5				6	7	8	9
			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3				
Course Outcomes (CO):		At the end of this course, learners will be able to:	-	3	3	-	1	-	-	-	-	-	-	-	1	-	-				
CO-1:	Exhibit knowledge on the components of storage infrastructure		-	3	3	-	1	-	-	-	-	-	-	-	-	2	-				
CO-2:	Gain knowledge to evaluate storage architectures including storage subsystems		-	3	3	-	1	-	-	-	-	-	-	-	-	2	-				
CO-3:	Understand the business continuity, backup and recovery methods.		-	3	3	-	1	-	-	-	-	-	-	-	-	2	-				
CO-4:	Appreciate the concepts of storage security and information security applied to virtual machine		-	3	3	-	1	-	-	-	-	-	-	-	2	-	-				
CO-5:	Acquire the knowledge on structure of cloud computing and its techniques		-	3	3	-	3	-	-	-	-	-	-	-	1	-	-				

Unit-1 - Introduction to Information Storage and Management	9 Hour
Introduction to Information Storage Management- Evolution of Storage Architecture- Data Centre Infrastructure- Evaluate storage architectures and key data center elements in classic, virtualized and cloud environments- physical and logical components of a storage infrastructure including storage subsystems, RAID and intelligent storage systems- Intelligent Storage Array T1: A hospital application stores the Patient records with core elements of the data center. Discussion of typical challenges the storage management team may face in meeting the service-level demands of the hospital staff T2: Design RAID- Real Life Scenario Business Application for Acme Telecom	
Unit-2 - Introduction to San, Ipsan and Cas	9 Hour
storage networking technologies -SAN- FCSAN- IP-SAN, IPSAN-iSCSI components FCoE- NAS and object-based, and unified storage (CAS) – NAS I/O Operations- NAS Implementations T5: USRobotics Mini NAS provides easy backup and remote access for college office setting T6: SAN Infrastructure implementation at Heterogeneous environment T7: Configuration and Tracing of FC scan and iSCSI scan	
Unit-3 - Introduction to Electronic Storage Information	9 Hour
Electronically Stored Information and the Federal Rules of Civil Procedure- Changes to the Federal Rules of Civil Procedure-Federal Rules of Evidence-The (Long) List of Stakeholders-Ownership of Data-Data Control Considerations-Business Continuity (BC) Terminology, BC Planning life cycle- Failure Analysis, Business Impact Analysis-Automatic Path fail over-Backup granularities T7: Discussion of Social Media Cases and Spoliation Cases T8: Use Backup techniques for archived data T9: Implement appropriate backup and restore model in virtual environments for sensitive information	

Unit-4 - Introduction to Storage Security, Recovery and Acquisition	9 Hour
Applications as a Vital User Interface-Hidden or Restricted Access Data -Privileged, Sensitive, and Inaccessible Data Management-Proving Ownership and Integrity-Legal and Forensically Sound Acquisition - Securing the Data-Access Control and Management-Organization and File Management Techniques-Safe Storage Issues and Considerations Information Security Framework-Risk Triad-Storage Security Domains. T10: Analyze various monitoring parameters in secured storage environment T11: Creation of Linux Instance in Public Cloud Generate a private key, Access using SSH client T12: Usage of RSA and VMware Security Products	
Unit-5 - Cloud Storage	9 Hour
key characteristics, services, deployment models, and infrastructure components for a cloud computing-Cloud Infrastructure Mechanism-Cloud Infrastructure Mechanism: Cloud Infrastructure Mechanism-Logical Network Perimeter-Cloud Usage Monitor-Cloud Adoption Considerations-Cloud Storage Gateways T13: Building programs to deploy cloud applications T14: Usage of Cloud services with open-source cloud tools (like Eucalyptus, Openstack, Open Nebula and others)	

Learning Resources	1. David R Matthews, <i>Electronically Stored Information The Complete Guide to Management, Understanding, Acquisition, Storage, Search, and Retrieval, Second Edition</i> 2. EMC Corporation, — <i>Information Storage and Management</i> II, 2nd edition Wiley India, ISBN13: 978- 1118094839	3. Thomas Erl, — <i>Cloud Computing: Concepts, Technology & Architecture</i> II, Prentice Hall, 2013, ISBN: 9780133387568 4. Ulf Troppen Rainer Wolfgang Muller, II <i>Storage Networks Explained</i> II, India, Wiley, 2010, ISBN13: 978- 0470741436
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Dr.V.Masillamani	1. Dr.D.Hemavathi, DSBS

Course Code	21CSE360T	Course Name	HIGH PERFORMANCE COMPUTING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the concepts of advanced processors	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Learn the core of high-end computers, components, and their capacities	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Understand the need for parallel algorithms																	
CLR-4:	Build applications using parallel programming paradigm																	
CLR-5:	Build solutions using programming model																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Elucidate on advanced processors	1	1	-	-	1	-	-	-	-	-	-	-	-	-	-		
CO-2:	Analyze the working of cluster and sky computing	1	-	1	1	-	-	-	-	-	-	-	-	-	-	-		
CO-3:	Apply Parallel Algorithmic concepts to solve problems	-	3	3	1	-	-	-	-	-	-	-	-	-	3	-		
CO-4:	Develop applications using OpenMP and MPI	-	1	1	1	-	-	-	-	-	-	-	-	-	3	-		
CO-5:	Describe GPU architecture and write programs using CUDA	-	-	1	1	2	-	-	-	-	-	-	-	-	3	-		

Unit-1 - Fundamentals of parallel processors	9 Hour
Stored Program Computer Architecture- General purpose cache- based microprocessor-Performance based metrics and benchmarks- Moore's Law- Pipelining- Superscalarity- SIMD- Memory Hierarchies Cache-mapping- prefetch- Multicore processors- Multithreaded processors- Vector Processors- Design Principles- Maximum performance estimates- Programming for vector architecture – Data flow computers and VLSI Computations – Need for Migrating to Nanoscale Processors – Design of Quantum Processors and Quantum Logic gates with Qubits Processing	
Unit-2 - Performance Enhancement Computing Cluster Computing and Sky Computing	9 Hour
Introduction to Cluster Computing- Scalable Parallel Computer Architectures- Cluster Computer and its Architecture- Classifications, Components for Clusters- Cluster Middleware and Single System Image- Resource Management and Scheduling, Programming Environments and Tools, Applications, Representative Cluster Systems, Heterogeneous Clusters, Security, Resource Sharing, Locality, Dependability, Cluster Architectures, Detecting and Masking Faults, Recovering from Faults, Condor, Evolution of Metacomputing. Virtualised Architecture for Cloud Computing Storage, Hypervisor usage and Integration of Cloud Computing for Sky Computing Model	
Unit-3 - Perspective of Parallel Algorithms	9 Hour
Principles of parallel algorithm design - Data Parallel, Task graph, Work pool, master- slave, pipeline, Hybrid – Non –numerical algorithms, sorting, graph algorithms, search algorithms for discrete optimization problems, Dynamic programming – Numerical algorithms, Dense matrix algorithms, fast Fourier transforms	
Unit-4 - Constructs of Parallel Programming	9 Hour
Introduction to parallel computing – parallel programming platforms – Basic communication operations – Programming using message passing paradigm, MPI– Programming shared address space platforms, POSIX threads, open MP	
Unit-5 - Gpu Architecture and Programming	9 Hour
Hardware Architecture – Integrated GPUs – Multi GPUs – GPU Architecture - Memory Handling with CUDA: Shared Memory, Global Memory, Constant Memory and Texture Memory. Introduction to CUDA C, parallel programming in CUDA C, Thread cooperation- Shared Memory and Synchronization	

Learning Resources	<ol style="list-style-type: none"> 1. Georg Hager, Gerhard Wellein, <i>Introduction to High Performance Computing for Scientists and Engineers</i>, Chapman & Hall / CRC Computational Science series, 2011. 2. Parag K. Lala "Quantum Computing: A Beginners Introduction", Mc Graw Hill, 2020. 3. R. Buyya, <i>High Performance Cluster Computing: Architectures and Systems</i>, Volume 1, Pearson Education, 2008. 4. <i>Introduction to Parallel Computing</i>, Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, 2nd edition, Addison-Welsey, 2003. 	<ol style="list-style-type: none"> 5. Nicholas Wilt, — <i>CUDA Handbook: A Comprehensive Guide to GPU Programming</i>ll, Addison - Wesley, 2013. 6. Jason Sanders, Edward Kandrot, — <i>CUDA by Example: An Introduction to General Purpose GPU Programming</i>ll, Addison - Wesley, 2010. 7. https://link.springer.com/article/10.1007/s10586-017-0727-5 8. http://www.nvidia.com/object/cuda_home_new.html
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	25%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Hemant Giri, NVIDIA	1. Dr.R.S.Singh, IIT, BHU, Varanasi	1. Dr.R.S.Ponmagal
2. AmarendraMohanty, AdvantagePro	2. Dr.Pradheepkumar, BITS, PILANI	2. Dr.Sathyapriya

Course Code	21CSE361T	Course Name	DATABASE SECURITY AND PRIVACY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Realize the fundamentals of security relates to information	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Gain knowledge of how security is maintained in information systems	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Comprehend the concept of security models in database																
CLR-4:	Study about the practices of database auditing																
CLR-5:	Implementation of data mining algorithms for PPDM																
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	Acquire the knowledge of information system and information security	3	-	2	-	-	-	-	-	-	-	-	-	1	-	-	
CO-2:	Manage the security of information system as well as database	3	3	-	-	1	-	-	-	-	-	-	-	1	-	-	
CO-3:	Design and develop the security model in database	3	-	3	-	-	-	-	-	-	-	-	2	3	-	-	
CO-4:	Mange the audit database activities, users, security	3	-	-	2	-	-	-	-	-	-	-	-	1	-	-	
CO-5:	Apply the security mechanism in PPDM using various algorithms	3	2	2	-	-	-	-	-	-	-	-	-	1	-	-	

Unit-1 - Security Architecture	9 Hour
Introduction, Information Systems, Database Management Systems, Information Security Architecture, Database Security, Asset Types and Their value, Security Methods. Operating System Security Fundamentals: Introduction, Operating System Overview, The Components of an Operating System Security Environment, Authentication Methods, User Administration, Password Policies, Vulnerabilities of Operating Systems, Email Security, Internet security	
Unit-2 - Administration of Users	9 Hour
Introduction, Documentation of User Administration, Operating System Authentication, Creating Users, creating a SQL Server user, removing users, Modifying users, Default users, Remote users, Database Links, Linked Servers, Remote Servers Practices for Administrators and Managers, Profiles, Password Policies. Privileges and Roles: Introduction, Defining and Using Profiles, Designing and Implementing Password Policies, Granting and Revoking User Privileges, Creating, Assigning and Revoking User Roles, Best practices	
Unit-3 - Database Application Security Models	9 Hour
Types of Users, Security Models, Application Types, Application Security Models, Transparent Data Encryption, Column Encryption Full Database Encryption, Column level Security with SQL Server. Virtual Private Databases: Implementation of VPD using Views, Application Context in Oracle, Implementing Oracle VPD, Viewing VPD Policies, VPD using views, Application contexts using Data Dictionary, Policy Manager Implementing Row and Column level Security with SQL Server	
Unit-4 - Audits	9 Hour
Ways to Audit a Database, Application API Code, Auditing with Trigger Code, Normal Audit, Unified Audit, Fine Grained Auditing, Comparing Methods Auditing Database Activities: Oracle Database Activities, Creating DLL Triggers with Oracle, Auditing Database Activities with Oracle, Auditing Server Activity with SQL Server 2022, Auditing Server Activity with Oracle21c, Case study: project security and auditing	

Unit-5 - Privacy Preserving Techniques		9 Hour
Privacy Preserving Data Mining Techniques, Privacy Preserving Data Mining Models and Algorithms-The Randomization Method, Group Based Anonymization, Distributed Privacy-Preserving Data Mining, Privacy-Preservation of Application Results, and Applications of Privacy-Preserving Data Mining. Case study: Joseph Domingo-Ferrer, Nine Measures of Anonymity, k-Anonymous Data Mining		
Learning Resources	1. HassanA.Afyouni, "Database Security and Auditing Protecting Data Integrity and Accessibility", Third Edition, Cengage Learning, 2013.	3. Osama Mustafa and Robert P. Lockard," Oracle Database Application Security with Oracle Internet Directory, Oracle Access Manager, and Oracle Identity Manager", First Edition Apress Publishers, 2019
	2. RonBenNatan," Implementing Database Security and Auditing", Elsevier Digital Press,2005	4. Charu C. Aggarwal and Philip S Yu," Privacy Preserving Data Mining Models and Algorithms", Kluwer Academic Publishers, 2008

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.S.Kumarasamy, Assistant Manager - MSSQL ,Sify Technologies Limited,Chennai-600113	1. Dr.L.Jayakumar, Assistant professor, Department of computer science and engineering, National institute of technology, Agartala, Tripura.	1. Dr.S.Gnanavel, SRMIST
	2. Dr.K.Jayashree, Professor, Panimalar engineering college, Chennai	2. Dr.C.Pretty Diana Cyril, SRMIST

Course Code	21CSE362T	Course Name	CLOUD COMPUTING	Course Category	E	PROFESSIONAL ELECTIVE							L	T	P	C				
													2	1	0	3				
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil													
Course Offering Department		School of Computing			Data Book / Codes / Standards		Nil													
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the cloud concepts with its features					1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3		
CLR-2:	Learn the cloud architecture and services																			
CLR-3:	Comprehend Security aspects for Cloud platforms																			
CLR-4:	Study the basic concepts of Virtualization and capacity planning																			
CLR-5:	Gain knowledge on Cloud Applications of different service providers																			
Course Outcomes (CO):		At the end of this course, learners will be able to:																		
CO-1:	Exhibit knowledge on basics of Cloud Computing					2	1	-	-	-	-	-	-	-	-	-	2	-	-	
CO-2:	Identify then type of services for various applications					1	3	1	-	-	-	-	-	-	-	-	2	-	-	
CO-3:	Predict the type of security to be applied for various cloud services					1	-	2	-	-	-	-	-	-	-	-	2	-	-	
CO-4:	Examine the concept of virtualization and capacity planning					2	1	-	-	2	-	-	-	-	-	-	2	-	-	
CO-5:	Recommend the service provider for specific requirement					2	-	-	1	2	-	-	-	-	-	-	2	-	-	
Unit-1 - Fundamentals of Cloud Computing																		9 Hour		
Define Cloud Computing, Cloud Types, Characteristics of Cloud Computing, Benefits and disadvantages of cloud systems, Assessing the Value Proposition, Measuring the Cloud's Value, Capital Expenditures, Total Cost of Ownership, Service Level Agreements, Licensing Models																				
Unit-2 - Cloud Architecture and Services																		9 Hour		
Cloud Computing Stack, Composability, Infrastructure, Platforms and Virtual Appliances, Communication Protocols and Applications, Connecting to the Cloud, Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS)																				
Unit-3 - Cloud Security																		9 Hour		
Cloud Security Challenges, Software-as-a-Service Security, End-User Access to Cloud Computing Overview, Identity Protocol Standards, Windows Azure Identity Standards																				
Unit-4 - Virtualization and Capacity Planning																		9 Hour		
Virtualization Technologies, Abstraction versus Virtualization, Load Balancing and Virtualization, The Google Cloud, Hypervisors, Virtual Machine Imaging, Porting Applications, Capacity Planning																				
Unit-5 - Cloud Computing Applications																		9 Hour		
Web Services: Amazon, Microsoft, Google, Case Studies:, Cloud as Infrastructure for an Internet Data Center (IDC), Cloud Computing for Software Parks, Enterprise with Multiple Data Centers																				

Learning Resources	1. Barrie Sosinsky (2011), "Cloud Computing Bible" Wiley Publishing Inc.	4. Michael Kavis, (2014) "Architecting the Cloud: Design Decisions for Cloud Computing Service Models (SaaS, PaaS, AND IaaS)", John Wiley & Sons.
	2. John W. Rittinghouse and James F. Ransome (2010), "Cloud Computing, Implementation, Management, and Security", CRC Press.	5. Sunil kumar Manvi, Gopal K. Shyam (2021) "Cloud Computing: Concepts and Technologies", CRC Press, 1st edition.
	3. Borko Furht, Armando Escalante (2010), "Handbook of Cloud Computing", Springer.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	20%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. T. Ruso, Senior Project Lead, HCL Technologies, Chennai	1. Dr. P. Varalakshmi, Professor, MIT, AnnaUniversity, Chennai	1. Dr. D. Malathi, Professor, CTECH, SRM IST
2. Mr. Saju G Nair, Senior Development ManagerKyndryl India Pvt Ltd.	2. Dr. S. Gopika, Kristu Jayanti College, Bangalore.	2. Dr. J. D. DorathiJayaseeli, Assistant Professor, CTECH, SRM IST

Course Code	21CSE399T	Course Name	ADVANCED MOBILE COMMUNICATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	understand the evolution of mobile communications	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	familiarize the basics of 5G technology															
CLR-3:	understand and apply the 5G networks and standards															
CLR-4:	understand and apply the 5G protocols, SDN and NFV															
CLR-5:	know the current state of the art technologies and challenges in 5G															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand and analyze the evolution of mobile communications	3		-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Analyze and apply 5G technology on	3		-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Evaluate the 5G networks and standards	3	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Apply the 5G protocols, SDN and NFV in implementations	3	-	2	-	2	-	-	-	-	-	-	-	-	-	-
CO-5:	Know the current state of the art technologies and challenges in 5G	2	-	2	-	2	-	-	-	-	-	-	-	-	-	-

Unit-1 - Evolution from 1G to 5G	9 Hour
Analog voice systems in 1G; digital radio systems in 2G, voice and messaging services, TDMA based GSM, CDMA, 2.5G (GPRS), 2.75G (EDGE); IMT2000: 3G UMTS, W-CDMA, HSPA, HSPA+, 3G services and data rates; IMT Advanced: 4G, LTE, VoLTE, OFDM, MIMO, LTE Advanced Pro (3GPP Release 13+); IMT2020: 5G, enhancements in comparison to IMT Advanced.	
Unit-2 - Basics of 5G	9 Hour
5G potential and applications; Usage scenarios: enhanced mobile broadband (eMBB), ultra-reliable low latency communications (URLLC), massive machine type communications (MMTC), D2D communications, V2X communications; Spectrum for 5G, spectrum access/sharing; millimeter Wave communication, channels and signals/waveforms in 5G, carrier aggregation, small cells, dual connectivity.	
Unit-3 - 5G Network and Standards	9 Hour
New Radio (NR), Standalone and non-standalone mode; non-orthogonal multiple access (NOMA); massive MIMO, beam formation, FAPI: PHY API Specification, flexible frame structure,	
Unit-4 - 5G Network protocols, SDN and NFV	9 Hour
Service Data Adaptation Protocol (SDAP); centralized RAN, open RAN; multi-access edge computing (MEC); software defined networking (SDN), network function virtualization (NFV); network slicing; restful API for service-based interface; private networks.	
Unit-5 - Current State and Challenges Ahead	9 Hour
5G penetration in developed countries; deployment challenges in low-middle income countries, stronger backhaul requirements, dynamic spectrum access and usage of unlicensed spectrum, contrasting radio resource requirements; large cell usage: LMLC; possible solutions for connectivity in rural areas (BharatNet, TVWS, Long-range WiFi, FSO); non-terrestrial fronthaul/backhaul solutions: LEOs, HAP/UAV.	

Learning Resources	1. 4G, LTE-Advanced Pro and The Road to 5G by Erik Dahlman	3. Standards Hardcover – 1 June 2019 by Sassan Ahmadi Dr. (Author)
	2. 5G NR: Architecture, Technology, Implementation, and Operation of 3GPP New Radio	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions Suggested by AICTE	Internal Experts

Course Code	21CSE451T	Course Name	PATTERN RECOGNITION TECHNIQUES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Know about various techniques in pattern recognition		Engineering Knowledge	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2:	Develop good knowledge of Bayesian Theory																
CLR-3:	Explore the various non-Parametric techniques																
CLR-4:	Understand the Linear Discriminant functions																
CLR-5:	Utilize Artificial Neural networks for classification problems																
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	Identify the various techniques involved in pattern recognition		3	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Summarize Bayesian decision theory and Bayesian learning		3	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Categorize the various non-Parametric techniques		2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-4:	Formulate appropriate Linear Discriminant Function, Nearest neighbor rule, Neural Network and SVM for the problem statement		3	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-5:	Demonstrate the Artificial Neural Network based Pattern recognition		3	-	2	-	2	-	-	-	-	-	-	-	-	-	2

Unit-1 - Introduction to Pattern recognition Systems	9 Hour
Basics of Probability, Independence of events, Conditional and Joint probability, Machine perception, Pattern Recognition Systems, The Design cycle, Learning and Adaptation, Minimum-error-rate classification, Classifiers, Discriminant functions, Decision surfaces, Normal density, and discriminant functions	
Unit-2 - Parameter Estimation Methods	9 Hour
Maximum Likelihood Estimation, Bayesian Estimation, Bayesian Parameter Estimation: Gaussian case, Bayesian Parameter Estimation: General Theory, Problems of Dimensionality, Component Analysis and Discriminants, Expectation-Maximization, Hidden Markov Model	
Unit-3 - Non-Parametric Techniques	9 Hour
Density Estimation, Parzen Windows, K- Nearest Neighbor Estimation, The Nearest Neighbor Rule, Metrics and Nearest Neighbor classification, Fuzzy classification, reduced coulomb energy networks, Approximations by series expansions	
Unit-4 - Linear Discriminant Functions	9 Hour
Linear Discriminant Functions and Decision Surfaces, Generalized Linear Discriminant Functions, Two-category linearly separable case, Perceptron criterion functions, Relaxation procedures, Nonseparable Behavior, Minimum Squared Error procedures, Linear Programming Algorithms, Support Vector Machines	
Unit-5: Multilayer Neural Networks and Nonmetric Methods	9 Hour
Introduction to Neural Networks. Multilayer Neural Networks: Feedforward operations and classification, Backpropagation algorithms, Nonmetric methods: Decision Trees, CART, Applications: Face recognition System	

Learning Resources	1. R.O. Duda, P.E.Hart and D.G.Stork, <i>Pattern Classification</i> , John Wiley 2001	5. K. Fukunaga, <i>Introduction to Statistical Pattern Recognition</i> , 2nd Ed. Academic Press, New York, 1990.
	2. S. Theodoridis and K.Koutroumbas, <i>Pattern Recognition</i> , 4th Ed., Academic Press, 2009	6. Wu, Jianxin. <i>Essentials of Pattern Recognition: An Accessible Approach</i> . United Kingdom, Cambridge University Press, 2020.
	3. C.M. Bishop, <i>Pattern Recognition and Machine Learning</i> , Springer, 2006	7. Bengio, Y., Goodfellow, I., Courville, A. (2016). <i>Deep Learning</i> . United Kingdom: MIT Press.
	4. P.A Devijver and J. Kittler, <i>Pattern Recognition: A Statistical Approach</i> , Prentice-Hall, International, Englewood Cliffs, NJ, 1980	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.Peter PethuruRaj, Jio Cloud, Bengaluru	1. Dr.S.Chithra, Associate Professor, SSN College of Engineering, Chennai	1. Dr.B.Baranidharan, Associate Professor, Dept of C.Tech, SRMIST
2. Mr. Srivathsa Pasumarthi, Senior Research Scientist Subtle Medical, Menlo Park, California, USA		

Course Code	21CSE452T	Course Name	SEMANTIC WEB	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the basic concepts of semantic web	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Analyze the Ontology terminologies	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	Investigate the concepts of semantic web services																											
CLR-4:	Construct and map Ontologies																											
CLR-5:	Apply semantic web knowledge using XML																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Acquire knowledge about Semantic Web	3	2	-	-	3	-	-	-	-	-	-	-	-	3	-												
CO-2:	Recognize Ontology Terminologies	-	-	2	-	2	-	-	-	-	-	-	-	-	3	-												
CO-3:	Analyze the XML web services	-	3	-	2	-	-	-	-	-	-	-	-	-	3	-												
CO-4:	Apply Ontology concepts	-	-	3	-	2	-	-	-	-	-	-	-	-	3	-												
CO-5:	Design XML documents	2	-	3	3	-	-	-	-	-	-	-	-	-	3	-												

Unit-1 - The Semantic Web	9 Hour
The Semantic Web: Introduction - Scenario - Layer Cake. Describing Data with RDF- properties - visualization, RDF Applications. Topic Maps - Introduction - Examples- Comparison with Web and RDF. Annotations - Searching - Strategies. Logic - order – pitfalls	
Unit-2 - Understanding Ontologies	9 Hour
Graphical ontology example: Human resources., Definitions-Syntax, Structure, Semantics, and Pragmatics- Ontology and Semantic Mapping Problem-Knowledge Representation: Languages, Formalisms, Logics- Levels of Ontologies- OWL-Ontologies Today	
Unit-3 - Semantic Web Services	9 Hour
Web Services-Invoking-Describing-finding services. Intelligent agents-Types-Interactions-Frameworks-Standards. Distributed trust and belief-tools of trust-	
Unit-4 - Ontology Engineering	9 Hour
Constructing Ontologies Manually-Reusing Existing Ontologies-Semiautomatic Ontology Acquisition-Ontology Mapping-Exposing Relational Databases-Semantic Web Application Architecture	
Unit-5 - Case Studies with XML	9 Hour
The XML Language-Structuring-Namespace-Addressing and Querying XML Documents-Processing-Case Studies: Friend of a Friend-Browser Bookmarks-Crafting Your Company's Roadmap to the Semantic Web	

Learning Resources	1. Thomas.B.Passin: Explorer's guide to the semantic web. Manning Publications Company 2004, ISBN 978-1-932394-20-7, pp. I-XXII, 1-281	3. Grigoris Antoniou and Frank Van Harmelen, "A Semantic Web Primer", the MIT Press, Cambridge, Massachusetts London, England, 2004.
	2. Michael C, Daconta, Leo J. Obrst and Kevin T. Smith, "The semantic Web: A guide to the future of XML, web services, and knowledge management", ohn wiley & sons, 2003.	4. www.semanticweb.org

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	25%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. R Velmurugan Manager, Cognizant	1. Prof. Dr. J. I. Sheeba, Department of CSE, Puducherry Technological University, Pondicherry, India	1. Dr. Sindhu C, Computing Technologies
	2. Prof. Dr. K. Prasanth, Dept of IT, KSRCT, Tiruchengode, India	2. Mrs. R. Lavanya, Computing Technologies

Course Code	21CSE453T	Course Name	SPEECH RECOGNITION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the basics of Acoustics and Phonetics	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Illustrate the concepts of Chatbots and Dialogue systems	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	Demonstrate the feature extraction process of speech recognition task																											
CLR-4:	Apply the deep learning architecture for speech recognition task																											
CLR-5:	Analyzing and applying the transfer learning models for machine translation task																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Familiarize the concepts of acoustics and phonetics	3	2	-	-	-	-	-	-	-	-	-	-	-	3	-												
CO-2:	Understand the applications of speech recognition	1	2	-	-	-	-	-	-	-	-	-	-	-	3	-												
CO-3:	Identify the feature extraction process involved in speech recognition	3	-	3	2	-	-	-	-	-	-	-	-	-	3	-												
CO-4:	Design and Develop the deep learning architecture	3	2	2	-	-	-	-	-	-	-	-	-	-	3	-												
CO-5:	Understand the recent technologies in machine translation process	2	-	2	-	-	-	-	-	-	-	-	-	-	3	-												

Unit-1 - Introduction to Acoustic Phonetics	9 Hour
Speech Sounds and Phonetic Transcription, Articulatory phonetics, Prosody, Acoustic Phonetics and Signals, Phonetic Resources	
Unit-2 - Chatbots & Dialogue Systems	9 Hour
Properties of Human Conversation, Chatbots, GUS: Simple Frame-based Dialogue Systems, The Dialogue-State Architecture, Evaluating Dialogue Systems, Dialogue System Design	
Unit-3 - Automatic Speech Recognition and Text-to-Speech	9 Hour
The Automatic Speech Recognition Task, Feature Extraction for ASR: Log Mel Spectrum, Speech Recognition Architecture, CTC, ASR Evaluation: Word Error Rate, TTS	
Unit-4 - Deep Learning Architectures for Sequence Processing	9 Hour
Language Models Revisited, Recurrent Neural Networks, RNNs as Language Models, RNNs for other NLP tasks, Stacked and Bidirectional RNN architectures, The LSTM, Self-Attention Networks: Transformers, Transformers as Language Models, Contextual Generation and Summarization	
Unit-5 - Machine Translation and Encoder-Decoder Models	9 Hour
Language Divergences and Typology, The Encoder-Decoder Model, Encoder-Decoder with RNNs, Attention, Beam Search, Encoder-Decoder with Transformers, Some practical details on building MT systems, MT Evaluation	

Learning Resources	<ol style="list-style-type: none"> 1. Daniel Jurafsky and James H Martin, "Speech and Language Processing: An introduction to Natural Language Processing, Computational Linguistics and Speech Recognition", Prentice Hall, 2nd Edition, 2018. 2. L. Rabiner and B. H. Juang, Fundamentals of Speech Recognition, Prentice Hall, 1993 3. Wang, Y., Skerry-Ryan, R.J., Stanton, D., Wu, Y., Weiss, R.J., Jaitly, N., Yang, Z., Xiao, Y., Chen, Z., Bengio, S. and Le, Q., Tacotron: Towards end-to-end speech synthesis. arXiv. 2017. 4. Ren, Y., Ruan, Y., Tan, X., Qin, T., Zhao, S., Zhao, Z., and Liu, T. Y. FastSpeech: Fast, robust and controllable text to speech. Advances in Neural Information Processing Systems 32. 2019. 5. Sutskever, Ilya, Oriol Vinyals, and Quoc V. Le. Sequence to sequence learning with neural networks arXiv 2014 6. The Illustrated Transformer – Jay Alammar – Visualizing machine learning one concept at a time
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. J.Balaji, Associate Manager, Allstate Solutions Pvt Ltd, jagank.balaji@gmail.com	1. Dr Gautam Srivatsava, Brandon University, Canada	1. Dr. R. Srinivasan, Assistant Professor, SRMIST, KTR.
	2. Mr.Tamilanaban, IBM Software Labs, Bangalore	2. Dr.Subalalitha C.N, Associate professor, SRMIST, KTR.

Course Code	21CSE454T	Course Name	COMPUTER VISION			Course Category	E	PROFESSIONAL ELECTIVE										L	T	P	C
																	2	1	0	3	
Pre-requisite Courses		Nil		Co- requisite Courses		Nil		Progressive Courses		Nil											
Course Offering Department		School of Computing			Data Book / Codes / Standards			Nil													
Course Learning Rationale (CLR):		The purpose of learning this course is to:																			
CLR-1:	Introduce students the foundations of Image Processing Techniques.																				
CLR-2:	Understand the shape and region analysis.																				
CLR-3:	Understand the Hough Transform and its applications to detect lines, circles, ellipses.																				
CLR-4:	Understand the Three-dimensional image analysis techniques and Motion Analysis.																				
CLR-5:	Study some applications of computer vision algorithms.																				
Course Outcomes (CO):		At the end of this course, learners will be able to:																			
CO-1:	Perform basic Point detection and Morphology.																				
CO-2:	Perform shape analysis, implement boundary tracking techniques and a apply chain codes and other region descriptors																				
CO-3:	Apply Hough Transform for line, circle, and ellipse detections.																				
CO-4:	Apply 3D vision techniques. Implement motion related techniques.																				
CO-5:	Develop applications using computer vision techniques.																				
Unit-1 - Image Processing Foundations																		9 Hour			
Image processing techniques - classical filtering operations - thresholding techniques - edge detection techniques - corner and interest point detection - mathematical morphology - texture.																					
Unit-2 - Shapes and Regions																		9 Hour			
Binary shape analysis – connectedness – object labeling and counting – size filtering – distance functions – skeletons and thinning – deformable shape analysis – boundary tracking procedures – active contours – shape models and shape recognition – centroidal profiles – handling occlusion – boundary length measures – boundary descriptors – chain codes – Fourier descriptors – region descriptors – moment.																					
Unit-3 - Hough Transform																		9 Hour			
Line detection – Hough Transform (HT) for line detection – foot-of-normal method – line localization – line fitting – RANSAC for straight line detection – HT based circular object detection – accurate center location – speed problem –ellipse detection – Case study: Human Iris location – hole detection – generalized Hough Transform (GHT) – spatial matched filtering – GHT for ellipse detection – object location – GHT for feature collation.																					
Unit-4 - Vision and Motion																		9 Hour			
Methods for 3D vision – projection schemes – shape from shading – photometric stereo – shape from texture – shape from focus – active range finding – surface representations – point-based representation – volumetric representations – 3D object recognition – 3D reconstruction – introduction to motion – triangulation – bundle adjustment – translational alignment – parametric motion – spline-based motion – optical flow – layered motion.																					
Unit-5 - Applications																		9 Hour			
Application: Photo album – Face detection – Face recognition – Eigen faces – Active appearance and 3D shape models of faces Application: Surveillance – foreground-background separation – particle filters – Chamfer matching, tracking, and occlusion – combining views from multiple cameras – human gait analysis Application: In-vehicle vision system: locating roadway – road markings – identifying road signs – locating pedestrians.																					

Learning Resources	<ol style="list-style-type: none"> 1. <i>Computer Vision: Algorithms and Applications</i>, Richard Szeliski, Springer-Verlag London Limited 2011 2. <i>E. R. Davies, — Computer & Machine VisionII, Fourth Edition</i>, Academic Press, 2012 3. <i>D. L. Baggio et al., —Mastering OpenCV with Practical Computer Vision ProjectsII</i>, Packt Publishing, 2012 4. <i>Computer Vision: A Modern Approach</i>, Forsyth, J. Ponce, Pearson Education, 2003. 	<ol style="list-style-type: none"> 6. <i>Jan Erik Solem, — Programming Computer Vision with Python: Tools and algorithms for analyzing imagesII</i>, O'Reilly Media, 2012. 7. <i>Mark Nixon and Alberto S. Aquado, —Feature Extraction & Image Processing for Computer VisionII, Third Edition</i>, Academic Press, 2012.] 8. <i>Davies, E. R. (2017). Computer Vision: Principles, Algorithms, Applications</i>, Learning. Netherlands: Elsevier Science. 9. <i>8. Bhuyan, M. K. (2019). Computer Vision and Image Processing: Fundamentals and Applications</i>. United States: CRC Press.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	20%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. BharathKumar, Senior Software Developer, MalwareBytes, Estonia, sadanandam@malwarebytes.com	1. Dr. K. Vivekanandan , Ph.D., Professor in Computer Science and Engineering , Pondicherry Engineering College, Puducherry-605014, k.vivekanandan@pec.edu	1. Dr M Suchithra, Associate Professor, Dept. of Computing Technologies.

Course Code	21CSE455T	Course Name	SOCIAL NETWORK ANALYSIS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Familiarize the Concept of semantic web and the introduction to social network analysis			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Get familiar with the modeling and aggregating of data from social networks.																	
CLR-3:	Explore the method of extracting and mining data from social network communities																	
CLR-4:	Understanding and predicting human behavior for social communities																	
CLR-5:	Acquire the ability to implement social networks and visualize its applications																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	understand the concepts of semantic web and introduction of social network analysis			2	-	2	3	-	-	-	-	-	-	-	-	-	2	2
CO-2:	Understand and design the roles of ontology in the semantic web			2	-	2	3	-	-	-	-	-	-	-	-	-	2	2
CO-3:	learn about the social network communities			-	3	2	-	3	-	-	-	-	-	-	-	-	2	2
CO-4:	understand and predict the human behavior for social communities			2	-	3	-	3	-	-	-	-	-	-	-	-	2	2
CO-5:	Design and implement the social network representations and visualize its applications			2	-	3	-	2	-	-	-	-	-	-	-	-	2	2

Unit-1 - Introduction	9 Hour
Introduction to Semantic web: Limitations of current web, Development of Semantic web, Emergence of the Social Web, Social Network analysis, Components, Development of Social Network Analysis, Key concepts and measures in network analysis, electronic sources for network analysis, Examples, Web-based networks, Examples with diagrams, Applications of Social Network Analysis, Examples	
Unit-2 - Ontology and their role in the Semantic Web	9 Hour
Roles of Ontology, Ontology-based knowledge Representation, Explanation of Diagram, Ontology languages for the Semantic Web, Resource Description Framework, Web Ontology Language, Examples, Modeling and aggregating social network data, State-of-the-art in network data Representation, Aggregating, Advanced representations, Examples for Representations	
Unit-3 - Extraction and Mining communities in web social networks	9 Hour
Extracting evolution of Web Community from a Series of Web Archive, Definition of Community, Examples for Community, detecting communities in social Networks, Examples for Detection of Communities, Algorithms, Tools for detecting communities social network infrastructures and communities, Examples for various tools	
Unit-4 - Predicting Human behavior and Privacy issues	9 Hour
User data management, Inference and Distribution, Enabling new human experiences, Reality mining, Context, Privacy in online social networks, Trust model example, Trust network analysis, Trust transitivity Analysis	
Unit-5 - Visualization and Applications	9 Hour
Graph theory, Centrality, Clustering, Node, Edge diagrams, Matrix representation, visualizing social networks with matrix-based representation, Matrix, Node, Link diagrams, Hybrid representations, Applications: Cover networks, Community welfare, Collaboration networks, Co-Citation networks	

Learning Resources	<ol style="list-style-type: none"> 1. Peter Mika, "Social Networks and the Semantic Web", First Edition, Springer 2007. 2. Borko Furht, "Handbook of Social Network Technologies and Applications", 1st Edition, Springer, 2010. 3. Guandong Xu, Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", First Edition Springer, 2011. 	<ol style="list-style-type: none"> 4. Dion Goh and Schubert Foo, "Social information Retrieval Systems: Emerging Technologies and Applications for Searching the Web Effectively", IGI Global Snippet, 2008. 5. Ian McCulloh, Helen Armstrong, and Anthony Johnson, "Social Network Analysis with Applications", Wiley Publications, 2013. 6. Borgatti, S. P., Everett, M. G., & Johnson, J. C., "Analyzing social networks", SAGE Publications Ltd; 1 edition, 2013.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	25%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Muthukumarasamy S, Capgemini India Pvt Ltd, Chennai	1. Prof.Dr. Deivamani Mallaya, College of Engineering, Guindy, Chennai.	1. Ms.Briskilal J, Computing Technologies, SRMIST, KTR, Chennai.
		2. Ms.Vijayalakshmi M, Computing Technologies, SRMIST, KTR, Chennai.

Course Code	21CSE456T	Course Name	SOFTWARE DEFINED NETWORKS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn the fundamentals of software defined networks.			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Explore different controllers of SDN.																	
CLR-3:	Study about the SDN Programming.																	
CLR-4:	Analyze the various applications of SDN																	
CLR-5:	Express the various components of SDN and their uses																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Differentiate between traditional and software defined networks			1	-	-	-	-	2	-	-	-	-	-	-	2	-	-
CO-2:	Associate appropriate Controllers for different applications			-	1	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Obtain skills to do advanced networking research and programming			2	-	1	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Learn how to use software programs to perform varying and complex networking tasks			-	3	-	-	1	-	-	-	-	-	-	-	2	-	-
CO-5:	Explore the knowledge learned and apply it to solve real time problems			-	1	-	3	-	-	-	-	-	-	-	-	2	-	-

Unit-1 - Introduction to SDN	9 Hour
Introduction - Evolution of SDN – Need for SDN - Centralized and Distributed Control and Data Planes - The Genesis of SDN Introducing Mininet - Setting up the Environment and Implementation of SDN Aspects in Mininet	
Unit-2 - SDN Abstractions	9 Hour
Working principle of SDN - Openflow Protocol, SDN Controllers: Introduction - General Concepts - VMware - Nicira - OpenFlow-Related - Mininet - NOX/POX - Trema - Ryu , Floodlight - Layer 3 Centric - Plexxi - Cisco One PK ,Implementation of Custom Topologies in POX, ODL, Floodlight 3 Click, ONOS,Interfacing: Northbound – Southbound and East bound -West bound.	
Unit-3 - Programming of SDN	9 Hour
Network Programmability - Network Function Virtualization - NetApp Development, Network Slicing, ONOS deployment ONOS – OPNFV	
Unit-4 - SDN Applications and Use Cases	9 Hour
SDN in the Data Center - SDN in Other Environments - SDN Applications - SDN Use Cases - The Open Network Operating System 3	
Unit-5 - SDN's Future and Perspectives	9 Hour
SDN Open Source - SDN Futures – SDN SECURITY- Switching and Load Balancers, Firewall and Access Control, Use cases in Legacy Networks security.	

Learning Resources	1. <i>Software Defined Networks: A Comprehensive Approach</i> by Paul Goransson and Chuck Black, Morgan Kaufmann Publications, 2016 Reprint 2. <i>SDN - Software Defined Networks</i> by Thomas D. Nadeau & Ken Gray, O'Reilly, 2013 3. <i>Software Defined Networking with OpenFlow</i> By SiamakAzodolmolky, Packt Publishing, 2013	4. <i>Feamster, Nick, Jennifer Rexford, and Ellen Zegura. "The road to SDN: an intellectual history of programmable networks." ACM SIGCOMM Computer Communication Review 44.2 (2014): 87-98</i>
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. P.Kumaran, Senior Engineer, CSS Corp , Navalur, Chennai	1. Dr. M. Sridevi, Associate Professor, Dept. of CSE, NIT, Trichy	1. Dr.B.Amutha, Prof./CTech/SRMIST
2. D.Dinesh Babu, Servion global solution private limited, Software Engineer, Chennai		2. D.Vanusha, Assistant Assistant Prof./CTech/SRMIST
		3. Dr.R.Thamizhamuthu Assistant Prof./CTech/SRMIST

Course Code	21CSE457T	Course Name	SERVICE ORIENTED ARCHITECTURE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:		CLR-2:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the main concepts, principles, needs and evolution of SOA	CLR-2:	Understand and apply patterns for service design from the provider and requester perspectives	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	Understand SOA challenges mainly regarding governance, testing and maintenance	CLR-4:	Understand the business case for SOA	2	1	1	-	-	-	-	-	-	-	-	-	2	-	-
CLR-5:	Understand the best strategies and practices of SOA			2	1	1	-	-	-	-	-	-	-	-	-	2	-	-
Course Outcomes (CO):				3	2	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-1:	Comprehend the need for SOA and its systematic evolution.	CO-2:	Design and analyze various SOA patterns and techniques.	2	1	1	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Create a best implementation model	CO-4:	Apply SOA technologies to enterprise domain	3	2	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-5:	Implement the best strategies and practices of SOA			2	1	1	-	-	-	-	-	-	-	-	-	2	-	-
				3	2	3	-	-	-	-	-	-	-	-	-	2	-	-

Unit-1 - Introduction	9 Hour
Introduction: SOA and MSA Basics: Service Orientation in Daily Life, Evolution of SOA and MSA. Service oriented Architecture and Microservices architecture – Drivers for SOA, Dimensions of SOA, Conceptual Model of SOA, Standards and Guidelines for SOA, Emergence of MSA Enterprise-Wide SOA: Considerations for Enterprise-wide SOA, Strawman Architecture for Enterprise-wide SOA, Enterprise SOA Reference Architecture, Object-oriented Analysis and Design (OOAD) Process, Service-oriented Analysis and Design (SOAD) Process, SOA Methodology for Enterprise	
Unit-2 - Analysis and Design	9 Hour
Service-Oriented Applications: Considerations for Service-oriented Applications, Patterns for SOA, Pattern-based Architecture for Service-oriented Applications, Composite Applications, Composite Application Programming Model. Service-Oriented Analysis and Design: Need for Models, Principles of Service Design, Nonfunctional Properties for Services, Design of Activity Services (or Business Services), Design of Data Services, Design of Client Services, Design of Business Process Services	
Unit-3 - Technologies for SOA	9 Hour
Technologies for SOA: Technologies for Service Enablement, Technologies for Service Integration, Technologies for Service Orchestration. SOA Governance and Implementation: Strategic Architecture Governance, Service Design-time Governance, Service Run-time Governance, Approach for Enterprise-wide SOA Implementation	
Unit-4 - Big Data and SOA	9 Hour
Big Data and SOA: Concepts, Big Data and its characteristics, Technologies for Big Data, Service-orientation for Big Data Solutions. Business Case for SOA: Stakeholder Objectives, Benefits of SOA, Cost Savings, Return on Investment (ROI), Build a Case for SOA	
Unit-5 - SOA Best Practices	9 Hour
SOA Best Practices: SOA Strategy – Best Practices, SOA Development – Best Practices, SOA Governance – Best Practices. EA and SOA for Business and IT Alignment: Enterprise Architecture, Need for Business and It Alignment, EA and SOA for Business and It Alignment	

Learning Resources	1. Shankar Kambhampaty; Service - Oriented Architecture & Microservices Architecture: For Enterprise, Cloud, Big Data and Mobile; Wiley; 3rd Edition; 2018; ISBN: 9788126564064.	3. Thomas Erl; Service Oriented Architecture Concepts Technology & Design; Pearson Education Limited; 2015; ISBN-13: 9788131714904.
	2. Icon Group International; The 2018-2023 World Outlook for Service-Oriented Architecture (SOA) Software and Services; ICON Group International; 1st Edition, 2017; ASIN: B06WGPN8YD.	4. Guido Schmutz, Peter Welkenbach, Daniel Liebhart; Service Oriented Architecture An Integration Blueprint; Shroff Publishers & Distributors; 2010; ISBN-13: 9789350231081

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Umesh Goyal Senior Manager System Engineering - End User Computing at VMware		1. Dr J Selvin Paul Peter

Course Code	21CSE458T	Course Name	WIRELESS AND MOBILE COMMUNICATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes						
CLR-1:	Analyze the fundamental of transmission and cellular systems	CLR-2:	Apply skills in real time engineering problems and can have capability to evaluate the transmission errors	CLR-3:	Comprehend the concept of mobile network, transport layer and wireless technologies	CLR-4:	Differentiate the various types of cellular standard by their unique services	CLR-5:	Grasp GSM, GPRS, Handover and Localization techniques, Apply skills in various Routing protocols	1	2	3	4	5				6	7	8	9
			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3				
Course Outcomes (CO):		At the end of this course, learners will be able to:	1	3	3	-	-	-	-	-	-	-	-	-	1	-	-				
CO-1:	Apply Wireless Technology concepts to Engineering problems related to communication	CO-2:	Improve their knowledge on Digital and analog Modulation techniques.	1	2	1	-	-	-	-	-	-	-	-	1	-	-				
CO-3:	Equip themselves familiar with principle of Mobile Communication	CO-4:	Familiarize with Digital Cellular Standards	1	3	2	-	-	-	-	-	-	-	-	1	-	-				
CO-4:	Familiarize with Digital Cellular Standards	CO-5:	Acquaint with routing protocols, Expose to the emerging wireless technologies	1	1	1	-	-	-	-	-	-	-	-	1	-	-				
CO-5:	Acquaint with routing protocols, Expose to the emerging wireless technologies			1	2	2	-	-	-	-	-	-	-	-	1	-	-				

Unit-1 - Introduction to wireless communication	9 Hour
Elements of wireless communication system- Frequencies for radio communication- Signals, Noise – Types of Noise- Introduction to modulation and demodulation- Signals in the modulation- Introduction to Analog modulation schemes- Amplitude Modulation Frequency modulation- Phase Modulation Introduction to Analog modulation schemes- Amplitude Shift Keying Frequency Shift Keying Phase Shift Keying- BPSK, QPSK- Multiplexing and multiple access techniques- Frequency-division multiplexing- Time-division multiplexing- Code-division multiplexing- Spread spectrum modulation- frequency hopping Spread spectrum- Direct Sequence Spread spectrum	
Unit-2 - Cellular Concept	9 Hour
Cell area- Signal strength- Cell parameter- Capacity of Cell- Co channel interference- Frequency reuse- Frequency reuse- Multiple Radio access protocols Frequency division Multiple Access- Multiple Radio access protocols Frequency division Multiple Access- Multiple Access with Collision Avoidance- Space division Multiple Access Code division Multiple Access- Space division Multiple Access Code division Multiple Access- OFDM- Variants of OFDM- Comparison of Multiple Access Technique	
Unit-3 – Generation of Cellular Systems	9 Hour
Introduction to GSM- Frequency Bands and Channels- Frames in GSM- Planes and layers of GSM- Protocols- Localization and calling- Handoff – Short messaging system- GPRS EDGE- 3G CELLULAR Systems MMS- 3G CELLULAR Systems MMS- Handover- Satellite System Infrastructure- GEO, LEO, MEO- Limitations of GPS- GPS Beneficiaries of GPS- 4G Cellular systems- 4G Standards (LTE/WiMax)	
Unit-4 – Communication Protocols	9 Hour
Mobile IP- IP packet delivery- Tunneling – Reverse Tunneling- IPv6- DHCP- Tradition TCP- Congestion control- Classical TCP Snooping- Mobile TCPFast retransmit / Fast recovery- Transaction oriented TCP TCP over 2.5/3G wireless Networks- Introduction to WAP WAP Architecture- Wireless Datagram Protocol Wireless Transaction Protocol- Wireless Session Protocol- Wireless Transport Layer Security- Wireless Markup Language- Push Architecture	

Unit-5 – Protocol Architectures and Standards	9 Hour
System Architecture- Protocol Architecture- MAC Layer and Management- 802.11a, 802.11b- HIPERLAN- Bluetooth Architecture- IEEE 802.15 IEEE 802.15.4-MANET characteristics ROUTING- AODV Routing VANET Communications in VANET- Wireless Sensor Networks- RFID Technology Two tags of RFID- Wi-Fi Standards- WiMax Standards- Fem-to-Cell Network- Push-to-talk technology for SMS	

Learning Resources	<ol style="list-style-type: none"> Roy Blake, "Wireless Communication Technology" CENGAGE learning, Sixth indian reprint 2013. Dharma Prakash Agarwal, Qing-An Zeng, "Introduction to Wireless and Mobile Systems" CENGAGE learning, First edition 2014 Jochen Schiller, "Mobile Communications", Addison Wesley, 2nd edition 2011. Singal TL, "Wireless Communication", Tata McGraw Hill Education Private Limited G.I. Papadimitriou, A.S.Pomportsis, P.Nicopolitidis, M.S.Obaidat, "Wireless Networks", John Wiley and Sons, 2003 G.I. Papadimitriou, A.S.Pomportsis, P.Nicopolitidis, M.S.Obaidat, "Wireless Networks", John Wiley and Sons, 2003 Upena Dalal, "Wireless Communication" Oxford University Press, First edition 2009. Kaveh Pahlavan & Prashant Krishnamurthy, "Wireless Networks" PHI 2002. Martyn Mallick, "Mobile and Wireless Design Essentials", Wiley Dreamtech India Pvt.Ltd., 2014.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Dr.V.Kavitha Associate professor,Kings Engineering college,Anna University,chennai	1. Dr.V.Deeban Chakravarthy
	2. Dr.Kadiyala Ramana,Associate professor,Chaitanya bharathi Institute of Technology,Osmania University.Hyderabad.	2. Dr.P.Kirubanantham

Course Code	21CSE459T	Course Name	WIRELESS SENSOR NETWORKS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the basic sensor network concepts	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Learn about various Medium Access Control Protocols	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	Comprehend the strategies of various routing Protocols																											
CLR-4:	Gain the knowledge on Localization and Time Synchronization																											
CLR-5:	Understand the concept of Middleware Services and Network Security																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Understand the challenges of WSN	1	3	3	-	-	-	-	-	-	-	-	-	1	-	-												
CO-2:	Analyze the variation in different protocols and apply in real time scenario	1	2	1	-	-	-	-	-	-	-	-	-	1	-	-												
CO-3:	Identify the best Routing Strategies	1	3	2	-	-	-	-	-	-	-	-	-	1	-	-												
CO-4:	Apply and Analyze the importance of various Localization and Time Synchronization	1	1	1	-	-	-	-	-	-	-	-	-	1	-	-												
CO-5:	Implement an application using middleware architecture with advanced security features	1	2	2	-	-	-	-	-	-	-	-	-	1	-	-												

Unit-1 - Introduction to Wireless Sensor Networks	9 Hour
Motivation for a network of Wireless Sensor nodes - Sensing and sensors- Challenges and constraints- Node architecture- Sensing sub system- Processor sub system- Communication interfaces-- prototypes- Application of Wireless sensors- WSN Tools- Overview and Limitations- Contiki -Introduction- Characteristics of Contiki WSN simulator- Sensor Network Programming- Challenges in Sensor Network Programming- Node-Centric Programming	
Unit-2 - MAC Protocols for WSN	9 Hour
Characteristics of MAC protocols in Sensor networks- Contention free MAC Protocols- MAC Protocols –Characteristics- Traffic Adaptive Medium Access- Y-MAC- Low energy Adaptive Clustering- Contention based MAC Protocols- Sensor MAC- Timeout MAC and pattern MAC- Hybrid MAC Protocol- MAC protocols in ContikiOS simulator- Nullmac in Contiki simulator	
Unit-3 - Routing Strategies	9 Hour
Routing Metrics- Flooding and Gossiping- Data-Centric Routing- Proactive Routing- On-Demand Routing- Hierarchical Routing- Location-Based Routing- QoS-Based Routing Protocols- Local Power Management Aspects- Dynamic Power Management	
Unit-4 - Localization and Time Synchronization	9 Hour
Clocks and the Synchronization Problem- Time Synchronization in Wireless Sensor Networks- Basics of Time Synchronization- Time Synchronization Protocols- Ranging Techniques- Range-Based Localization- Range-Free Localization- Event-Driven Localization	
Unit-5 - WSN Security and Middleware Services	9 Hour
Fundamentals of Network Security- Challenges of Security in Wireless Sensor Networks- Security Attacks in Sensor Networks- Protocols and Mechanisms for Security- Middleware Architecture- Data related functions, Architecture- Existing middleware- MiLAN,IrisNet- AMF,DSWare- CLMF	

Learning Resources	<ol style="list-style-type: none"> 1. Waltenegus Dargie, Christian Poellabauer, — Fundamentals of Wireless Sensor Networks, Theory and Practicell, Wiley Series on wireless Communication and Mobile Computing, 2011 2. Kazem Sohraby, Daniel manoli, — Wireless Sensor networks- Technology, Protocols and Applicationsll, Wiley InterScience Publications 2013. 3. S. Swapna Kumar, "A Guide to Wireless Sensor Networks", kindle Edition, USP publications,2017 	<ol style="list-style-type: none"> 4. C.S Raghavendra, Krishna M. Sivalingam, Taieb znati, — Wireless Sensor Networksll, Springer Science 2010. 5. Bhaskar Krishnamachari, — Networking Wireless Sensorsll, Cambridge University Press, 2005 6. https://www.amazon.in/Guide-Wireless-Sensor-Networks-ebook/dp/B072R53JJM 7. https://anrg.usc.edu/contiki/index.php/Contiki_tutorials 8. file:///C:/Users/Administrator.RD27/Downloads/Fundamentals-of-Wireless-Sensor-Networks-Waltenegus-Dargie.pdf
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.J.Shelton Samson Vedharaj Head of Global Software Application Support Digital and Technology Coats	1. Dr. N. Radha, SSN College of Engineering,	1. P.Renukadevi AP/CTech ,SRMIST,KTR
	2. Dr.N.Poongavanam Veltech Rangarajan Dr.Sagunthala R & D Institute of Science and Technology,	2. R.Brindha AP/Ctech SRMIST,KTR

Course Code	21CSE460T	Course Name	NETWORK PROTOCOLS AND ALGORITHMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the layered architecture for communication networks and the specific functionality of the network layer.	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Gain knowledge on the need for network protocols, its functionality, and different architectures.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Understand fundamental basis of various algorithms in centralized and distributed point of view.																	
CLR-4:	Understand the various types of key routing protocols used in wireless networks.																	
CLR-5:	Gain knowledge on past experiences and prepare for next generation networks and routing																	
Course Outcomes (CO):		At the end of this course, learners will be able to:		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	Acquire the knowledge of conventional networks routing operations	1	2	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Comprehend Router Architectures and IP Address Lookup Algorithms	2	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-3:	Model and evaluate various routing techniques and protocols	-	2	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-4:	Examine how different dimensions of routing differ for different types of networks	-	2	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-5:	Analyze and evaluate various routing paradigms in next generation	-	1	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-

Unit-1 - Introduction	9 Hour
ISO OSI Layer Architecture, TCP/IP Layer Architecture, Functions of Network layer, General Classification of routing, Routing in telephone networks, Dynamic Nonhierarchical Routing (DNHR), Trunk status map routing (TSMR), real-time network routing (RTNR), Distance vector routing, Link state routing, Hierarchical routing	
Unit-2 - TCP/IP protocols	9 Hour
BOOTP, DHCP, DNS, Finger, FTP, HTTP, S-HTTP, IMAP and IMAP4, MIME (S-MIME), NAT, NNTP, POP and POP3, rlogin, RMON, SLP, SMTP, SNMP, SNMPv1, SNMPv2, SNMPv3, SNTP, TELNET, URL, Whois (and RWhois), XMPP, X Window/X Protocol, RPC, ITOT, RDP, RUDP, TCP, UDP, BGP (BGP4),	
Unit-3 - LAN Protocols	9 Hour
LAN Protocols: Ethernet: IEEE 802.3 Local Area Network protocols – Fast Ethernet: 100Mbps Ethernet (IEEE 802.3u)- Gigabit (1000 Mbps) Ethernet:IEEE 802.3z (1000Base-X) and 802.3ab (1000Base-T)- 10-Gigabit Ethernet: IEEE 802.3ae and 802.3an – WLAN: Wireless LAN by IEEE 802.11 protocols – IEEE 802.11i: WLAN Security Standard – IEEE 802.1X: EAP over LAN(EAPOL) for LAN/WLAN Authentication and Key Management – WPAN: Wireless Personal Area Network Communication Protocols – IEEE 802.15.1 and the Bluetooth for WPAN Communications – FDDI: Fiber Distributed Data Interface – Token Ring: IEEE 802.5 LAN Protocol – LLC: Logic Link Control (IEEE 802.2)- SNAP: SubNetwork Access Protocol – STP: Spanning Tree Protocol (IEEE 802.1D).	
Unit-4 - WAN Protocols	9 Hour
WAN Protocols: ATM: Asynchronous Transfer Mode Reference Model and Protocols -SONET/SDH: Synchronous Optical Network and Synchronous Digital Hierarchy – EoS: Ethernet over SONET/SDH – BISDN: Broadband Integrated Services Digital Network (Broadband ISDN) -ISDN: Integrated Services Digital Network – PPP: Point-to-Point Protocols – FTP: File Transfer Protocol – PAP: Password Authentication Protocol – PoS:	

Unit-5 - Network Security Technologies and Protocols	9 Hour
Kerberos: Network Authentication Protocol – RADIUS: Remote Authentication Dial In User Service – SSH: Secure Shell Protocol – L2F: Layer 2 Forwarding Protocol – L2TP: Layer 2 Tunneling Protocol – PPTP: Point-to-Point Tunneling Protocol – DiffServ: Differentiated Service Architecture – GRE: Generic Routing Encapsulation – IPsec: Internet Protocol Security Architecture – IPsec AH: IPsec Authentication Header – IPsec ESP: IPsec Encapsulating Security Payload – IPsec IKE: Internet Key Exchange Protocol – IPsec ISAKMP:	

Learning Resources	1. Jielin Dong, <i>Network Protocols Handbook</i> , 4th Edition, Javvin Press, 2007 2. Bruce Hartpence, <i>Packet Guide to Core Network Protocols</i> , O'Reilly Media, Inc., 2011. 3. Walter Y. Chen, <i>Home Network Basis: Transmission Environments and Wired/Wireless Protocols</i> , Prentice Hall, 2003.	4. Ana Minaburo, Laurent Toutain, <i>Local Networks, and the Internet: From Protocols to Interconnection</i> , John Wiley, and Sons, 2011
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Amarendra Mohanty, AdvantagePro	1. Dr. Pradheepkumar, BITS, PILANI	1. Dr. S. Nagadevi, Assistant Professor, CTECH, SRM IST
2. Mr. Saju G Nair, Senior Development Manager Kyndryl India Pvt Ltd.	2. Dr. P. Varalakshmi, Professor, MIT, Anna University, Chennai	2. Dr. R. Vidhya, Assistant Professor, CTECH, SRM IST

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 11B

**(Syllabi for Computer Science and Engineering w/s in
Artificial Intelligence and Machine Learning Programme
Courses)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC401J	Course Name	DEEP LEARNING TECHNIQUES	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										3	0	2	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Illustrate the basic concepts of deep learning	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Gain knowledge in Optimization algorithms and dimensionality reduction	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Develop a broad understanding of word2vec models and Convolution Neural Network models																	
CLR-4:	Acquire knowledge in Transfer learning and Sequential Models																	
CLR-5:	Implement the attention mechanism and advanced deep learning models																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Understand the basic concepts of deep learning	-	3	-	-	-	-	-	-	2	-	-	-	-	-	2		
CO-2:	Compare the optimization algorithms and high dimensional data using reduction techniques	-	2	-	-	-	-	-	-	2	-	-	-	-	-	2		
CO-3:	Implement word2vec models and Convolution Neural Network models	-	3	-	2	-	-	-	-	3	-	-		-	-	2		
CO-4:	Apply RNN and transfer learning to real world scenarios	-	3	-	2	-	-	-	-	3	-	-	-	-	-	3		
CO-5:	Use deep learning models to solve real-world applications	-	3	-	2	-	-	-	-	3	-	-	2	-	-	3		

Course Outcomes (CO):		At the end of this course, learners will be able to:	
CO-1:	Understand the basic concepts of deep learning	-	3
CO-2:	Compare the optimization algorithms and high dimensional data using reduction techniques	-	2
CO-3:	Implement word2vec models and Convolution Neural Network models	-	3
CO-4:	Apply RNN and transfer learning to real world scenarios	-	3
CO-5:	Use deep learning models to solve real-world applications	-	3

Unit-1 - Introduction to Neural Networks	15 Hour
Biological neuron, Motivation from biological neuron, McCulloch Pitts Neuron, Perceptron, Perceptron learning Algorithm, Representation power of a network of perceptrons, Activation functions-Sigmoid, tanh, ReLU, leaky ReLU, Sigmoid neuron, Gradient descent learning Algorithm, Representation power of multilayer Network of Sigmoid Neurons, Representation power of function: Complex functions in real world examples, Feedforward Neural Networks, Learning parameters, output and loss functions of FFN Networks, Backpropagation learning Algorithm, Applying chain rule across in a neural network, Computing partial derivatives w.r.t a weight	
Unit-2 - Optimization	15 Hour
Limitations of gradient descent learning algorithm, Momentum based gradient descent, Nesterov accelerated gradient descent, AdaGrad, RMSProp, Adam learning algorithm, Stochastic gradient descent, Mini-batch gradient descent, Bias Variance tradeoff, Overfitting in deep neural networks, Hyperparameter tuning, Regularization: L2 regularization, Dataset Augmentation and Early Stopping, Dimensionality reduction, Principal Component Analysis, Autoencoders, Relation between PCA and Autoencoders, Regularization in Autoencoders	
Unit-3 - Word2vec and Convolutional Neural Networks	15 Hour
One hot representation of words, Distributed representation of words, SVD for learning word Representations, Continuous bag of words model, Skip-gram model, Introduction to Convolution Neural Networks, Kernel filters, the convolution operation with Filters, padding and stride, Max pooling and non-linearities, Classic CNNs architecture- The ImageNet challenge, Alex Net architecture, ZFNet, The intuition behind GoogleNet, Residual CNN-ResNet architecture, DenseNet Architecture.	
Unit-4 - Recurrent Neural Networks	15 Hour
Transfer Learning, Need for Transfer Learning, Applications of Transfer learning, Sequence Learning Problems, Recurrent Neural Networks, Backpropagation through time, Unfolded RNN, problem of exploding and vanishing Gradients, Seq to Seq Models, how gates help to solve the problem of vanishing gradients, Long-Short Term Memory architectures, dealing with exploding gradients, Gated Recurrent Units, Encoder-Decoder Models, and its applications.	

Unit-5 - Attention models & Generative Adversarial Networks		15 Hour
Language Modeling, Image Captioning, Machine Translation, Attention Mechanism, Attention over images, Hierarchical Attention, Monte Carlo Methods, Local Independencies in a Markov Network, Joint Distributions, the concept of a latent variable, Restricted Boltzmann Machines, RBMs as Stochastic Neural Networks, Unsupervised Learning with RBMs, Setting up a Markov Chain for RBMs, Generative Adversarial Networks- Architecture, Generative Adversarial Networks- Applications		
Lab Experiments		
Lab1: Apply MP Neuron and perceptron to solve a binary classification problem	Lab 8: Implement LeNet for image classification	
Lab2: Apply sigmoid neuron to solve a real-world classification / regression problem	Lab 9: Implement ResNet for detecting objects.	
Lab3: Build a FFN Network to solve a multi-class classification problem	Lab 10: Transfer learning implementation using VGG16 model to classify images.	
Lab4: Implement linear regression with stochastic gradient descent.	Lab 11: Building a RNN to perform Character level language modeling	
Lab5: Implement linear regression with stochastic mini-batch gradient descent and compare the results with previous exercise.	Lab 12: Build a LSTM network for Named Entity recognition.	
Lab 6: Optimizing neural networks using L2 regularization, Dropout, data augmentation and early stopping	Lab 13: Neural Machine Translation with attention.	
Lab 7: Implement skip gram model to predict words within a certain range before and after the current word.	Lab 14: Case study on Scene Understanding using RBMs	
	Lab 15: Case study on generating examples for Image dataset using Generative Adversial Networks	

Learning Resources	1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.	6. NPTEL course: Deep Learning, Prof. Mitesh M. Khapra https://archive.nptel.ac.in/noc/courses/noc18/SEM2/noc18-cs41/
	2. Stevens, Eli, Luca Antiga, and Thomas Viehmann. Deep learning with PyTorch. Manning Publications, 2020.	7. MIT Deep Learning and Artificial Intelligence Lectures: https://deeplearning.mit.edu
	3. Eugene Charniak, Introduction to Deep Learning, MIT Press, 2018.	8. Stanford course CS231n: Deep Learning for Computer Vision: http://cs231n.stanford.edu
	4. Charu C. Aggarwal, Neural Networks and Deep Learning, Springer, 2018.	9. MIT's introductory course on deep learning methods: http://introdeeplearning.com
	5. Francois Chollet, Deep Learning with Python, Manning Publications, 2017	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Marriappan Vaithilingam, Senior Director of Engineering, Fresh works	1. Dr. Lathaparthiban, Pondicherry University	1. Dr. Athira M Nambiar SRMIST

Course Code	21CSC402P	Course Name	REPORT WRITING	Course Category	C	PROFESSIONAL CORE										L	T	P	C	
																2	0	0	2	
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil													
Course Offering Department		School of Computing			Data Book / Codes / Standards			Nil												
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Employ an efficient process for planning and organizing information.					1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3		
CLR-2:	Communicate the information to those who need it.					-	-	-	3	-	-	-	-	-	-	-	-			
CLR-3:	Demonstrate an understanding of the ethical implications of decisions and actions.					-	2	-	-	-	-	-	-	-	-	-	-			
CLR-4:	Express themselves effectively, professionally, and persuasively both orally and in writing.					-	-	-	-	-	-	3	-	-	-	-	-			
CLR-5:	Provide facts and results of an enquiry.					-	2	-	2	-	-	-	-	-	-	-	-			
Course Outcomes (CO):		At the end of this course, learners will be able to:				-	-	-	2	-	-	-	-	-	-	-	-	1		
CO-1:	Illustrates the current professional practices and concepts of writing reports.					-	2	-	-	-	-	-	-	-	-	-	-	1		
CO-2:	Discover sensible decisions by employing logical and critical thinking.					-	-	-	-	-	-	-	3	-	-	-	-	2		
CO-3:	Demonstrate the effective way of communications.					-	2	-	2	-	-	-	-	-	-	-	-	2		
CO-4:	Discuss about the competent in applying relevant techniques to commercial problems.					-	-	-	2	-	-	-	-	-	-	-	-	2		
CO-5:	Apply knowledge in ethical report writing.					-	-	-	2	-	-	-	-	-	-	-	-	2		
Unit-1 - Introduction																		6 Hour		
Preparing to Write, Define the audience for report writing, Types of Reports, Planning -brainstorming and mind mapping, Formatting guidelines, Components of a report, Text of report.																				
Assignment1: Define the problem of the proposal, learn the report types, and submit an assignment with all components of a report.																				
Unit-2 - Research Methodology																		6 Hour		
Defining the problem, Literature Review, Methodologies, and Findings Decision-Making Techniques, Collecting Appropriate Data, Analyzing Information and Interpreting Results, Effective Collaborative Writing																				
Problem-Solving Skills, Oral Report Assignments.																				
Assignment 2: Do the survey on existing system of the proposal, Identify the data collections, and submit an assignment																				
Unit-3 - Communication																		6 Hour		
Communication Skills - Written Assignments, Oral Communication Activities: Class Discussions, Group Analysis of Problem Situations and Formal Oral Presentation, communication tools-Cloud-Based Collaboration Apps																				
Assignment 3: Conduct an oral presentation to evaluate the communication skills																				
Unit-4 - Layouts																		6 Hour		
Technical knowledge: Logical sections, Cohesive subsections, Analyze and visual software packages, Data Storage and Retrieval, Layout and Proof-reading.																				
Assignment 4: Find the technologies to implement the problem defined																				
Unit-5 - Documentation																		6 Hour		
Scope of the work, Literature review, computational details, Results and Discussions, Figures and Tables preparation, Conclusions and future works, Bibliography, Appendices. Uses of plagiarism detection tools																				
Case Study: Reports Writing for research proposals.																				
Assignment 5: Submit the complete project report with all components																				

Learning Resources	<ol style="list-style-type: none"> 1. Phillip A. Laplante <i>Technical Writing: A Practical Guide for Engineers, Scientists, and Nontechnical Professionals</i>, Second Edition (What Every Engineer Should Know), July 2019 2. Edith Cowan University. (n.d.). Report writing: Academic tip sheet [Fact sheet]. Retrieved from https://intranet.ecu.edu.au/data/assets/pdffile/0018/20628/reportwriting.pdf 3. McKeown, J. Newcastle Business School: Postgraduate students manual 2016 (5th Ed.). Retrieved from GSBS6001 Blackboard course. 	<ol style="list-style-type: none"> 4. Anne Winkel and Bonnie Hart "Report Writing Style Guide for Engineering Students" School of Natural and Built Environments, University of South Australia, July 2002. 5. https://canvas.bham.ac.uk/courses/11845/pages/what-is-a-report?module_item_id=355522
---------------------------	--	--

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	--	15%	-	15%	-	-
Level 2	Understand	25%	-	-	20%	-	20%	-	-
Level 3	Apply	30%	-	-	25%	-	25%	-	-
Level 4	Analyze	30%	-	-	25%	-	25%	-	-
Level 5	Evaluate	-	-	-	10%	-	10%	-	-
Level 6	Create	-	-	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Gowtham R, Senior Data Engineer, Mercedes Benz Research Development of India, gowtham.rajakodeesvaran@mercedes-benz.com	1. Dr. Sindia, AP, NIT – Trichy, sindhia@nitt.edu	1. Dr. Sudha Rajesh, SRMIST
	2. Dr. Vidhyavathi Prasath, AP, Government arts college for men, pravith_vidhu@yahoo.co.in	

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSE271T	Course Name	PROGRAMMING IN JAVA	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Introduce the fundamental concepts and programming environment.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Outline the Concepts of classes and IO streams															
CLR-3:	Acquire Object oriented concepts like inheritance, reusability, and encapsulation															
CLR-4:	Learn the custom exceptions and employ concurrency concepts															
CLR-5:	Exploit the power of advanced data structures and basic GUI design.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Summarize the knowledge of fundamentals of Java Programming	3	-	1	2	-	-	-	-	-	-	-	-	1	1	-
CO-2:	Determine the type of constructor and class concepts used in OOPS based programming paradigms.	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Articulate the different concepts involved in information hiding and reusability techniques.	3	2	1	-	-	-	-	-	-	-	-	-	3	2	-
CO-4:	Understand the different concepts of Exception Handling and Concurrency topics.	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Acquire the integration of Collection Frameworks and GUI programming to product development.	3	2	-	1	-	-	-	-	-	-	-	1	-	-	-

Unit-1 - Fundamentals of Java Technology and Programming	9 Hour
Java platform features, Java technologies-JSR, JCP, Data types, Key words, and Scoping rules, Automatic Type Conversion, Type Casting and Arrays, Operators Precedence & Associativity, Expression. Flow control, enhanced for loop, switch statements, String handling	
Unit-2 - Classes, Objects and Streams	9 Hour
Class fundamentals: Declaring objects, Assigning object reference variable, Methods & Method Signatures, Method with parameters, Variable arguments, I/O Basics: Byte stream& Character Stream, Getting user input: Reading console input & Writing console output, Reading and Writing files, Command Line arguments, Constructors and its Types, this keyword, Garbage Collector, finalize() method, Overloading methods and constructors, Using object as parameters, returning object in methods, recursion, Access control, static and final keyword, Nested and Inner classes.	
Unit-3 - Information Hiding & Reusability	9 Hour
Inheritance basics, Using super, Method Overriding, Dynamic method dispatch, Abstract class, Using final with inheritance, Default Package, Path & Class Path Environment Variables, Package level access, Importing Packages, Interface: Multiple Inheritance, Extending interface, Wrapper Class, Auto Boxing.	
Unit-4 - Exception, Concurrency, Enumeration and Annotations	9 Hour
Exception handling mechanism, try/catch mechanism, Thread class & Runnable Interface, Inter Thread Communication, Synchronization of threads using Synchronized keyword and lock method, Thread pool and Executors framework, Futures and callable, Fork-Join, Deadlock conditions, Enumeration, Annotations: basics of annotation.	
Unit-5 - Generics, Collections Framework and GUI Programming	9 Hour
Generics: Basics, Collections Interfaces – Set, List, Queue, Collections Classes – Array List, Hash Set, Tree Set. Abstract Map, Hash Map, Tree Map, Introduction to GUI and its component basics	

Learning Resources	1. Herbert Schildt, "The Complete Reference (Fully updated for jdk7)", Oracle press Ninth Edition, 2014.	4. Herbert Schildt, "Java: A Beginner's Guide", Eight Edition, Oracle Press, 2018.
	2. Cay S. Horstmann, "Core Java Volume –I Fundamentals", Prentice Hall, 11th Edition, 2018.	5. https://docs.oracle.com/javase/tutorial
	3. Deitel&Deitel, "Java How to Program", Prentice Hall, 10th Edition, 2016.	6. NPTEL Course: https://onlinecourses.nptel.ac.in/noc22_cs47/preview

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	35%	-	30%	-	30%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	25%	-	30%	-	30%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Jero Terrence, Assistant Consultant in Tata Consultancy Services, United Kingdom	1. Dr.R.Ganeshan, VIT Bhopal, Madhya Pradesh.	1. Dr.S.Amudha, SRMIST

Course Code	21CSE272T	Course Name	GENETIC ALGORITHM AND ITS APPLICATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand evolutionary computation and Genetic Algorithms	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Learn terminologies and operators of GA	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Gain knowledge on advanced operators and techniques in GA and classification of Genetic Algorithms																	
CLR-4:	Acquire knowledge in Genetic Programming and Genetic Algorithm Optimization problems																	
CLR-5:	Build the applications of Genetic Algorithms																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Gain knowledge on the basics of evolutionary computing and genetic algorithms	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-		
CO-2:	Acquire knowledge on the GA terminologies and operators	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
CO-3:	Understand the advanced operators in Genetic Algorithm optimization problems	1	2	-	-	-	-	-	-	-	-	-	-	2	-	-		
CO-4:	Apply the knowledge of Genetic algorithms using optimization problems on wireless networks	1	1	3	-	-	-	-	-	-	-	-	-	3	-	-		
CO-5:	Design and develop the GA-based application in different engineering fields	1	2	3	-	-	-	-	-	-	-	-	-	-	1	-		

Course Outcomes (CO):		At the end of this course, learners will be able to:														Engin	Proble	Design	soluti	Condu	of com	Model	The e	societ	Envir	Susta	Ethics	Individ	Comm	Projec	Life L	PSO-	PSO-	PSO-
CO-1:	Gain knowledge on the basics of evolutionary computing and genetic algorithms	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-				
CO-2:	Acquire knowledge on the GA terminologies and operators	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
CO-3:	Understand the advanced operators in Genetic Algorithm optimization problems	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-				
CO-4:	Apply the knowledge of Genetic algorithms using optimization problems on wireless networks	1	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-				
CO-5:	Design and develop the GA-based application in different engineering fields	1	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-				

Unit-1 - Evolutionary Computation and Genetic Algorithms	9 Hour
Introduction to genetic algorithms-The Historical Development of Evolutionary Computing, Genetic Algorithms and Genetic Programming, Features of Evolutionary Computation, Advantages of Evolutionary computation, Genetic Algorithms-Biological background. Cell, Chromosomes, Genetics, Reproduction, and Natural selection, Search space, GA world, Evolution and optimization, Evolution and genetic algorithms, Limitations of GA.	
Unit-2 - GA Terminologies and Operators	9 Hour
Terminologies and operators of GA, Key elements, Individuals, Genes, Fitness, Populations, Data Structures, Breeding, Selection, Crossover, Mutation, and Replacement, Search Termination or Convergence criteria, Best individual, Worst individual, Sum of fitness and Medium fitness, Genetic algorithms working mechanism: Building block hypothesis, A Macro mutation hypothesis. An adaptive mutation hypothesis, The Schema theorem, Optimal allocation of Trials Implicit Parallelism, Advanced operators and techniques in GA, Convergence problems in GA	
Unit-3 - Advanced Operators and Techniques in Genetic Algorithm	9 Hour
Introduction of advanced operators-Diploidy, Dominance and Abeyance, Multiploid, Inversion and Reordering, Order Crossover and Cycle crossover, Micro operators: Segregation and translocation, Duplications and Deletion, Sexual determination, non-binary representation, multi-objective optimization, combined optimization and Knowledge-based techniques, Classification of GAs. Simple Genetic algorithms (SGA). Parallel and distributed Gas, Master-slave, Fine-grained parallel GAs. Multiple-Deme Parallel Gas, Hierarchical Parallel algorithms. Hierarchical Genetic Algorithms: Crossover, Initialization heuristics, Remove sharp algorithms, Adaptive GA., Initialization, Evaluation function, Selection operators, Crossover operators, and mutation operators, Independent sampling GA and Breeding Phase, Niche pareto genetic algorithm.	
Unit-4 - Genetic Programming and Optimization Problems	9 Hour
Introduction to Genetic programming, Comparison of GP, and other algorithms. Genetic operators, Tree-based GP, Representation of GP, Attributes in GP, Steps and Characteristics of GP, Applications of Genetic Programming, GA Optimization problems, Fuzzy optimization problems, Multi-objective Reliability Design Problem. Network and bicriteria reliability design, Combinatorial Optimization problems. Linear integer model, Applications of combinatorial optimization methods, Network design and Routing problems, planning of passive optical networks, Packet switched networks, Optimal topological design of all terminal networks	

Unit-5 - Applications of Genetic Algorithms	9 Hour
Applications of Genetic Algorithms, GA in network synthesis, Control systems engineering and Fuzzy based speed control of Brushless DC motor, Feature Selection in Machine learning using GA, Designing texture filters with GA, GA based knowledge acquisition in Image Processing, Object localization in image using GA, Data mining applications such as feature selection in data mining, GA in intrusion detection, Applications in wireless networks for topology planning, GA application in ATM network, VLSI design applications, Genetic Layout optimization using GA, Introduction to Particle Swarm Optimization (PSO) and Ant Colony Optimization (ACO), Examples on PSO and ACO, Comparison of GA with PSO and ACO, Comparison of GA with PSO and ACO	

Learning Resources	1. S.N. Sivanandam and S.N. Deepa, "Introduction to Genetic Algorithms", Springer, 2nd edition (2008) 2. Mitsuo Gen and Runwei Cheng, "Genetic Algorithms and Engineering Optimization", John Wiley, Fourth edition (2010). 3. Michael Negnevitsky, "Artificial Intelligence, A Guide to Intelligent Systems", Second edition ((2005)) 4. David E.Goldberg, "Genetic Algorithms in search, Optimization & Machine Learning", Pearson Education, 2001
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	30%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	30%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. K. Selvaraj, Caterpillar, Bangalore	1. Dr. A.P. Shanthy, CSE, Anna University, Chennai	1. Dr.R. Athilakshmi, SRMIST

Course Code	21CSE291T	Course Name	INTRODUCTION TO COGNITIVE NEUROSCIENCE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Outline the fundamental framework of brain and its function	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Explain the importance of neurons and their interconnections															
CLR-3:	Illustrate the geography of living brain															
CLR-4:	Introduce the functional overview of learning and memory, thinking and problem solving															
CLR-5:	Provide the insight of executing goals and social cognition															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Acquire knowledge on mind-brain science and working memory	1	-	-	-	-	-	-	-	-	-	-	1	2	-	-
CO-2:	Understand the adaptation of neural arrays and coordinating neural sets	1	2	-	-	-	-	-	-	-	-	-	1	3	-	-
CO-3:	Comprehend the usage of functional neuroimaging and the roles of brain regions	1	-	-	-	-	-	-	-	-	-	-	1	1	-	-
CO-4:	Apply the varieties of memories and find ways to use existing knowledge	-	3	-	2	-	-	-	-	-	-	-	1	-	2	-
CO-5:	Analyze and perceive the mental state of others	-	3	2	-	-	-	-	-	-	-	-	1	-	2	-

Unit-1 - Mind and Brain Frameworks	9 Hour
An invitation to mind-brain science - Distance: seven orders of magnitude - Time: ten orders of magnitude - The need to make inferences - going beyond the raw observations - The importance of convergent measures - The mind and the brain - Biology shapes cognition and Emotion - Cajal's neuron doctrine: the working assumption of brain science - Pierre-Paul Broca and the localization of speech production - The conscious and unconscious mind - The return of consciousness in the sciences - Classical working memory - Limited and large-capacity functions - The inner and outer senses - The central executive - Action - Consolidation of short-term events into long-term memory.	
Unit-2 - Neurons and their Interconnections	9 Hour
Real and idealized neurons - Excitation and inhibition - Neural computation - Working assumptions - Arrays and maps - Maps flow into other maps - Temporal codes: spiking patterns and brain rhythms - Choice-points in the flow of information - Top-down or expectation-driven processing - Hebbian learning - Neural Darwinism: survival of the fittest cells and synapses - Symbolic processing and neural nets - Coordinating neural nets - Functional redundancy.	
Unit-3 - Imaging the Living Brain	9 Hour
Imaging the living brain - Brain recording: more and less direct measurements - The time-space tradeoff - Measuring electric and magnetic signals - Functional neuroimaging: a bold new world - New ways to measure brain connectivity: diffusion tensor imaging - Conscious versus unconscious brain events - Correlation and causation.	

Unit-4 - Learning and Memory, Thinking and Problem solving	9 Hour
Learning and memory - A functional overview - Implicit and explicit memory - Electrically evoked autobiographical memories - Long-term potentiation and long-term depression: excitatory and inhibitory memory traces - Consolidation: from temporary to permanent storage - Rapid consolidation: synaptic mechanisms, gene transcription, and protein synthesis - System consolidation: interaction between the medial temporal lobes and neocortex - Varieties of memory - MTL in explicit learning and memory - Prefrontal cortex, consciousness, and working memory - Retrieval and metacognition - Thinking and problem solving - Explicit problem solving - Mental workload and cortical activity - Using existing knowledge - Implicit thinking.	
Unit-5 - Goals, Executive control, action, and Social Cognition	9 Hour
Goals, executive control, and action - Phylogeny and ontogeny - Function overview - Closer look at frontal lobes - Neuroimaging the executive brain - Frontal lobe dysfunction - A current view of organizing principles of the frontal lobes - Social cognition: Perceiving the mental states of others - An organizing framework for social cognition - Mirror neurons and intention detection.	

Learning Resources	1. Cognition, Brain, and Consciousness: Introduction to Cognitive Neuroscience (2010), Bernard J. Bears, Nicole M. Gage, Academic Press (2010) 2. Quantum Models of Cognition and Decision, Jerome R. Busemeyer, Peter D. Bruza, Cambridge University Press (2014) 3. Cognitive Science. B M Bly & D E Rumelhart (Ed) (1999) the new cognitive neurosciences. M S Gazzaniga (ed) (2000)	4. Sternberg, Robert J., Cognitive Psychology, 4th ed., Cengage Learning India, 2008 5. MIND, An Introduction to Cognitive Science, Paul Thagard, MIT Press, 2 nd edition, 2005 6. Cognitive Science, Jay Freidenberg and Gordon Silverman, SAGE, 2016.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	25%	-	25%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	25%	-	25%	-
Level 4	Analyze	10%	-	10%	-	10%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.V.Anbarasan, Senior Engineer, Nielsen IQ India Pvt. Ltd.	1. Dr.K.Jayashree, Professor, Department of Artificial Intelligence and Data Science, Panimalar Engineering College, Chennai	1. Dr. R. Babu, SRMIST
2. Ms.A.Saranya, Application Development Team Lead, Accenture India		

Course Code	21CSE311P	Course Name	ROBOT PROGRAMMING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Introduce the fundamentals of robot programming.	1	2	3	4	5	6	7	8	9	10	11	12							
CLR-2:	Explain the fundamentals of Embedded programming.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3				
CLR-3:	Acquire knowledge for selection and calibration of sensors, actuator and how to interface with Robot.																			
CLR-4:	Understand the Robot operating system fundamentals.																			
CLR-5:	Understand the integration of Hardware controllers with ROS.																			
Course Outcomes (CO):		At the end of this course, learners will be able to:																		
CO-1:	Gain the knowledge of robot building system.	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-				
CO-2:	Create the program for robot.	-	2	-	3	-	-	-	-	-	-	-	-	2	-	-				
CO-3:	Gain knowledge on the sensor signal calibration, and actuator control for interfacing with Robot.	-	2	-	3	-	-	-	-	-	-	-	-	-	-	3				
CO-4:	Obtain the insights of Robot Operating system	-	-	-	3	-	-	-	-	-	-	-	-	-	-	3				
CO-5:	Design and program the robot for its intelligent operation.	-	-	-	3	-	-	-	-	-	-	-	-	1	-	3				

Unit-1 - Robot Fundamentals	9 Hour
Basic of Robots – Anatomy - Links and joints - Basic terminology- Accuracy, Repeatability, Resolution, Degree of freedom - Robot Movement: Pitch, Roll, Yaw - Mechanisms and transmission - Work volume - End effectors. Tutorial: 1. Study the anatomy of Robot and create a Robot structure for pick and place operation. 2. Problems on Degrees of Freedom, understanding robot work space and movement.	
Unit-2 - Embedded Programming	9 Hour
Basic Embedded File system – hex files - Simulators and Emulators - Integrated development environments - commonly used IDE. Basics of Embedded C for Robot Programming –. Python for Robot Programming - Program structure, data types, control structure. Practice: 1. Understanding file system and using IDE. 2. Create a Embedded C program for I/O operation.	
Unit-3 - Robot Programming Interface	9 Hour
Sensor- Principle of sensors - Analog signal - Digital signal - I/O of Sensors – Calibration of sensors – Interfacing -Serial - I2C. Actuator – Types – I/O of Actuator, Direct control, and speed control, PWM, analog control. Programming and interfacing of sensors. Programming and interfacing of actuators. Practice: 1. Interfacing of sensor and calibration. 2. Interfacing of motor and control of motors.	

Unit-4 - Robot Operating System:	9 Hour
ROS Basics- Sensors and Robots Supporting ROS - ROS Architecture and Concepts - ROS File system - ROS Computation Graph Level, ROS Community Level - Creating ROS Workspace and Package, Using ROS Client Libraries, Programming Embedded Board using ROS - Interfacing Arduino with ROS, ROS on a Raspberry Pi.	
Practice:	
1. Serial and I2C communication.	
2. Programming with Raspberry Pi.	
Unit-5 - Building the Robots:	9 Hour
Introduction to Wheeled Robot - Building Robot Hardware - Block Diagram and Assembling Robot Hardware - Programming Robot Firmware - path planning. Case study: Tetrix – NAO – Ned Niryo – Auto Auto.	
Practice:	
1. Programs of Tetrix and NAO.	
2. Programs on Ned Niryo and Auto Auto.	

Learning Resources	1. Mikell P. Groover, "Industrial Robotics", McGraw Hill, 2nd edition, 2012 2. Lentin Joseph, Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy, 1st Edition, APress, 2018. 3. Mark Siegesmund, "Embedded C Programming Techniques and Applications of C and PIC® MCUS", Newnes, 2014 4. Jonathan Cacace; Lentin Joseph, Mastering ROS for Robotics Programming: Design, build, and simulate complex robots using the Robot Operating System, 2nd Edition, Packt Publishing, 2018. 5. John J. Craig, "Introduction to Robotics", 3rd Edition, Addison Wesley, ISE 2008. 6. Jacob Fraden, "Handbook of Modern Sensors", Springer 2016 7. W. Bolton, "Mechatronics", Pearson, 2018
---------------------------	--

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	--	15%	-	15%	-	-
Level 2	Understand	25%	-	-	20%	-	20%	-	-
Level 3	Apply	30%	-	-	25%	-	25%	-	-
Level 4	Analyze	30%	-	-	25%	-	25%	-	-
Level 5	Evaluate	-	-	-	10%	-	10%	-	-
Level 6	Create	-	-	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rijo Jackson Tom Lead Data Scientist Augusta hitech soft solution	1. Dr. Thiyagarajan R Assistant Professor, Department of Mechanical Engineering, Indian Institute of Technology Tirupati	1. Dr.J.J. Jayakanth, SRMIST

Course Code	21CSE312P	Course Name	SOFTWARE ENGINEERING IN ARTIFICIAL INTELLIGENCE	Course Category	E	PROFESSIONAL ELECTIVE										L	T	P	C												
																2	1	0	3												
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil																								
Course Offering Department		School of Computing			Data Book / Codes / Standards		Nil																								
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes													
CLR-1:	Learn the different GPU Components				1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Know to access NGC Containers and docker images																														
CLR-3:	Utilize the Pytorch and Jupyter notebook																														
CLR-4:	Learn the CUDA ecosystem																														
CLR-5:	Explore the DL deployments																														
Course Outcomes (CO):		At the end of this course, learners will be able to:				-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-1:	Distinguish the different components in GPU systems				-	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Create environments to work with different NGC container packages				-	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Implement codes using jupyter notebook and pytorch				-	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Develop and work with CUDA				-	3	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Visualize different DL deployments for various scientific applications				-	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unit-1 - Introduction to System Software Engineering																	9 Hour														
System S/W Platforms: Virtualization, Containerization- Introduction to NVIDIA NGC Cloud, DockerHub																															
T1: Accessing DGX A100																															
T2: Working DOCKER Images and NGC Container																															
T3: Installation and Pulling Specific NGC Packages																															
Unit-2 - Scheduling and Resource Management																	9 Hour														
Introduction to Schedulers/Orchestration Tools - Fundamentals of Ansible/Kubernetes/KubeFlow/SLURM																															
T4: Implementing and executing Kubernetes																															
T5: Working with Ansible																															
T6: Demo Executions on Kubeflow/SLURM																															
Unit-3 - Introduction to IDE / Exploratory Programming																	9 Hour														
Introduction to various IDE like VSCode/PyCharm/Others-Introduction to Jupyter-Ecosystem for Exploratory Programming- Features of Jupyter-Ecosystem for building Python Packages/Scientific Manuscript																															
T7: Working with VScode/ Pycharm																															
T8: Using Jupyter note and PyTorch																															
T9: Run a simple data centric application using Jupyter note.																															
Unit-4 - System Software for Accelerated Computing																	9 Hour														
ML/DL/DS/HPC Workloads-Overview of CUDA Platform: GPGPU Computing Platform - Overview of CUDA-X Platform: cuBLAS/cuDNN/cuTensor [Compute]- Framework for Differential Computation																															

T10: Testing the GPGPU Computing
T11: Testing and working with Tensor (CUDA-X)
T12: Implementing Mixed Precision and Quantization Aware training
Unit-5 – GPU Programming
Distributed Computing Software Stack-Multi-GPU/Multi-Node: [MPI/NCCL/RDMA] Horovod- Accelerating DL Deployments- MLOps: Hands-on
T13: Accelerating Neural Network Inferencing: TensorRT & Triton Inference Server
T14: Monitoring load Balancers & Schedulers
T15: Deployment of various services for monitoring, jupyter environment and other services.

9 Hour

Learning Resources	<ol style="list-style-type: none"> Ekman, M., 2021. Learning Deep Learning: Theory and Practice of Neural Networks, Computer Vision, NLP, and Transformers Using TensorFlow. Addison-Wesley Professional. Sanders, J. and Kandrot, E., 2010. CUDA by example: an introduction to general-purpose GPU programming. Addison-Wesley Professional. Christopher Love, Jay Vyas, Core Kubernetes, 2022 Chollet, F., 2021. Deep learning with Python. Simon and Schuster.
---------------------------	--

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	--	15%	-	15%	-	-
Level 2	Understand	25%	-	-	20%	-	20%	-	-
Level 3	Apply	30%	-	-	25%	-	25%	-	-
Level 4	Analyze	30%	-	-	25%	-	25%	-	-
Level 5	Evaluate	-	-	-	10%	-	10%	-	-
Level 6	Create	-	-	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. A.G.Rangaraj, Deputy Director (Technical), R&D, RDAF and SRRA Division, National Institute of Wind Energy (NIWE)	1. Dr.I.Joe Louis Paul, Associate Professor, SSN College of Engineering	1. Dr.Kottilingam K

Course Code	21CSE313P	Course Name	ACCELERATED DATA SCIENCE	Course Category	E	PROFESSIONAL ELECTIVE										L	T	P	C		
																2	1	0	3		
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil														
Course Offering Department		School of Computing		Data Book / Codes / Standards		Nil															
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes			
CLR-1:	Learn the different GPU Components				1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3				
CLR-2:	Know to work with GPUs for Accelerated Data Sciences																				
CLR-3:	Utilize CUDA and RAPIDS for Accelerated Data Science and Array Computing																				
CLR-4:	Learn and work with Data Wrangling and Machine learning																				
CLR-5:	Explore the cuSignal worklets																				
Course Outcomes (CO):		At the end of this course, learners will be able to:																			
CO-1:	Distinguish the different components in GPU systems				1	1	-	-	-	-	-	-	-	-	-	-	1	-	-		
CO-2:	Create environments to work with different packages for data science environments				-	2	-	-	-	-	-	-	-	-	-	-	-	-	2		
CO-3:	Implement codes using CUDA and RAPIDS for Data Science and Array Computing				-	-	-	3	-	-	-	-	-	-	-	-	-	-	2		
CO-4:	Develop and work with cuML and RAPIDS Memory manager				-	-	-	3	-	-	-	-	-	-	-	-	-	-	2		
CO-5:	Working with cuSignal				-	-	-	3	-	-	-	-	-	-	-	-	-	-	2		
Unit-1 - Introduction to GPU Systems																		9 Hour			
Introduction to GPU and DGX A100, Accessing DGX A100, Working DOCKER Images and NGC Container, Installation and Pulling Specific NGC Packages																					
Unit-2 - GPUs for Data Sciences																		9 Hour			
Introduction to Data Science Packages in Python Ecosystem: NumPy, Pandas, Scikit-Learn, SciPy, NetworkX- Overview of Jupyter Environment, GPU Accelerated Data Science Workflow with RAPIDS, Data Preparation- NVTABULAR, ETL for RecSys-Model Training and XGBoost: Distributed XGBoost with DASK Visualization- cuXFilter																					
Unit-3 – CUDA and RAPIDS																		9 Hour			
Accelerated Data Science and Array Computing, CUDA and GP-GPU Computing, RAPIDS: GPU Accelerated Data Science Python Ecosystem, CuPy, cuDF, cuML, cuSignal,cuGraph, Deep-Dive: CuPy & Numba for accelerated Array Computation- Dask: Distributed Array Processing Scheduler, Multi-GPU training																					
Unit-4 - Accelerated Data Wrangling and Machine Learning																		9 Hour			
GPU Accelerated Data Wrangling using cuDF- RAPIDS Memory Manager & NVTabular, Hands-on practical labs on cuDF with practical problem statement & benchmarking, GPU Accelerated Machine Learning using cuML -Hands-on practical on cuDF + cuML on a practical problem statement & benchmarking																					
Unit-5 - Accelerated Signal Processing																		9 Hour			
GPU Accelerated Signal Processing using cuSignal, Hands-on practical on cuSignal, Hands-on practical on cuSignal + Dask on a practical problem statement & benchmarking																					
Learning Resources	1. Goodfellow, I., Bengio, Y. and Courville, A., 2017. Deep learning (adaptive computation and machine learning series). Cambridge Massachusetts, pp.321-359. 2. Ng, A., 2017. Machine learning yearning. URL: http://www. mlyearning. Org/ (96), 139. 3. Christopher Love, Jay Vyas, Core Kubernetes, 2022 4. Chollet, F., 2021. Deep learning with Python. Simon and Schuster.																				

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	--	15%	-	15%	-	-
Level 2	Understand	25%	-	-	20%	-	20%	-	-
Level 3	Apply	30%	-	-	25%	-	25%	-	-
Level 4	Analyze	30%	-	-	25%	-	25%	-	-
Level 5	Evaluate	-	-	-	10%	-	10%	-	-
Level 6	Create	-	-	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Thamaraiselvam S, Zoho Corporation Private Limited, Estancia IT Park, Guduvancherry, Tamil Nadu-603202	1. T. Sudhakar Associate professor School of computer science and engineering VIT-AP University	1. Dr. K. Kottilingam SRMIST
		2. Dr.N. Arivazhagan, SRMIST

Course Code	21CSE323T	Course Name	MARKETING ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Learn to build brand architecture on brand value	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Know to create functions to access and manipulate numbers, strings and date time data	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Know the emphasis on scaling for brands																
CLR-4:	Utilize the information for strategic marketing alternatives																
CLR-5:	Explore the experiments for digital marketing efforts																
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	analyse user Generated Contents	-	-	-	-	-	-	-	3	-	3	-	-	1	-	-	
CO-2:	analyse the digital products	-	-	-	-	-	-	-	3	-	3	-	-	2	-	-	
CO-3:	understand customer Lifetime Value	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	
CO-4:	analyse the marketing with ML models	-	-	-	-	-	-	-	3	-	-	-	-	2	-	-	
CO-5:	communicate with digital analytics	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	

Unit-1 - User Generated Contents	9 Hour
Marketing Analytics, Data for Marketing Analytics, Business Intelligence, Analytics, and Data Science, Analysis, Exploratory Data Analysis, Descriptive Analysis, Predictive Analytics, Prescriptive Analytics, Benefits of Customer Analytics, Factors Essential for Obtaining Benefits from Customer Analytics, Segmentation Analytics, Cluster Analysis.	
T1: Data for Marketing Analytics	
T2: Predictive Analytics	
T3: Segmentation and cluster analysis	
Unit-2 - Product Analysis	9 Hour
Product Analytics, Perceptual Mapping, White Spaces, Umbrella Brands, Multidimensional Scaling, Analyzing Digital Products, Analyzing Non-Digital Products,	
T4: Product analysis	
T5: Multimodel scaling	
T5: Digital and Non - digital Products	
Unit-3 - Customer Lifetime Value	9 Hour
Customer Lifetime Value (CLV), Calculating CLV, Understanding the CLV Formula, Applying the CLV Formula, Extending the CLV Formula, Using CLV to Make Decisions, A Forward-Looking Measure.	
T7: Customer Lifetime Value (CLV)	
T5: Applying the CLV Formula,	
T6: Using CLV to Make Decisions	
Unit-4 - Market Analysis	9 Hour

Market Mix Modeling, Variables in Market Mix Modeling, Techniques of Market Mix Modeling, Metrics for Tracking Customer Experience, Upgrading Customers: Use Case of Upselling, Logistic Regression Analysis, Use of Logistic Regression as a Classification Technique T10: Regression Analysis T11: Multivariable Regressions T12: Marketing Mix Models
Unit-5 - Digital Analytics 9 Hour
Search Engine Marketing, Search Engine Optimization, Social Media Analytics, App Marketing Metrics, Importance of AI in Marketing, Random Forests, Model Evaluation Using ROC, AUC, and Confusion Matrix, Simple Feed-Forward Network, Deep Neural Network, Recommendation Systems, Necessity of Data Visualization, Visualizations Useful with Common Data Science Techniques T13: Search Engine Marketing T14: AI in Marketing T15: Data Visualization Techniques

Learning Resources	<ol style="list-style-type: none"> Seema Gupta, Avadhoot Jathar, "Marketing Analytics", ISBN: 9789354242625 Brea Cesar (2014), "Marketing and Sales Analytics: Proven Techniques and Powerful Applications from Industry Leaders", FT Press, ISBN-0133761711 Emmett Cox (2012), "Retail Analytics: The Secret Weapon", Wiley, ISBN- 978-1-118-09984-1 Fok Dennis (2003), "Advanced Econometric Marketing Models", ERIM, ISBN 90-5892-049-6 Mireles Carlos Hernandez (2010), "Marketing Modeling for New Products", ERIM, ISBN 978-90-5892-237-3 Rackley Jerry (2015), "Marketing Analytics Roadmap: Methods, Metrics, and Tools", Apress, ISBN-1484202597
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.K.Jafar Ali MBA, Ph.D. Consultant, iSpark Learning Solutions, Chennai.	1. Angeline Gautami Fernando, Associate Professor (Marketing & Analytics) at Great Lakes Institute of Management	1. Dr. R. Rajkumar, SRMIST

Course Code	21CSE326T	Course Name	ARTIFICIAL NEURAL NETWORKS	Course Category	E	PROFESSIONAL ELECTIVE						L	T	P	C							
						3	0	0	3													
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil															
Course Offering Department		School of Computing		Data Book / Codes / Standards		Nil																
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes				
CLR-1:	Understand the biological background and basic concepts of neural networks					1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Gain knowledge about perceptron and back propagation					Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Know about various training rules and error minimization																					
CLR-4:	Learn the concepts of unsupervised neural networks																					
CLR-5:	Explore the fine-tuning procedures and case studies for designing neural network models																					
Course Outcomes (CO):		At the end of this course, learners will be able to:																				
CO-1:	Explain the basic concepts of neural networks					-	-	-	-	-	-	-	-	-	-	-	-	1	-	-		
CO-2:	Describe perceptron and back propagation					-	-	-	-	-	-	-	-	-	-	-	-	-	2	-		
CO-3:	Apply various training rules in neural networks					-	-	-	-	-	-	-	-	-	-	-	-	2	-	-		
CO-4:	Explain unsupervised neural networks					-	-	-	-	-	-	-	-	-	-	-	-	-	-	2		
CO-5:	Fine tune the neural networks					-	-	-	-	-	-	-	-	-	-	-	-	-	-	1		
Unit-1 - Introduction to Neural Networks																				9 Hour		
History of neural network research- Biological inspiration: Neural computation, Models of computation, Elements of computing models- Network of neurons: structure, Information processing at neurons and synapses, Information storage, Neurons as self-organizing systems- Artificial Neural Networks: Network of primitive functions, approximation of functions- Neuron Model: Single and multiple input neurons, Transfer functions- Network architectures: Single layered and multi layered neurons, Recurrent Networks																						
Tutorials:																						
1. Implement various neural network architectures																						
2. Implement and study the effect of various activation functions																						
Unit-2 - Perceptron																				9 Hour		
Introduction to Perceptron- Perceptron Architecture: Single Neuron Perceptron, Multi Neuron Perceptron- Perceptron learning rule: Constructing Learning rules, Unified Learning rule, Training multi neuron perceptron- Complexity of perceptron learning-Computational Limits of Perception-Linearly separable functions- Learning XOR-Feed forward Networks- Back propagation: Chain of rule Calculus, Back-Propagation Computation in Fully-Connected Multi-layer Perceptron																						
Tutorials:																						
1. Implement Feed forward networks																						
2. Implement back propagation																						

Unit-3 - Learning and Training	9 Hour
Paradigms of Learning - Using training samples - Gradient Optimization Procedure- Batch Gradient Descent, Stochastic Gradient Descent, Mini-Batch Gradient Descent - Hebbian learning rule – Delta learning rule- Convergence and local minima, representational power of feed forward networks, hypothesis search space and inductive bias, generalization, overfitting and stopping criterion-Error functions, Error minimizing procedures-Hebbian learning Tutorials: 5. Implementation of gradient descent 6. Implementation of delta learning rule	
Unit-4 - Unsupervised Neural Networks	9 Hour
Unsupervised learning in neural networks: Hebbian learning rule, Principle Component Learning, Learning Vector Quantizer-I- Self Organizing Maps: Functionality, Training, Topology Function, Decreasing Learning Rate, Variations of SOMs, Neural gas, Multi-SOM, Multi-neural gas, Growing neural gas- Adaptive Resonance Theory, Orienting subsystems, Learning Laws 7. Implementation of Principle Component analysis 8. Implementation of Self Organizing Maps	
Unit-5 - Tuning the Neural Networks	9 Hour
Pretraining the model: Data selection, Preprocessing, Selection of network architecture- Training the network: Initializing weights, Choice of training algorithm, stopping criteria, Choice Of performance function, Committees of Networks-Post Training Analysis: Fitting, Pattern Recognition, Clustering- Time delay and Recurrent Neural Networks-Case Studies: Smart Sensor system with function approximation- Myocardial Infarction Recognition using pattern recognition-Forest cover problem using Clustering	

Learning Resources	1. Martin T. Hagan, <i>Neural Network Design</i> , 2nd edition. 2. Tom M. Mitchell, <i>Machine Learning</i> , McGraw-Hill Education (India) Private Limited. 3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, <i>Deep Learning</i> , MIT Press, 2016	4. Andries P., <i>Computational Intelligence: An Introduction</i> , Second Edition, Wiley, 2007 5. David Kriesel, <i>A Brief Introduction to Neural Networks</i> , 2009
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Dr. Sharanya, SRMIST

Course Code	21CSE371T	Course Name	ADVANCED ALGORITHMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Interpret the recurrence relations for analyzing the algorithms	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Classify various algorithmic techniques for appropriate applications and problems	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Evaluate the worst-case, average-case, and best-case analysis of various algorithms																
CLR-4:	Illustrate string matching algorithms																
CLR-5:	Understand the purpose of different randomized, approximation and Geometric Algorithms																
Course Outcomes (CO):		At the end of this course, learners will be able to:	-	2	-	-	-	-	-	-	-	-	-	-	-	2	
CO-1:	Analyze the performance of algorithms	-	2	-	-	-	-	-	-	-	-	-	-	-	-	1	
CO-2:	Choose appropriate data structures and algorithm design methods for a specified application.	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2	
CO-3:	Assess the case analysis of various algorithms	-	-	-	2	-	-	-	-	-	-	-	-	1	-	1	
CO-4:	Infer the performance of string-matching algorithms	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2	
CO-5:	Compare and contrast various randomized, approximation and Geometric Algorithms	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2	

Unit-1 - Introduction to Algorithm Analysis	9 Hour
Role of algorithms in computation, Notation order, Recurrences, Probabilistic Analysis, Statistics of Sorting, and its order notations: Heap Sort and Quick Sort in Linear time and space, Dynamic Programming: Matrix Chain Multiplication, Operations on Polynomials, DFT & FFT Algorithms, longest common Subsequence, and optimal binary Search trees	
Unit-2 - Graph Algorithms and Network Flow	9 Hour
Greedy Algorithms - Huffman Codes, Activity Selection Problem, Amortized Analysis. Graph Algorithms - Topological Sorting, Minimum Spanning trees, Single Source Shortest Paths, Maximum Flow algorithms, Augmenting Paths, and Push-Relabel Methods. Network Flow – Ford-Fulkerson Algorithm, Push-relabel algorithm, Maximum bipartite matching, and Hopcroft-Karp algorithm. Parallel Algorithms – PRAM, Pointer Jumping and Parallel Prefix, Tree Contraction, Randomized Symmetry Breaking, Maximal Independent Set. Case Study: Finding the shortest path between two cities using Travelling salesperson problem	
Unit-3 - Sorting Networks and Matrix Operations	9 Hour
Sorting Networks: Comparison Networks, Zero-one principle, Bitonic Sorting Networks, Merging Network, Sorting Network. Matrix Operations- Strassen's Matrix Multiplication, inverting matrices, Solving system of linear Equations	
Unit-4 - String Matching & Randomized Algorithms	9 Hour
String Matching - Naive String Matching, Rabin-Karp algorithm, Matching with finite Automata, Knuth- Morris - Pratt algorithm, Suffix Trees. Randomized Algorithms – Mathematical Background, Introduction and analysis, Monte Carlo Algorithms, Las Vegas Algorithms, Atlantic City Algorithms, Computational Complexity	
Unit-5 - Approximation Algorithms and Linear Programming	9 Hour
Polynomial time, polynomial time verification, NP-Completeness and reducibility, NP-Complete problems. Approximation Algorithms- Vertex cover Problem, Travelling Sales person problem, Set Vector and Subset Sum. Geometric Algorithms – Preliminaries, Convex Hull, Segment Intersection, Closest Pair, Voronoi-Delaunay diagrams, Flip algorithm. Linear Programming – Framework, Formulation of Problems as Linear Programs. Duality. Simplex, Interior Point, and Ellipsoid Algorithms. Case Study : Types of algorithms used for finding convex hull for any given area	

Learning Resources	1. <i>Introduction to Algorithms</i> , T. H. Cormen, C.E. Leiserson, R. L. Rivest, and C. Stein, Third Edition, PHI.	4. <i>Algorithm Design: Foundations, Analysis and Internet examples</i> , M.T. Goodrich and R. Tomassia, John Wiley and sons
	2. <i>Fundamentals of Computer Algorithms</i> , Ellis Horowitz, Satraj Sahni and Rajasekharam, Galgotia publications pvt. Ltd	5. <i>Data structures and Algorithm Analysis in C++</i> , Allen Weiss, Second edition, Pearson education.
	3. <i>Design and Analysis Algorithms</i> - Parag Himanshu Dave, Himanshu Bhalchandra Dave Publisher: Pearson	6. <i>Cormen, Leiserson, Rivest, and Stein. Introduction to Algorithms. 2nd ed. Cambridge, MA: MIT Press, 2001. ISBN: 0262032937.</i>

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	10%	-	20%	-
Level 2	Understand	20%	-	10%	-	20%	-
Level 3	Apply	30%	-	40%	-	30%	-
Level 4	Analyze	30%	-	40%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Bragadeesh SA, Associate Analyst, Infosys Pvt Limited	1. Mr. Mani Deepak, PGP College of Engineering, Coimbatore	1. Mrs. Akshya J, SRMIST

Course Code	21CSE375T	Course Name	COMPUTATIONAL NEUROSCIENCE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Know What happens in your brain when you make a decision	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Gain knowledge mathematical and computational models that are used in the field of theoretical neuroscience	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Understand basics of adaptively and learning.															
CLR-4:	Acquire knowledge on Basic models of cognitive processing and neuro models.															
CLR-5:	Acquire knowledge on various computational algorithm															

Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Describe the design Models of single neurons, and small networks	3	1	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-2:	Illustrate Implementation of all simple as well as more complex numerical computations with few neurons.	3	1	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Analyse connected networks in the mean-field limit	3	1	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-4:	Formalize biological facts into mathematical models	3	1	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-5:	Understand a simple mathematical model of memory formation in the brain	3	1	-	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to Computational Neuroscience	9 Hour
History of Computational Neuroscience- Models in Computational Neuroscience - Intro- Neuron - axons, dendrites etc, the four components of Neural Signalling Neuro transmission: neuro transmitter, reception channel, Electrophysiology -Nernst potential, resting potential, Goldman- Hodgkin-Katz voltage equation, outline of the Hodgkin- Huxley model. Modelling channel kinetics, activation, and inactivation gates Complete formulation of Hodgkin- Huxley model.	
Unit-2 - Components of Neural Signalling	9 Hour
Four components of Neural Signalling -Neurotransmission -Population dynamics -Modelling the average behaviour of neurons- Modelling the average behaviour of neurons - Huxley Model -Spiking neuron models Single Spiking neuron models - Detailed Spiking neuron models – 2D Model Integrate and firing model -Leaky integrate-and-fire model - Integrate and firing model -Nonlinear integrate-and-fire model - Integrate and firing model -	
Unit-3 - Artificial Neural Network to Realistic	9 Hour
Introduction Modelling the ventral stream Modelling the dorsal and auditory stream Mechanical behaviour of ceramics-flexural strength -The Perceptron. Mapping function Multi-layer Perceptron Back-propagation – Intuition, Derivation Back-propagation –Loss Function Back-propagation – Limitation Support Vector Machines - Classification Support Vector Machines - Regression Support Vector Machines – Kernel Function Self-Organizing Maps - Introduction Self-organizing Maps - Variable Self-organizing Maps - Algorithm Self-organizing Maps – SOM Initialization Self-organizing Maps Case studies: Regression Support Vector Machines, Korhonen Algorithm	

Unit-4 - Memory Classification	9 Hour
Memory Classification Scheme – Declarative, Non-declarative Auto-associative network and hippo campus - Learning and retrieval phase Point-attractor neural networks - Network dynamics and training Signal-to-noise analysis - Noisy weights and diluted attractor networks- Asymmetrical networks Non-monotonic networks Complementary memory systems Distributed model of working memory- Limited capacity of working memory The spurious synchronization hypothesis The interacting-reverberating-memory hypothesis Motor Learning and Control Feedback controller Forward and inverse model controller The cerebellum and motor control	
Unit-5 - Different Learning Methods	9 Hour
Hebbian Learning-Hebbian- versus Perceptron Learning- Gradient Descent Learning-Stabilizing Hebbian Learning-Variations of Hebbian Learning Nonlinear Hebbian learning -Linker's Model of the Visual System - Lateral Geniculate Nucleus -Striate Cortex Linker's model for orientation columns - Reinforcement Learning -Elements of Reinforcement Learning -Markov decision process-Dynamic - programming algorithms for solving MDPs - Algorithms for large state spaces. Case studies: Gradient temporal difference learning, Reinforcement Learning,	

Learning Resources	<ol style="list-style-type: none"> 1. Thomas Trappenberg, "Fundamentals of Computational Neuroscience" Oxford University Press, January 2010 2. Peter Dayan & LF Abbot, "Theoretical Neuroscience: Computational and Mathematical Modelling of Neural Systems", MIT Press, 2005 3. Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning an Introduction", 2nd Edition, The MIT Press, 2018
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. P S Saravanan, Associate Consultant, CTS, USA	1. Dr.A Balaji, Senior Assistant Professor at VIT Bhopal University,	1. Dr. K Suresh, SRMIST
	2. Prof.K Somasundram, Department of Computer Science and Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences,	2. Dr. R.Siva, SRMIST

Course Code	21CSE376T	Course Name	NATURE INSPIRED COMPUTING TECHNIQUES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Analyze concepts of Natural systems and its applications	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Study new basic natural systems functions(operations)	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Introduce fundamentals of nature inspired techniques which influence computing																
CLR-4:	Integrate Hardware and software in Natural applications																
CLR-5:	Understand natural design considerations																
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	Illustrate the basic concepts of Swarm Intelligence processes	3	3	-	-	-	-	-	-	-	-	-	-	-	-	1	
CO-2:	Examine the principle of Immune computing techniques	3	2	-	-	-	-	-	-	-	-	-	-	-	-	1	
CO-3:	Manage the scope changes of nature inspired techniques which influence computing	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2	
CO-4:	Identify optimization Techniques to provide functionality and value	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2	
CO-5:	Understand the needs and familiarize the DNA Computing	2	2	-	-	-	-	-	-	-	-	-	-	-	-	3	

Course Outcomes (CO):		At the end of this course, learners will be able to:	
CO-1:	Illustrate the basic concepts of Swarm Intelligence processes		
CO-2:	Examine the principle of Immune computing techniques		
CO-3:	Manage the scope changes of nature inspired techniques which influence computing		
CO-4:	Identify optimization Techniques to provide functionality and value		
CO-5:	Understand the needs and familiarize the DNA Computing		

Unit-1 - Introduction	9 Hour
Introduction, Overview of Philosophy, Nature to Nature Computing, A Brief Overview of Three Branches, Computing Inspired by nature, Simulation and Emulation of Nature i Computers, Computing with Natural Materials, Nature Inspired Computing Approaches.	
Unit-2 - Conceptualization	9 Hour
Natural Phenomena, Models and metaphors, Nature to computing and back again, Individuals, Entities and agents, Parallelism and Distributivity Interactivity, Adaptation- Feedback, Self-Organization, Complexity, Emergence, Bottom-up Vs Top-Down Approach, Determination, Chaos and Fractals.	
Unit-3 - Evolutionary Computing	9 Hour
Hill Climbing, Simulated Annealing, Simulated Annealing, Genetics Principles, Standard Evolutionary Algorithm, Genetic Algorithms, Reproduction, Crossover Mutation, Evolutionary Programming, Genetic Programming	
Unit-4 - Neurocomputing	9 Hour
The Nervous System, Levels of Organization in the Nervous System, Networks Layers and Maps, Basis of learning and Memory, Artificial Neural Networks, Network Architectures, Learning Approaches, ANNS and Learning Algorithms- Hebbian Learning, Single Layer Perceptron, Multilayer Perceptron. Case Study: Bank loan approval using ANN	
Unit-5 - Swarm Intelligence	9 Hour
Introduction, Ant Colony Optimization, Ant Foraging Behaviour, Ant Colony Optimization, SACO algorithm, Ant Colony Algorithm (ACA), scope of ACO algorithms, Swarm Robotics, Social Adaptation of Knowledge, Particle Swarm Optimization - Case Study: Swarm Intelligence in Bio Inspired Computing Problem.	

Learning Resources	<ol style="list-style-type: none"> 1. "Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/CRC, Taylor and Francis Group, 2007. 2. Floreano D. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories, Methods and Technologies", MIT Press, Cambridge, MA, 2008. 3. Nature-Inspired Computing and Optimization Theory and Applications, Srikanta Patnaik • Xin-She Yang, Kazumi Nakamatsu, Springer, 2018 4. Albert Y. Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006 4. Marco Dorigo, Thomas Stutzle, "Ant Colony Optimization", PHI, 2005. 5. Nature-Inspired Computing Concepts, Methodologies, Tools, and Applications, IGI Global, 2016
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Jothi Basu Kamaraj, jothibasukamaraj@gmail.com	1. Dr.D.Paulraj, Professor, RMKCET, kingrajapaul@gmail.com	1. Dr.B.Hariharan, SRMIST
2. Mr.Sankara Mukunthan sankaramukunthan@gmail.com	2. Dr.S.Kaliraj, Assistant Professor, MAHE, kaliraj.se@gmail.com	

Course Code	21CSE377T	Course Name	INFORMATION RETRIEVAL	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Outline of theoretical basis behind the standard models of Information Retrieval			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Analyze relevance feedback and query expansion processes																	
CLR-3:	Classify text and usage of supervised and unsupervised algorithms																	
CLR-4:	Study Information Retrieval process and Web Retrieval Techniques																	
CLR-5:	Understand content Based Image Retrieval and Deep learning models for Information Retrieval																	

Course Outcomes (CO):		At the end of this course, learners will be able to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CO-1:	Apply the standard retrieval models and comprehend the operations of information processing			2	3	2	-	-	-	-	-	-	-	-	-	-	-	1
CO-2:	Analyze the query expansion mechanism and evaluate the model by applying various metrics			-	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Gain the knowledge on text classification algorithms and apply for the process of feature selection			-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Acquire the concepts of Probabilistic Information Retrieval models and practice mechanisms for web crawling			-	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Gain insight into image retrieval techniques and analyze the deep learning models for information retrieval			-	3	3	-	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Introduction to Information Retrieval	9 Hour
Information Retrieval Process, Indexing, Information retrieval model, Boolean and Vector-Space Retrieval models; Ranked retrieval; Text-similarity metrics; TF-IDF weighting; Dictionary and Postings - Tokenization, stop words, Stemming, Inverted index, Skip pointers, Phrase queries.	
Unit-2 - Query Evaluations and Metrics	9 Hour
Query Expansion - Relevance feedback, Rocchio algorithm, Query Expansion and its types, Query drift; XML Indexing - A vector space model for XML retrieval, Evaluation of XML retrieval, Text-centric vs. Data-centric XML retrieval; Evaluation - Precision, Recall, F-measure, E-measure, Normalized recall, Evaluation problems	
Unit-3 - Text Classification and Clustering	9 Hour
Text Classification and Clustering - Characterization of Text Classification – Unsupervised Algorithms: Clustering – Naïve Text Classification – Supervised Algorithms – Decision Tree – k-NN Classifier – SVM Classifier – Feature Selection or Dimensionality Reduction - Case study using Clustering.	
Unit-4 - Probabilistic and Web-based Retrieval	9 Hour
Probabilistic Information Retrieval - Probabilistic relevance feedback, Probability ranking principle, Binary Independence Model, Bayesian network for text retrieval; Web Retrieval and Web Crawling - Web search basics, crawling, indexes, Link analysis - Web Characteristic, Crawling, Web As a graph, Page Rank, Hubs and Authorities - Case study on Web Retrieval.	
Unit-5 - Image Retrieval Methods	9 Hour
Content Based Image Retrieval - Introduction to content Based Image retrieval, Challenges in Image retrieval, Image representation, Indexing and retrieving images, Relevance feedback.	

Learning Resources	1. C. Manning, P. Raghavan, and H. Schütze, <i>Introduction to Information Retrieval</i> , Cambridge University Press, 2008.	5. ChengXiangZhai, Sean Massung, "Text Data Management and Analysis: A Practical Introduction to Information Retrieval and Text Mining", ACM Books, 2016.
	2. Stefan Buettcher, Charles L. A. Clarke and Gordon V. Cormack, <i>Information Retrieval: Implementing and Evaluating Search Engines</i> , the MIT Press, 2010.	6. Soumen Chakrabarti, <i>Mining the Web Discovering Knowledge from Hypertext Data</i> , Morgan-Kaufmann Publishers, 2002
	3. Tanveer Siddiqui and U. S. Tiwary, <i>Natural Language Processing And Information Retrieval</i> , Oxford Higher Education, 2008	7. David A. Grossman, Ophir Frieder, <i>Information Retrieval: Algorithms and Heuristics</i> , the Information Retrieval Series, 2nd Edition, 2004.
	4. Ricardo Baeza-Yates, Berthier Ribeiro-Neto, "Modern Information Retrieval: The Concepts and Technology Behind Search", Addison Wesley, 2010.	8. Hang Li, <i>Learning to Rank for Information Retrieval and Natural Language Processing</i> , Morgan & Claypool publishers, Second Edition, 2014

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	30%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	30%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ms. Padmapriya Madhivanan, Senior Data Scientist, DXC Technologies	1. Dr.P.Shanthi Bala, CS, Pondicherry University, Puducherry	1. Dr. M Vimaladevi, SRMIST

Course Code	21CSE396T	Course Name	DESIGN PRINCIPLES OF SMART SPACE MANAGEMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
				1	2	3	4	5	6	7	8	9	10	11	12			
CLR-1:	Understand Space fundamentals and IoT Architecture	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-2:	Learn different Protocols for IoT Design																	
CLR-3:	Familiarize the Concepts of smart space design																	
CLR-4:	Build IoT with Raspberry Pi and Arduino for smart space																	
CLR-5:	understand the role of psychology in space making and applying IoT in space design																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Distinguish IoT applications in different domains	3	2	2	-	-	-	-	-	-	-	-	-	1	-	-		
CO-2:	Apply various protocols for design of IoT systems	3	2	2	-	-	-	-	-	-	-	-	-	1	2	-		
CO-3:	Illustrate the techniques for smart spaces	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-		
CO-4:	Deploy an IoT application using Raspberry Pi/Arduino	3	2	2	-	-	-	-	-	-	-	-	-	1	2	3		
CO-5:	Analyze applications of IoT in Real time scenario	3	2	2	-	-	-	-	-	-	-	-	-	1	2	3		

Course Outcomes (CO):		At the end of this course, learners will be able to:														Engin	Probl	Design solution	Conduct of complex	Modern	The e society	Environ	Sustai	Ethics	Indivi	Comm	Projec	Life L	PSO-1	PSO-2	PSO-3
CO-1:	Distinguish IoT applications in different domains	3	2	2	-	-	-	-	-	-	-	-	-	-	-	1	-	-													
CO-2:	Apply various protocols for design of IoT systems	3	2	2	-	-	-	-	-	-	-	-	-	-	-	1	2	-													
CO-3:	Illustrate the techniques for smart spaces	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-													
CO-4:	Deploy an IoT application using Raspberry Pi/Arduino	3	2	2	-	-	-	-	-	-	-	-	-	-	-	1	2	3													
CO-5:	Analyze applications of IoT in Real time scenario	3	2	2	-	-	-	-	-	-	-	-	-	-	-	1	2	3													

Unit-1 - Introduction to Space Design and IoT	9 Hour
Introduction to spatial design, Characteristics of space design aspects, Spatial Requirements, User & function, Standards & Requirements in spatial Design, Introduction to Internet of Things - Characteristics of IoT, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures – The oneM2M IoT Standardized Architecture, The IoT World Forum (IoTWF) Standardized Architecture, A Simplified IoT Architecture, The Core IOT Functional Stack, IoT Data Management and Compute Stack Hierarchy of Edge, Fog and Cloud, Smart Objects: Things in IOT, Sensors, Actuators, Micro-Electro- Mechanical Systems (MEMS) and Smart objects, Sensor Networks, Wireless Sensor Networks (WSNs)	
Unit-2 - IoT Protocols	9 Hour
Protocol Standardization for IoT, M2M and WSN Protocols, SCADA and RFID Protocols, Unified Data Standards, WPAN Technologies for IoT, Protocols – IEEE 802.15.4, Zigbee Architecture, Wireless HART, Near-field communication (NFC), Z-Wave, Bluetooth Low Energy (BLE), BACnet, Modbus IP Based Protocols for IoT, Network layer – 6LoWPAN, CoAP, Edge connectivity and protocols, Cloud Platforms for IOT	
Unit-3 - Smart Space Design	9 Hour
Introduction to smart spaces, Need and Significance of smart space, Example projects for smart space, Presentation, Factors considered for smart space design, Need User profile, Factors considered for smart space design Activity Efficiency required, Application of smart concepts in space Lighting, Application of smart concepts in space Automation Signage, Exercise and Discussion (essential factors and applications)	
Unit-4 - IoT Development Boards	9 Hour
IoT Development Boards: Arduino IDE and Board Types, Building IOT with Raspberry Pi, IoT Systems - Logical Design using Python, IoT Physical Devices & Endpoints, IoT Device -Building blocks - Raspberry Pi – Board-,Linux on Raspberry Pi, Raspberry Pi Interfaces, Programming Raspberry Pi with Python, Other IoT Platforms – Arduino, Interfacing Relay Driver with Arduino Uno, Programming Logic to Control Electrical Devices via Bluetooth using Arduino, Control Electrical Devices via Bluetooth Communication, Check Electrical Device status over Internet, Implementation of Home Automation using Arduino.	
Unit-5 - Psychology and Future Trends	9 Hour
Role of user experience in spatial design, Introduction to Psychology in space making – smart spaces, Impact of Psychology in space making – IQ, Impact of Psychology in space making – EQ, Impact of Psychology in space making – SQ, Applications in smart spatial Design, Examples for Current research and Future trends in smart spatial design, Case Study: Smart Home Automation, Case Study: Smart Lighting.	

Learning Resources	<ol style="list-style-type: none"> David Hanes, Gonzalo Salgueiro, Rob Barton, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press, 2017 Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach, Universities Press, 2015 Hakima Chaouchi, — "The Internet of Things Connecting Objects to the Web" ISBN : 978-1- 84821-140-7, Wiley Publications Olivier Hersent, David Boswarthick, and Omar Elloumi, — "The Internet of Things: Key Applications and Protocols", Wiley Publications Juan Carlos Augusto, Chris D Nugent, "Designing Smart Homes", Springer 	<ol style="list-style-type: none"> Tom Hargreaves, Charlie Wilson, "Smart Homes and their users", Springer Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things, Springer, 2011. https://in.pcmag.com/simplisafe-home-security-system/129484/how-to-set-up-your-smart-home-a-beginners-guide https://www.homebuilding.co.uk/advice/how-to-design-a-smart-home https://www.archdaily.com/936027/psychology-of-space-how-interiors-impact-our-behavior https://sushantuniversity.edu.in/blog/do-you-know-how-psychology-of-space-is-impacting-interior-designing/ https://www.ylighting.com/blog/smart-home-lighting-guide/
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ar.Apsaran Raja, Kaalo, NID, Chennai	1. Prof. Premkumar, NIT Trichy	1. Dr.R.Annie Uthra, SRMISTL
		2. Dr.M.Ferni Ukrit, SRMIST
		3. Mrs.Sri Vallaba, Architecture and Interior Design, SRMIST
		4. Dr.A.Alice Nithya, SRMIST

Course Code	21CSE397T	Course Name	PHILOSOPHY OF COGNITIVE SCIENCE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the fundamentals of cognitive Science and Computing	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Identify the role of brain simulation in the area of cognitive system															
CLR-3:	Comprehend the relationship between Machine learning algorithms and cognitive systems and the different types of Knowledge representation.															
CLR-4:	Apply the techniques of advanced analytics to cognitive computing and cloud															
CLR-5:	Create a cognitive application and analyse their implementation in various sectors															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the basic concept and building blocks of cognitive Science	-	1	-	2	-	-	-	-	-	-	-	-	1	-	2
CO-2:	Apply the base concept of Brain simulation in cognitive computing.	-	2	-	2	-	-	-	-	-	-	-	-	1	-	2
CO-3:	Develop the relationship between Machine learning and cognitive systems	-	3	-	2	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Experiment with the various advanced analytics to cognitive computing.	-	2	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Build a cognitive application and their deployment in various domains.	-	2	-	3	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to Cognitive Science	9 Hour
Introduction –Philosophy of cognitive science- Interdisciplinary Nature of Cognitive Science and Cognitive Computing Systems-Representations for information and knowledge - Principal technology enablers of cognitive computing- Cognitive Computing Architectures and Approaches	
Unit-2 - Analytics on Neuroscience	9 Hour
Brain scalability - Neocortical Brain Organisation- Concept of a basic circuit- Hardware support for brain simulation- Visual Analytics as an approach to cognitive computing- time evolving graphs- Description of Cygraph	
Unit-3 - Role of Machine Learning in Cognitive science	9 Hour
Types of Learning - Machine Learning Algorithms- Supervised Learning -Unsupervised Learning -Predictive Analytics -Business Value of Predictive Analytics -Text Analytics -Business Value of Text Analytics-Image and Speech Analysis Cognitive analytics applications- Random Forest Classifiers- STE-M Model - Cognitive random forest- Cognitive computing system.	
Unit-4 - Advanced Analytics	9 Hour
Applying Advanced Analytics to Cognitive Computing -Advanced Analytics Is on a Path to Cognitive Computing -Key Capabilities in Advanced Analytics -The Relationship Between Statistics, Data Mining, and Machine Learning –Using Machine Learning in the Analytics Process – Role of Cloud Computing in Cognitive science- Case study: Role of Cognitive science in human behaviour analysis, Monitoring the facial expression of down syndrome patient	

Unit-5 - Application and Case studies.	9 Hour
The Process of Building a Cognitive Application -The Emerging Cognitive Platform -Defining the Objective -Defining the Domain -Understanding the Intended Users and Defining their Attributes -Defining Questions and Exploring Insights - Typical Question-Answer pairs -Anticipatory Analytics -Acquiring the Relevant Data Sources -The Importance of Leveraging Structured Data Sources the Business Implications of Cognitive Computing. Case study: Recording the data in healthcare concierge, detection of anomaly in cerebral palsy	

Learning Resources	1. Vijay V Raghavan, Venkat N. Gudivada, Venu Govindaraju, C.R. Rao, Cognitive Computing: Theory and 2. Applications: (Unit 1, 2, 3) 3. V. Judith Hurwitz, Marcia Kaufman, Adrian Bowles, Cognitive Computing and Big Data Analytics, Wiley 4. Publications, 2015 Volume 35 (Handbook of Statistics), chapter 5, 2016 (Unit 4, 5)	5. Computational Intelligence for Big Data Analysis Frontier Advances and Applications, D.P. Acharjya 6. Satchidananda Dehuri, Sugata Sanyal 7. Cognitive Computing for Human-Robot Interaction: Principles and Practices, Mamta Mittal, Sudipta 8. Roy, Rajiv Ratn Shah.
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. K. Selvanayagam, Practise Lead CPQ, Salesforce, Preldesys India Pvt Ltd	1. Dr. Mariammal, Anna University	1. Dr.M. Maheswari, SRMIST

Course Code	21CSE398T	Course Name	LOGIC AND KNOWLEDGE REPRESENTATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Gain knowledge on propositional logic and first order logic	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Understand the concept of description logic and reasoning methods	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Know about uncertainty, probability notations and non-monotonic reasoning																	
CLR-4:	Gain knowledge on qualitative modeling representations																	
CLR-5:	Understand and construct Bayesian Networks and apply inference techniques.																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Understand and illustrate propositional and First order logic representations	-	2	-	2	-	-	-	-	-	-	-	-	1	-	-		
CO-2:	Understand inference in FOL and description logic representations	-	1	-	3	-	-	-	-	-	-	-	-	2	-	-		
CO-3:	Apply Bayes rule in uncertainty and understand non-monotonic reasoning methods	-	2	-	2	-	-	-	-	-	-	-	-	-	-	2		
CO-4:	Illustrate qualitative modeling representation techniques	-	2	-	2	-	-	-	-	-	-	-	-	-	-	2		
CO-5:	Construct Bayesian network and apply its inference methods	-	2	-	3	-	-	-	-	-	-	-	-	-	-	3		

Course Outcomes (CO):		At the end of this course, learners will be able to:	
CO-1:	Understand and illustrate propositional and First order logic representations		
CO-2:	Understand inference in FOL and description logic representations		
CO-3:	Apply Bayes rule in uncertainty and understand non-monotonic reasoning methods		
CO-4:	Illustrate qualitative modeling representation techniques		
CO-5:	Construct Bayesian network and apply its inference methods		

Unit-1 - Introduction to Knowledge and Logic	9 Hour
Knowledge Representation terminologies: syntax –Semantics, Representation languages, Inference validity and satisfiability, Inference in Computers, Logics, Fuzzy logic Propositional Logic: syntax, semantics, validity and inference, Rules of inference for propositional logic, An agent for the Wumpus world, First order Logic: syntax and semantics, Extensions and Notational variations, Logical agent for Wumpus world	
Unit-2 - Procedural Control of Reasoning	9 Hour
Inference in FOL: inference rules involving quantifiers forward and backward chaining, Resolution, Description Logics, Introduction A basic DL and its Extensions, Relationships with other Formalisms, Tableau Based Reasoning Techniques, The Automata Based Approach, Structural Approaches.	
Unit-3 - Uncertainty	9 Hour
Uncertainty: Handling uncertain knowledge basic probability notation, Conditional probability, The axioms of probability, The joint probability distribution, Bayes' rule and its use Applying Bayes' rule. Nonmonotonic Reasoning Introduction, Default Logic, Auto epistemic Logic, Circumscription, Nonmonotonic Inference Relations, Semantic Specification of Inference Relations, Default Conditionals, Relating Default and Auto epistemic Logics, Case study: Relating Default Logic and Circumscription	
Unit-4 - Qualitative Modeling	9 Hour
Qualitative Modelling, introduction Qualitative Mathematics, Ontology, Component Ontologies, Process Ontologies, Field Ontology, Causality, Compositional Modelling, Qualitative Spatial Reasoning, Topological Representations, Shape, Location, and Orientation Representations, Diagrammatic Reasoning, Qualitative Modelling Applications, Automating or Assisting Professional Reasoning, Education, Cognitive Modelling	
Unit-5 - Bayesian Networks	9 Hour
Bayesian Networks: Introduction Syntax and Semantics of Bayesian Networks Exact Inference, Inference with Local (Parametric) Structure, Solving MAP and MPE by Search, Compiling Bayesian Networks, Inference by Reduction to Logic, Approximate Inference: Inference by Stochastic Sampling, Inference as Optimization, Constructing Bayesian Networks: Knowledge Engineering, High-Level Specifications, Learning Bayesian Networks, Case study: Knowledge representation and Question Answering	

Learning Resources	1. S. Russell and P. Norvig. <i>Artificial Intelligence</i> 2nd ed. Prentice Hall, 2002.	3. Boolos, G. S., Burgess, J. P., Jeffrey, R. C. <i>Computability, and logic.</i> – Cambridge university press, 2002.
	2. <i>Handbook of Knowledge Representation.</i> Frank van Harmelen, Vladimir Lifschitz and Bruce Porter (Eds). <i>Foundations of Artificial Intelligence</i> , 2008.	4. <i>An Introduction to Description Logic.</i> Franz Baader, Ian Horrocks, Carsten Lutz, Uli Sattler

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Kaniitha Anand, CTS	1. Dr.A. Padmavathy, Amrita University Chennai Campus	1. Dr.A. Maheswari, SRMIST

Course Code	21CSE411T	Course Name	ARTIFICIAL INTELLIGENCE IN GENOMICS AND DISEASE PREDICTION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Generate knowledge about biological macromolecules and bioinformatics	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Provide knowledge on bioinformatics terms and file formats	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	Create an interest about integrating artificial intelligence and genomics																											
CLR-4:	Initiate interest on the role of artificial intelligence cancer diagnosis																											
CLR-5:	Understand the applications of artificial intelligence in proteomics and drug discovery																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Illustrate knowledge about biological macromolecules and bioinformatics	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-												
CO-2:	Discuss about different file formats, NGS pipelines and tools	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-												
CO-3:	Outline the concepts of artificial intelligence in genomics and pandemic predictions	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-												
CO-4:	Demonstrate applicability of AI in cancer forecasting and diagnosis	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3												
CO-5:	Develop an approach in artificial intelligence for proteomics and drug discovery	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-												

Unit-1 – Introduction to Molecular Biology	9 Hour
Overview of Central Dogma of Molecular Biology - Post Transcriptional & Post Translational Modifications; Classification of Nucleic Acid Bases and Amino Acids; Genomics, Transcriptomics and Proteomics; Mutation and its types; Evolution of Sequencing methods – first, next and third generation – differences; Sequence Data and Quality	
Unit-2 – File Formats and NGS Pipelines	9 Hour
Evolution of Bioinformatics – Sequence alignment – Indels – Homology, Identity, Similarity, Orthology, Paralogy&Xenology; Similarity Search Tools and its types; NCBI – Genbank; Unitprot – Swissprot; KEGG; File formats – Fasta, Fastq, CSFasta; Mutalyzer and HGVS Python Pacakge - Transvar	
Unit-3 – AI Genomics and Pandemic Prediction	9 Hour
Numpy, Pandas, Supervised learning algorithms, Random Forest, KNN, SVM, ANN, Clustering in bioinformatics, Supervised learning methods in analyzing transcriptomics data, AI and ML methods to the investigation of Pandemics, Case study :Forecasting of pandemic using LSTM and in infectious disease diagnostics	
Unit-4 – AI in Cancer Forecasting and Diagnosis	9 Hour
AI, ML and DL in cancer – determining cancer susceptibility, enhanced cancer diagnosis and staging, treatment response, recurrence and survival and personalized cancer pharmacotherapy, Random Forest classification for breast cancer, ML approach to diagnose cancer at early stage.	
Unit-5 – AI in Proteomics and Drug Discovery	9 Hour
AI in proteomics, AI in proteomics data integration, Scope of AI in drug discovery, Molecular modeling and databases in AI for drug molecules, computational mechanics ML methods in molecular modeling, Drug characterization using isopotential surfaces, Case study :Drug design for neuroreceptors using ANN techniques	

Learning Resources	<ol style="list-style-type: none"> 1. Krane, D. E., Raymer, M. L. "Fundamental Concepts of Bioinformatics", Benjamin Cummings, (2003). 2. Federico Divina, Francisco A. Gómez Vela, Miguel García-Torres. "Computational Methods for the Analysis of Genomic Data and Biological Processes", MDPI (AG) (2021). 3. Attwood.T.K. Parry-Smith D.J., "Introduction to Bioinformatics", 1st Edition, 11th Reprint, Pearson Education. 2005. 4. Adam Bohr and Kaveh Memarzadeh. Artificial Intelligence in Healthcare. 1st Edition. Academic publishers. Elsevier Science. 2020 5. Christophe Lambert, Darrol Baker, George P. Patrinos. "Human Genome Informatics - Translating Genes into Health", Elsevier Science, (2018). 6. Smith KP, Kirby JE. Image analysis and artificial intelligence in infectious disease diagnostics. Clin Microbiol Infect. 2020 Oct; 26(10):1318-1323. doi: 10.1016/j.cmi.2020.03.012. 7. Mann M, Kumar C, Zeng WF, Strauss MT. Artificial intelligence for proteomics and biomarker discovery. Cell Syst. 2021 Aug 18; 12(8):759-770. doi: 10.1016/j.cels.2021.06.006.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	25%	-	25%	-	25%	-
Level 4	Analyze	25%	-	25%	-	25%	-
Level 5	Evaluate	10%	-	10%	-	10%	-
Level 6	Create	-	-	-	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.C.Ramakrishnan, Principal Scientist, Molecular Design Division Aroniter Co., Seoul, South Korea ramakrishnan@aroniter.co	1. Dr Shandar Ahamad, Professor, Jawaharlal Nehru University,shandar@jnu.ac.in	1. Dr.Habeeb. S. K. M, SRMIST
2. Mr. Sudheendra Rao, Director, DataLore Labs, Bengaluru sudheendra@datalore.ai	2. Dr. Balachandran Manavalan, Research Professor, Department of Physiology, Ajou University School of Medicine, World Cup-ro, Yeongtong-gu, Suwon,	2. Dr.ThirumurthyMadhavan, SRMIST
		3. Dr.G.Maragatham, SRMIST

21CSE412T	Course	MACHINE LEARNING IN DRUG DISCOVERY	Course	E	PROFESSIONAL ELECTIVE	L	T	P	C
-----------	---------------	------------------------------------	---------------	---	-----------------------	---	---	---	---

Course Code		Name		Category		3	0	0	3
-------------	--	------	--	----------	--	---	---	---	---

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Generate knowledge about macromolecules and their structural importance	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Acquire the basis of small molecule descriptor calculations and their algorithms	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Provide the knowledge about drug discovery process																	
CLR-4:	Manipulate data using Python																	
CLR-5:	Understand various ML algorithms and their application in biological dataset																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Recall knowledge about macromolecules and their structural importance	2	2	-	-	-	-	-	-	-	-	-	-	-	-	2		
CO-2:	Apply knowledge on developing various models	2	2	-	-	-	-	-	-	-	-	-	-	-	-	2		
CO-3:	Discuss knowledge about drug discovery pipeline	2	2	3	-	-	-	-	-	-	-	-	-	-	-	-		
CO-4:	Learn how to use Scikit-learn to apply powerful machine learning algorithms	3	-	2	-	-	-	-	-	-	-	-	-	-	-	3		
CO-5:	Apply knowledge on ML models and learn best practices for drug discovery dataset	3	-	2	-	-	-	-	-	-	-	-	-	-	-	-		

Unit-1 - Macromolecules and Their Structural Importance	9 Hour
Central Dogma of molecular Biology, Structure of DNA, RNA, Amino acids, Classes of Proteins, Protein architecture, Structure stabilizing interactions, Protein folding problem, Solving protein structures, Mechanisms of enzyme actions	
Unit-2 - Computer Representation for Developing 2D and 3D Models	9 Hour
Computer representation of 2D chemical structures, Graph theory to represent Chemical Structures, Connection table, Computer representation of 3D chemical structures, biological databases	
Unit-3 – Drug Discovery Pipeline	9 Hour
Sequence analysis, Methods of sequence analysis, Introduction to drug discovery process and computational approaches, “Drug-Likeness” and Compound Filters, ligand and Structure based drug design, Virtual screening, Protein–Ligand Docking	
Unit-4 - Scikit-Learn for Machine Learning Analysis	9 Hour
Basics of Python for ML data analysis, String function for nucleic acid sequence, Numpy, and Pandas, basic graph theory	
Unit-5 – Knowledge of ML Models for Drug Discovery	9 Hour
Machine learning pathway overview, Types of Machine learning algorithms, Cross validation: Test and Training split, Introduction to Biological Dataset construction, case studies of drug molecules benchmarking datasets and ML model generation	

Learning Resources	1. Attwood.T.K. Parry-Smith D.J., "Introduction to Bioinformatics", 1st Edition, 11th Reprint, Pearson Education. 2005. 2. Murthy.C.S.V. "Bioinformatics", 1st Edition, Himalaya Publishing House.2003. 3. Rastogi.S.C. Namita., M., Parag, R., "Bioinformatics- Concepts, Skills, and Applications", CBS Publishing. 2009.	4. Online Sources: https://wiki.python.org/moin/BeginnersGuide/Programmers . 5. Mount D., "Bioinformatics: Sequence and Genome Analysis", 2 nd Edition, Cold Spring Harbor Laboratory Press, New York. 2004.
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	10%	-
Level 2	Understand	25%	-	20%	-	20%	-
Level 3	Apply	30%	-	35%	-	35%	-
Level 4	Analyze	30%	-	35%	-	35%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.C.Ramakrishnan, Principal Scientist, Molecular Design Division Aroniter Co., Seoul, South Korea ramakrishnan@arontier.co	1. Dr Shandar Ahamad, Professor, Jawaharlal Nehru University, shandar@jnu.ac.in	1. Dr.ThirumurthyMadhavan, SRMIST
2. Mr. Sudheendra Rao, Director, DataLore Labs, Bengaluru	2. Dr. Balachandran Manavalan, Research Professor, Department of Physiology, Ajou University School of Medicine, Yeongtong-gu, Suwon, South Korea	2. Dr. Habeeb. S. K. M, SRMIST
		3. Dr.G.Maragatham G, SRMIST

Course Code	21CSE414T	Course Name	IOT CONCEPTS AND APPLICATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Introduce the concept of Basics of IoT and different devices and architecture of IoT Technology.	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Outline the State of the Art – Data Management and IoT Component Explanation.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Acquire the knowledge of Data Link Layer and Network Layer protocols.																	
CLR-4:	Learn the IoT Reference Architecture, Transport, Session, and Service Layer Protocols																	
CLR-5:	Exploit the various IoT Security attacks and Applications																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Interpret the vision of IoT architecture from a global context.	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-		
CO-2:	Articulate the state-of-the-art Data management and IoT component.	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-		
CO-3:	Compare and Contrast the use of data link and Network layer protocols in different applications.	1	2	-	-	-	-	-	-	-	-	-	-	1	-	-		
CO-4:	Implement using the available IoT Transport, Session, and Service Layer Protocols to different applications.	1	1	1	-	-	-	-	-	-	-	-	-	-	-	2		
CO-5:	Apply the IOT Security Techniques to avoid several attacks in relevant areas of IoT Product development	2	3	3	-	-	-	-	-	-	-	-	1	-	-	3		

Course Outcomes (CO):		At the end of this course, learners will be able to:		1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CO-1:	Interpret the vision of IoT architecture from a global context.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Articulate the state-of-the-art Data management and IoT component.	1	2	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Compare and Contrast the use of data link and Network layer protocols in different applications.	1	2	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Implement using the available IoT Transport, Session, and Service Layer Protocols to different applications.	1	1	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Apply the IOT Security Techniques to avoid several attacks in relevant areas of IoT Product development	2	3	3	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - IoT Fundamentals and Architecture Overviews	9 Hour
IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, State of the art-ETSI M2M, IoT Reference model-IoT Domain model, Communication Model.	
Unit-2 - Data Management Introduction and IoT Components	9 Hour
Managing M2M data: Data generation, Data acquisition, Data validation, Data storage, Data processing, Data remanence, Data analysis, Business Process in IOT, M2M and IoT Analytics, Basics of Sensors and Actuators,, Introduction to Arduino and its applications ,Sensor Interfacing Using Tinker CAD, Interfacing Sensor with Raspberry Pi 4.	
Unit-3 - IoT Data Link Layer & Network Layer Protocols	9 Hour
PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH, DHCP (Dynamic Host Configuration Protocol), ICMP(Internet Control Message Protocol), RPL(Routing Protocol for Low-Power and Lossy Networks), CORPL(Cognitive RPL), CARP(Common Address Redundancy Protocol).	
Unit-4 - Transport, Session, and Service Layer Protocols	9 Hour
Transport Layer (TCP, MPTCP (Multipath TCP), UDP, DCCP(Datagram Congestion Control Protocol), SCTP(Stream Control Transmission Protocol)) -(TLS, DTLS) – Session Layer-HTTP, CoAP(Constrained Application Protocol), XMPP(Extensible Messaging Presence Protocol), AMQP(Advanced Message Queuing Protocol), MQTT(Message Queuing Telemetry Transport.), Service Layer -oneM2M(Machine to Machine), ETSI M2M, OMA(Open Mobile Alliance), BBF. Real-Time Case Studies: Smart Travel Applications, Smart Home using Drones	
Unit-5 - IoT Security Attacks and Applications	9 Hour
Understanding Security and Interoperability, Modes of attack: Web Crawl, Search Features and Wild Cards, Breaking Cipher Tools for achieving Security: VPN, X.509, Authentication, Tools for achieving Security: User names and Passwords, Message Brokers, Real-Time Case Studies: Disaster Prevention, Smart Agriculture.	

Learning Resources	<ol style="list-style-type: none"> 1. "IoT Fundamentals: Definitions, Architectures, Challenges, and Promises", by Farshad Firouzi, Bahar Farahani, Markus Weinberger, and Fereidoon Shams Aliee. DOI: 10.1007/978-3-030-30367-9_1, January 2020. 2. Uckelmann, D., Harrison, M., & Michahelles, F. (Eds.). Architecting the Internet of Things. doi:10.1007/978-3-642-19157-2, 2011. 3. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things by Rob Barton, Gonzalo Salgueiro, David Hanes, Publisher: Cisco Press, Release Date: June 2017, ISBN: 9780134307091 (https://www.oreilly.com/library/view/iot-fundamentals-networking/9780134307091/). 4. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Karmouskos, David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014 5. Peter Waher, "Learning Internet of Things", PACKT publishing, BIRMINGHAM – MUMBAI 6. Daniel Minoli: Building the Internet of Things with IPV6 and MIPV6 evolving World of M2M Communication", ISBN 978-1-118-47347-4 Willy Publications. WebSite Reference: <ol style="list-style-type: none"> 1) https://onlinecourses.nptel.ac.in/noc22_cs53/preview 2) https://www.coursera.org/specializations/uiuc-iot 3) https://www.mygreatlearning.com/academy/learn-for-free/courses/what-is-iot 4) https://www.edx.org/learn/iot-internet-of-things
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	25%	-	25%	-
Level 3	Apply	15%	-	30%	-	30%	-
Level 4	Analyze	15%	-	25%	-	25%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Vinay Solanki, Head IoT, Lenovo (APAC & MEA)	1. Dr. Zayaraj, Professor / CSE, PEC, Pondicherry	1. Dr. S. Amudha, SRMIST
2. Dr. Paventhan Arumugum, Director (R&D), ERNET India	2. Dr. Vijalakshmi Associate Professor / CSE, PEC, Pondicherry	2. Dr. Kayalvizhi Jayavel, SRMIST
3. Shiv Kumar Ganesh, Full Stack Developer, Altimetrik	3. Dr. P. Yogesh, Professor/IT, Anna University, Chennai.	3. Dr. S. Babu, SRMIST

Course Code	21CSE415T	Course Name	FUZZY LOGIC AND ITS APPLICATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:		CLR-2:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Outline the ideas of fuzzy sets, fuzzification and defuzzification.	CLR-2:	Explain fuzzy logic and fuzzy systems with examples	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	Introduce decision making with fuzzy information	CLR-4:	Gain knowledge on fuzzy classification and pattern recognition															
CLR-5:	Design and implement fuzzy control systems and industrial applications																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Gain knowledge on Fuzzy sets to recognize the appropriateness of computational task	CO-2:	Learn the foundations of fuzzy logic and methods for fuzzy systems	3	2	2	-	-	-	-	-	-	-	-	-	1	-	-
CO-3:	Understand rule-based inference and decision making with fuzzy information	CO-4:	Acquire and apply fuzzy classification and recognition methods	3	2	3	-	-	-	-	-	-	-	-	-	1	-	-
CO-5:	Apply and Design fuzzy control systems with example applications			3	2	3	-	-	-	-	-	-	-	-	-	2	-	-

Unit-1 - Introduction	9 Hour
The Case for Imprecision, The Utility of Fuzzy Systems, Limitations of Fuzzy Systems, Uncertainty and Information, Fuzzy Sets and Membership, Chance versus Fuzziness - Fuzzy Sets: Fuzzy Set Operations, Properties of Fuzzy Sets, Noninteractive Fuzzy Sets, Alternative Fuzzy Set Operations - Fuzzy Relations: Crisp Relations, Fuzzy Relations, Fuzzy Tolerance and Equivalence Relations, Value Assignments, Problems on fuzzy relation - Membership function – various forms –fuzzification – defuzzification to crisp sets.	
Unit-2 - Logic and Fuzzy Systems	9 Hour
classical logic, fuzzy logic, fuzzy systems – Development of Membership functions: membership value assignments, intuition, Inference, rank ordering – Automated Methods for Fuzzy Systems: Definitions, Batch Least Squares Algorithm, Recursive Least Squares Algorithm, Gradient Method, Learning From Example, Modified Learning From Example, Problems on logic and fuzzy systems	
Unit-3 - Rule-Base Reduction Methods	9 Hour
: Fuzzy Systems Theory and Rule Reduction, Singular Value Decomposition, Combs Method, SVD and Combs Method Examples, problems on SVD and Combs method for rapid inference - Decision Making with Fuzzy Information: Fuzzy Synthetic Evaluation, Fuzzy Ordering, Nontransitive Ranking, Preference and Consensus, Multiobjective Decision Making, Decision Making under Fuzzy States and Fuzzy Actions, problems on decision making with fuzzy information.	
Unit-4 - Fuzzy Classification and Pattern Recognition	9 Hour
Classification by Equivalence Relations, Cluster Analysis, Cluster Validity, c-Means Clustering, Fuzzy c-Means, Classification Metric, Similarity Relations from Clustering - Pattern Recognition: Feature Analysis, Partitions of the Feature Space, Single-Sample Identification, Multifeature Pattern Recognition, problems on fuzzy classification and pattern recognition, Case Study: Hand written character recognition using fuzzy logic.	
Unit-5 - Fuzzy Control Systems	9 Hour
Control System Design Problem, Control (Decision) Surface, Assumptions in a Fuzzy Control System Design, Simple Fuzzy Logic Controllers, Examples of Fuzzy Control System Design, Aircraft Landing Control Problem - Fuzzy Optimization - Fuzzy Linear Regression – problems on fuzzy optimization and regression, Case study: Robot Navigation using fuzzy logic.	

Learning Resources	1. Ross, T. J., "Fuzzy logic with engineering applications," John Wiley & Sons, Second Edition, 2017 2. H.-J. Zimmermann, "Fuzzy Set Theory and Its Applications", 4 th edition, Springer Science+Business Media, LLC, 2001 3. J.-S. R. Jang, C.-T. Sun, and E. Mizutani, "Neuro-Fuzzy and Soft Computing" Prentice Hall, 1997.	4. Klir, G. Yuan B.B. Fuzzy sets and Fuzzy Logic Prentice Hall of India private limited, 1997 5. https://ieeexplore.ieee.org/document/519069/ 6. https://www.academia.edu/2073261/A_case_study_of_fuzzy_logic_based_robot_navigation
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	30%	-	20%	-	20%	-
Level 3	Apply	50%	-	50%	-	50%	-
Level 4	Analyze	-	-	10%	-	10%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.A.Vasanthi, Senior Consultant, Slalom · Sydney, New South Wales, Australia	1. Dr.A.Punitha, Associate Professor, Annamalai University	1. Mr.S.Joseph James, SRMIST

Course Code	21CSE416T	Course Name	ROBOTICS: COMPUTATIONAL MOTION PLANNING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	understand the concepts of motion planning			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Able to study the potential functions and navigations																	
CLR-3:	Acquire knowledge of different Algorithms																	
CLR-4:	Discuss the localization and mapping methods.																	
CLR-5:	Gain knowledge about Trajectory and motion planning																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Discuss the methods of motion planning			2	3	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Apply knowledge of Potential functions and Navigations			2	3	1	-	-	-	-	-	-	-	-	-	1	-	2
CO-3:	Implement the Sampling Algorithms			2	3	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Gain knowledge of mapping and path planning			2	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Design and deploy trajectory and motion planning			3	3	2	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Motion Planning	9 Hour
Overview of Motion Planning –introduction to basic concepts and methods for motion planning – Simultaneous Localization and Mapping (SLAM) - GPS based obstacle avoidance – path finding - A* Algorithm - Bug Algorithms -Bug1 and Bug 2 - Tangent Bug - Implementation: The Tangent Line - Distance On Gradient - Continuation Method.	
Unit-2 - Potential Function	9 Hour
Additive Attractive/Repulsive Potential - Gradient Descent - Computing Distance from Implementation In The Plane - Local Minima Problem - Wave-Front Planner - Navigation Potential Function: Sphere world, from sphere to stars and beyond - Potential Functions for Rigid-Body Robots - Robot path planning using generalized Voroni diagrams.	
Unit-3 - Probabilistic Road Map Path Planning	9 Hour
Sampling Based Algorithms- Basic PRM - Implementation of basic PRM - PRM sampling Strategies - PRM connection Strategies - Single-Query Sampling Based Planners: Expensive Spaces Trees - Rapidly Exploring Random Trees - Connection Strategies and SBL Planner - Integration of Planners Sampling Based Roadmap- Analysis of PRM - Control based Planning - Multiple Robots - Manipulation Planning - Assembly Planning.	
Unit-4 - Filtering and Mapping	9 Hour
Linear Kalman Filtering - Kalman Filter: Example - Bayesian Methods: Localization - Basic Idea Probabilistic Localization - Probabilistic Localization as Recursive Bayesian Filtering - Derivation of Probabilistic Localization - Representation Of Posterior - Sensor Model - Mapping: Mapping with known locations - Bayesian Simultaneous Localization and Mapping. Case study: Vision-based multi-robot simultaneous localization and mapping.	
Unit-5 - Trajectory Planning	9 Hour
Preliminaries - Decoupled Trajectory Planning - Direct Trajectory Planning: Optimal Control - Nonlinear Optimization - Grid-Based Search - Nonholonomic and Underactuated Systems: preliminaries - Control Systems – Controllability - Motion Planning: Optimal Control - Steering Chained -Form Systems Using Sinusoids - Nonlinear Optimization. Case study: Motion planning.	

Learning Resources	1. Howie M. Choset, Seth Hutchinson, Kevin M. Lynch, George Kantor, Wolfram Burgard, Lydia E. Kavraki, Sebastian Thrun, "Principles of Robot Motion: Theory, Algorithms, and Implementation", 2016	3. Rafel Valencia, Juan Andrade-Cetto, "Mapping, Planning and Exploration with Pose SLAM", Springer, 2018
	2. Jean-Claude Latombe, "Robot Motion Planning", Springer Science & Business Media, 2012	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	10%	-	10%	-
Level 2	Understand	15%	-	10%	-	10%	-
Level 3	Apply	35%	-	45%	-	45%	-
Level 4	Analyze	30%	-	35%	-	35%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Rijo Jackson Tom Lead Data Scientist Augusta hitech soft solution	1. Dr. Thiyagarajan R Assistant Professor, Department of Mechanical Engineering, Indian Institute of Technology Tirupati	1. Dr. J. J. Jayakanth, SRMIST

Course Code	21CSE417T	Course Name	REINFORCEMENT LEARNING TECHNIQUES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Introduce the fundamentals of Reinforcement Learning	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Illustrate model-based prediction and control using dynamic programming	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Illustrate model-free prediction and control																
CLR-4:	Introduce planning and learning with tabular methods																
CLR-5:	Explain approximation of a value function																
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	Understand basic concepts of reinforcement learning	3	2	-	2	-	-	-	-	-	-	-	-	-	-	2	
CO-2:	Perform model-based prediction and control using dynamic programming	3	3	-	3	-	-	-	-	-	-	-	-	-	-	2	
CO-3:	Apply model-free prediction and control	3	3	-	3	-	-	-	-	-	-	-	-	-	-	3	
CO-4:	Comprehend the use of tabular methods	3	3	-	3	-	-	-	-	-	-	-	-	-	-	3	
CO-5:	Understand how a value function can be approximated	3	3	-	3	-	-	-	-	-	-	-	-	-	-	3	

Unit-1 - Introduction	9 Hour
Introduction to Reinforcement learning, examples - Elements of reinforcement learning - Limitations and Scope- An extended example - multi-armed bandits - k-armed bandit problem - action-value methods - the 10-armed testbed - incremental implementation - tracking a nonstationary problem - optimistic initial values - upper-confidence-bound action selection - associative search (contextual bandits)	
T1: Implementing the 10-armed testbed	
T2: Comparing performance for different ϵ values	
T3: Upper-confidence bound action selection performance comparison with ϵ -greedy	
Unit-2 - Markov Decision Process and Model-Based Prediction and Control	9 Hour
Finite Markov Decision Process - The Agent-Environment Interface - Goals and Rewards - Returns and Episodes - Unified Notation for Episodic and Continuing Tasks - Policies and Value Functions - Optimal Policies and Optimal Value Functions - Optimality and Approximation - Dynamic Programming - Policy Evaluation (Prediction) - Policy Improvement - Policy Iteration - Value Iteration - Generalized Policy Iteration - Efficiency of Dynamic Programming - Asynchronous Dynamic Programming	
T4: MDP for Recycling Robot	
T5: Policies and value functions for Gridworld example	
T6: Policy evaluation for Gridworld example	

Unit-3 - Model-Free Prediction and Control	9 Hour
Model-free learning - Model-free prediction - Monte Carlo methods - Monte Carlo Prediction - Monte Carlo Estimation of Action Values - Temporal-Difference Learning - TD Prediction - Advantages of TD Prediction Methods - Optimality of TD(0) - n-step Bootstrapping - n-step TD Prediction - n-step Sarsa - Model-free control - Monte Carlo Control - Monte Carlo Control without Exploring Starts - Off policy learning - Importance sampling - Off-policy Monte Carlo Control - Sarsa: On-policy TD Control - Q-learning: Off-policy TD control T7: Monte Carlo Policy Evaluation for Blackjack T8: TD Prediction for Driving Home example T9: Sarsa vs Q-learning using Cliff Walking example	
Unit-4 - Planning and Learning with Tabular Methods	9 Hour
Models and planning - Dyna: Integrated Planning, Acting and Learning - When the model is wrong - Prioritized Sweeping - Real-time Dynamic Programming - Monte Carlo Tree Search T10: Simple maze using Dyna-Q T11: Prioritized sweeping on Maze example T12: Real-time Dynamic Programming for Racetrack example	
Unit-5 - Value Function Approximation	9 Hour
On-policy Prediction with Approximation - Value Function Approximation - The Prediction Objective (VE) - Stochastic-gradient and Semi-gradient Methods - Linear Methods - Least-Squares TD T13: State aggregation on the 1000-state Random Walk T14: Bootstrapping on the 1000-state Random Walk T15: Least squares TD example	

Learning Resources	<ol style="list-style-type: none"> 1. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An introduction, 2nd edition, The MIT Press, 2015. 2. Martijn van Otterlo, Marco Wiering, Reinforcement Learning: State-of-the-Art, Springer-Verlag Berlin Heidelberg, 2012. 3. Artificial Intelligence: A Modern Approach, Stuart J. Russell and Peter Norvig, 3rd edition, Pearson, 2015. 4. I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, MIT Press Ltd., 2016. 5. https://deepmind.com/learning-resources/-introduction-reinforcement-learning-david-silver 6. Reinforcement Learning with MATLAB, MathWorks Inc., 2020.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Ghulam Ahmed Ansari, Applied Research Engineer, LinkedIn	1. Dr. Manikantan Srinivasan, , Adjunct Faculty, CSE, IIT Madras	1. Dr. Saad Y. Sait, SRMIST

Course Code	21CSE418T	Course Name	CYBER PHYSICAL SYSTEMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Outline the basic concepts, requirements, principles, and techniques in emerging cyber physical systems	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the components that define the physical and cyber aspects of real-world technologies.															
CLR-3:	Analyze the processing units applicable for cyber physical system.															
CLR-4:	Understand embedded systems vs Internet of Things implementing a cyber-physical system from a computational perspective															
CLR-5:	Acquire knowledge on Security and Privacy in Cyber Physical System															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Acquire the basic concepts and purpose of the different components of Cyber Physical Systems.	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Analyze the new system and ability to interact with Cyber Physical System	1	2	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Illustrate the abstraction of various system architectures and understand the semantics of a CPS model	2	2	-	-	-	-	-	-	-	-	-	-	1	-	2
CO-4:	Implement the ability to interact with cyber-physical systems protocols with Internet of Things	3	3	2	-	-	-	-	-	-	-	-	-	2	-	3
CO-5:	Apply the common methods used to secure cyber-physical systems	3	3	-	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Framework for Cyber-Physical Systems (CPS)	9 Hour
Introduction to CPS- IoT Vs CPS- Concept map- CPS analysis by example- Application Domains-Significance of CPS- Hybrid System Vs. CPS- Multi dynamical system- Component of CPS- Physical- Cyber and Computational Components.	
Unit-2 - Physical Components	9 Hour
Introduction to sensors and actuators – Deployment- assignment and coordination – Network criteria designs- Importance of sensors- causality-sensor reliability-memory requirement- computational complexity- redundant sensors-Operational criteria- Testbed.	
Unit-3 - Cyber Components	9 Hour
Networking technologies for CPS- sensing networks and data connectivity- M2M communication- characteristics of IP and Non-IP solutions, 6LoWPAN, RPL- CoAP and HTTP- CoAP- Mobile cloud computing- Definition and types.	
Unit-4 - Computational Components	9 Hour
Embedded system design flow for CPS- processing units-Overview-ASIC-Processor-DSP, Multimedia processor- VIEW-microcontroller and MPSoC- Reconfigurable logics.	
Unit-5 - Secure Deployment of CPS & Applications of CPS	9 Hour
Secure Task mapping and Partitioning - State estimation for attack detection - Automotive Vehicle ABS hacking - Power Distribution Case study: Attacks on Smart Grids – Virtual Instrumentation; Case study: Applications of CPS.	

Learning Resources	1. A.Platzer, Logical Foundations of Induction.2018	6. Wolf, Marilyn. High-Performance Embedded Computing: Applications in Cyber-Physical Systems and Mobile Computing. Elsevier, 2014.
	2. Principles of Cyber Physical Systems, Rajeev Alur, MIT Press, 2015	7. Guido Dartmann, Houbing song, Anke schmeink, "Big data analytics for Cyber Physical System", Elsevier, 2019
	3. E. A. Lee, Sanjit Seshia , "Introduction to Embedded Systems – A Cyber-Physical Systems Approach", Second Edition, MIT Press, 2017, ISBN: 978-0-262-53381-2	8. Chong Li, Meikang Qiu, "Reinforcement Learning for Cyber Physical Systems with Cyber Securities Case Studies", CRC press, 2019
	4. P.Ashok, G. Krishnamoorthy, and D. Tesar, "Guidelines for managing sensors in cyber physical systems with multiple sensors," J. Sensors, vol.2011, 2011.	9. Christopher Greer, Martin Burns, David Wollman, Edward Griffor "Cyber-Physical Systems and Internet of Things", NIST Special Publication, https://doi.org/10.6028/NIST.SP.1900-202
	5. P.Marwedel, Embedded System Design: Embedded system foundations of Cyber-Physical Systems, vol.16.2010.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	50%	-	20%	-	20%	-
Level 2	Understand	50%	-	30%	-	30%	-
Level 3	Apply	-	-	20%	-	20%	-
Level 4	Analyze	-	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Ponnambalam Mudivai Arun, Director of Products Citrix System, Bangalore	1. Dr. Munesh Pal Singh, IIITDM, Kancheepuram	1. Dr. Krishnaveni, SRMIST
	2. Dr. N.Balaji, SSN College of Engineering	

Course Code	21CSE421T	Course Name	BUSINESS INTELLIGENCE AND ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :	Familiarize with Business Intelligence, Analytics and Decision Support	1	2	3	4	5	6	7	8	9	10	11	12	PO-1	PO-2	PO-3
CLR-2 :	Understand the technologies for Decision making	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3 :	Familiarize with predictive modeling techniques															
CLR-4 :	Familiarize with sentiment analysis techniques															
CLR-5 :	Understand about Decision making systems															

Course Outcomes (CO):	At the end of this course, learners will be able to:	1	2	3	4	5	6	7	8	9	10	11	12	PO-1	PO-2	PO-3
CO-1:	Gain knowledge on Business Intelligence, Analytics and Decision Support	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Understand the technologies for Decision making	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Apply predictive modeling techniques	-	-	-	-	-	-	-	3	-	3	-	-	2	-	-
CO-4:	Apply sentiment analysis techniques	-	-	-	-	-	-	-	3	-	3	-	-	-	-	2
CO-5:	Gain knowledge on Decision making systems	-	-	-	-	-	-	-	3	-	3	-	-	-	1	1

Unit-1 - Introduction: Business Intelligence, Analytics and Decision Support	9 Hour
Information Systems Support for Decision Making - An Early Framework for Computerized Decision Support - The Concept of Decision Support Systems - A Framework for Business Intelligence - Business Analytics Overview - Brief Introduction to Big Data Analytics - Clickstream Analysis – Metrics - Clickstream Analysis - Practical Solutions - Competitive Intelligence Analysis	
T1: Introduction to Power BI and SSMS	
T2: Installing Power BI and SSMS	
T3: Prepare data in Power BI Desktop	
Unit-2 - Decision Making	9 Hour
Decision Making - Introduction and Definitions - Phases of the Decision - Making Process - The Intelligence Phase - Design Phase - Choice Phase - Implementation Phase - Decision Support Systems Capabilities - Decision Support Systems Classification - Decision Support Systems Components	
T4: Load data in Power BI Desktop	
T5: Model data in Power BI Desktop part-1	
T6: Model data in Power BI Desktop part-2	
Unit-3 - Predictive modeling and sentiment analysis	9 Hour
Basic Concepts of Neural Networks - Developing Neural Network - -Based Systems - Illuminating the Black Box of ANN with Sensitivity - Support Vector Machines - A Process Based Approach to the Use of SVM - Nearest Neighbor Method for Prediction -Sentiment Analysis Overview - Sentiment Analysis Applications - Sentiment Analysis Process - Sentiment Analysis - Speech Analytics	
T7: Implement data model using SQL in Power BI	
T8: Create DAX calculations in Power BI Desktop part-1	
T9: Create DAX calculations in Power BI Desktop part-2	

Unit-4 - Multi-criteria Decision making systems	9 Hour
Decision Support Systems modeling - Structure of mathematical models for decision support - Decision making under certainty - Uncertainty and Risk - Decision modeling with spreadsheets - Mathematical programming optimization - Decision analysis introduction - Decision tables - Decision Trees - Multi-criteria decision making - Pairwise comparisons	
T10: Design a report in Power BI Desktop part-1	
T11: Design a report in Power BI Desktop part-2	
T12: Create a Power BI dashboard	
Unit-5 - Automated Decision Systems	9 Hour
Automated Decision Systems - The Artificial Intelligence field - Basic concepts of Expert Systems - Applications of Expert Systems - Structure of Expert Systems - Knowledge Engineering - Development of Expert Systems - Location based Analytics - Cloud Computing - Business Intelligence	
T13: Create a Power BI paginated report	
T14: Perform data analysis in Power BI Desktop	
T15: Enforce Row-level security	

Learning Resources	<ol style="list-style-type: none"> 1. Ramesh Sharda, Dursun Delen, Efraim Turban, J.E.Aronson, Ting-Peng Liang, David King, "Business Intelligence and Analytics: System for Decision Support", 10th Edition, Pearson Global Edition, 2013. 2. Brett Powell, "Mastering Microsoft Power Bi: Expert techniques for effective data analytics and business intelligence", 2018 3. Alberto Ferrari Marco Russo, "Definitive Guide to DAX, The: Business intelligence for Microsoft Power BI, SQL Server Analysis Services, and Excel", Second Edition, By Pearson, 2020
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.V.Selvakumar, Hexaware Technologies, selvakumarv@hexaware.com	1. Dr. T. Veerakumar, Professor, NIT Goa	1. Dr. T. Karthick, SRMIST

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 11C

**(Syllabi for Computer Science and Engineering w/s in
Software Engineering Programme Courses)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC309J	Course Name	SOFTWARE ARCHITECTURE AND DESIGN	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Classify the essential elements of software architecture	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the issues related to architecting a large-scale software system															
CLR-3:	Understand different software architectures views and styles															
CLR-4:	Able to use the four-views approach for developing and documenting a software architectures															
CLR-5:	Understand the implications of different design patterns and critique an architecture of a software system															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe different approaches to design software application	-	-	-	3	2	-	-	-	-	-	-	-	-	-	3
CO-2:	Analyze specifications and identify appropriate design strategies.	2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Develop an appropriate design for a given set of requirements	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-4:	Identify applicable design patterns for the solution	-	3	-	-	3	-	-	-	-	-	-	-	-	-	3
CO-5:	Abstract, document and evaluate reusable design patterns specifications	1	-	-	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to Software Architecture	12 Hour
Software Architecture –Software Design, Importance and Need of Software Architecture, 4 +1 View Model, Activities in Software Architecture, Fundamental design issues, Understanding quality attributes, Six parts of Quality Scenario, Design for quality attributes - Availability, Design for quality attributes - Modifiability, Design for quality attributes – Security, Design for quality attributes - Usability, Testability (General Scenario, Tactics)	
Unit-2 - Software Architecture Patterns	12 Hour
Software Architectural Patterns & Styles, Types of Architectural Styles, Layered pattern, Merits and Demerits of Layered Pattern, Pipe-Filter pattern, Merits and Demerits of Pipe and Filter, Shared Data Pattern, Merits and Demerits of Shared Data Pattern, Client Server pattern, Merits and Demerits of Client Server, Blackboard Architectural Pattern, Merits and Demerits, Flight Simulation: A Case Study in an Architecture for Integrability, Relationship to the Architecture Business Cycle, Requirements and Qualities related to flight simulation, Architectural Solution for flight simulation	
Unit-3 - Software Architecture Analysis	12 Hour
Evaluating a Software Architecture, evaluate Architecture, What Qualities Can We Evaluate an Architecture?, Outputs of an Architecture Evaluation, Evaluating the Architecture – ATAM, Participants and Outputs of ATAM, Phases of ATAM, CASE Study for ATAM, Evaluating the Architecture – CBAM, Decision-Making Context, Basis for the CBAM - Case Study A, Evaluating Software Architecture - SAAM D, SAAM Evaluation Process, Evaluating Software Architecture – ARID, ARID Evaluation Process	
Unit-4 - Design Process	12 Hour
Introduction to Design Process, Design Strategy, Describing the design process the D-Matrix,, Views associated with D-matrix, Design by top-down decomposition, Design by composition, Function-oriented design, Object-oriented design, Aspect Oriented Design, Design Metrics - Need for Metrics, WMC –DIT, NOC – CBC, RFC- LCOM	

Unit-5 - Design Patterns	12 Hour
Introduction to Design Pattern, Component of Design Pattern – Types, Creational Design Pattern - Abstract Factory Pattern, Factory Method, Singleton Pattern, Structural design Pattern – Types, Adaptor pattern, Decorator Pattern, Proxy Pattern, Behavioral Design Pattern – Types, Observer Pattern, Strategy Pattern, Iterator pattern, Introduction to ADL, Components of ADL- Example, Future Directions in Architecture	
Practice	
Lab1: Introduction to Design patterns. Describe the organization of catalogue along with the following design patterns. a. Creational Patterns. b. Structural Patterns. c. Behavioral Patterns.(Use case Diagram for Scenario to work on future Labs)	Lab5: Program to implement Composite design pattern
Lab2: Program to implement Factory pattern.	Lab 6: Program to implement decorator pattern
Lab3: Program to implement abstract factory.	Lab 7: Program to implement proxy design pattern.
Lab4: Program to implement Singleton pattern	Lab 8: Program to implement Iterator Design pattern
	Lab 9: Program to design mediator pattern
	Lab 10: program to implement visitor pattern.

Learning Resources	1. Len Bass, Paul Clements, & Rick Kazman. Software Architecture in Practice (Third Edition). AddisonWesley,2013	6. Jason McC. Smith, –Elemental design Patternsll. Addison Wesley, 2012 VasudevaVarma, Software Architecture: A Case Based Approach. Pearson Education,2009.
	2. Mark Richard, Neal Ford. Fundamentals of Software Architecture: An Engineering Approach, O'Reilly, 2020	7. Adrian Ostrowski, Piotr Gaczkowski · "Software Architecture with C++ - Design Modern Systems Using Effective Architecture Concepts, Design Patterns, and Technique with C++", Packt Publishing, 2021.
	3. Humberto Cervantes, Rick Kazman, Designing Software Architectures: A Practical Approach. Pearson Education,2016	8. Essential Software Architecture (2. Ed.).
	4. CarlosOtero,"Software Engineering Design: Theory and Practice", CRC Press, 2012.	9. https://www.researchgate.net/publication/220690558_Essential_Software_Architecture_2_ed , 2011.
	5. Paul Clements, Rick Kazman, Mark Klein, Evaluating Software Architectures: Methods and Case Studies. Addison Wesley; 1 edition (22 October2001)	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	-	10%	10%	-
Level 2	Understand	20%	-	-	20%	20%	-
Level 3	Apply	30%	-	-	30%	30%	-
Level 4	Analyze	20%	-	-	40%	40%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.Mariappan Vaithilingam, Engineering Leader Amazon, dr.v.m@ieee.org	1. Dr.B. Dhanalakshi, AP-CSE, BS Abdul Rahman Crescent, Chennai.	1. Mrs. Sasi Rekha Sankar, SRMIST
2. Mr. Badinath, SDET, Amzon, sbadhrinath@gmail.com		

Course Code	21CSC403T	Course Name	SOFTWARE MEASUREMENTS AND METRICS	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
CLR-1:	Familiarize with different metrics used in different process levels	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Apply metrics knowledge to measure Engineering problems															
CLR-3:	Improve their ability in making decisions via continuous practice like assessment and usage of metrics.															
CLR-4:	Design, implement, and change metrics based on industry practice															
CLR-5:	Discuss current research trends in software metrics															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand and measure the software features	2	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Understand the need of software quality	3	3	-	-	3	-	-	-	-	-	2	-	2	-	-
CO-3:	Will be able to understand the software development tools	3	2	2	-	-	-	-	-	-	-	2	-	-	-	-
CO-4:	Evaluate the stages of process improvement and its necessities in Development Life Cycle	-	2	-	-	3	-	-	-	-	-	-	-	2	-	-
CO-5:	Apply the process quality models in development life cycle	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction	9 Hour
Software Sizing Metrics- Fundamentals in Measurement- Basic Measures- Reliability and Validity- Measurement Errors- Assessing Reliability- Evolution in software Metrics- Functional Size Measurements- Cost of counting function point metrics- Software measures and metrics not based on function points- Future Technical Developments in Functional Metrics- Case Study to Measure software size using various size Metrics	
Unit-2 - Metrics and Models	9 Hour
Complexity Metrics and Models- Lines of Code- Halstead's Software Science- Cyclomatic Complexity- Syntactic Constructs- Structure Metrics- Case Study for the usage of complexity metrics with tools- Testing Metrics: Test Progress S Curve- Testing Defect Arrivals Over Time- Product Size Over Time- CPU Utilization- Effort/Outcome Model- Case Study to apply Testing metrics	
Unit-3 - Sampling Methods	9 Hour
Customer Satisfaction Surveys: Methods of survey data collection- Analyzing Satisfaction with practice- Satisfaction with Company terms- Metrics for Object-Oriented Projects with tools- Concepts and Constructs- Design and Complexity Metrics- Lorenz Metrics and Rules of Thumb- CK OO Metrics Suite- Productivity Metrics- Case Study for the usage of Object-oriented metrics with tools	
Unit-4 - Software Quality Model	9 Hour
Software Quality - Five steps to software quality control- Product Quality Metrics with practice- In-Process Quality Metrics- Metrics for Software Maintenance- shikawa's Seven Basic Tools with practice- Defect removal Effectiveness- The Rayleigh Model- Reliability Growth Models - Jelinski Moranda Model- Goel-Okumoto Model- Musa-Okumoto Model	
Unit-5 - Software Process Assessment	9 Hour
Conducting In-Process Quality Assessments- The Preparation Phase- The Evaluation Phase- The Summarization Phase- Conducting Software Project Assessments- Audit and Assessment- Software Process Maturity Assessment and Software Project Assessment- Software Process Assessment Cycle- Measures and metrics of industry leaders- Measures and metrics of industry leaders- Measures, Metrics, Innovation- Measurements, Metrics and outsource Litigation- Software Process Improvement Sequences- Measuring Process Maturity- Measuring Process Capability	

Learning Resources	<ol style="list-style-type: none"> 1. Stephen H. Kan, "Metrics and Models in Software Quality Engineering", Addison Wesley, Second Edition, 2020 2. Caper Jones, "Applied Software Measurement: Global Analysis of Productivity and Quality", Third Edition, McGraw Hill Companies, 2020 3. Mark Lorenz, Jeff Kidd, "Object-Oriented Software Metrics", Prentice Hall, 2000 	<ol style="list-style-type: none"> 4. Naresh Chauhan, "Software Testing Principles and Practices", Oxford University Press, 2010. 5. Ravindranath Pandian C, "Software Metrics A Guide to Planning, Analysis, and Application", Auerbach, First Indian Reprint, 2011
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	30%	-	40%	-	40%	-
Level 3	Apply	40%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Girish Raghavan, Senior DMTS Member, Wipro Ltd.	1. Dr.N.Prakash, Associate Professor, Department of Information technology, B.S.A Crescent Institute of Science and Technology.	1. Mrs.B.Jothi SRMIST

Course Code	21CSC404T	Course Name	SOFTWARE VERIFICATION AND VALIDATION	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes																			
CLR-1:	Provide an understanding of concepts and techniques for testing software													Engineering Knowledge	2	3	4	5	6	7	8	9	10	11	12																				
CLR-2:	Prepare test plan based on the requirement document, design test plans and document test plans																																												
CLR-3:	Design test cases suitable for a software development in various domains																																												
CLR-4:	Validate and document test cases, assuring software component or system satisfies its requirements and meets stakeholder expectations																																												
CLR-5:	Use of automation testing tools																																												
															Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3																
Course Outcomes (CO):		At the end of this course, learners will be able to:																																											
CO-1:	Identify, design different types of test cases for software development in any domain													3																3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Design, develop, implement, validate, and document test plans at various levels													3																3	-	-	-	-	-	-	-	-	-	-	-	-	2	-	
CO-3:	Develop Test cases for a given Software/System Specification													3																3	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
CO-4:	Validate Test Cases with the Requirement Specifications													3																3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-5:	Use various automation tools to implement test cases													3	3	-	-	3	-	-	-	-	-	-	-	-	-	-	3																

Unit-1 - Introduction	9 Hour
Fundamentals of Testing: Necessity of Testing-Case Studies on "Impact of Software bugs", Objectives of Testing, Basics Definitions, Testing Principles-Illustrations, Fundamental Test Process, The tester's role in a software development organization, Test Planning, Establishing Test Policy, Structured approach to testing Test Factors, Eleven Step software testing process, Origin of Defects, Defect Repository and Test Design, Developer/Tester support of developing a defect repository, Defect Examples, Case Studies – "Identify the defect", Defect Analysis and Prevention Strategies, Project: Developing adhoc test cases for a case study	
Unit-2 - Test Case Design Strategies	9 Hour
Test Case Design Strategies: Introduction to basic design strategies. White Box Strategies - Peer Reviews, Inspections, Walkthrough, Comparative Analysis, Static Analysis Tools: Coding Standards, Code Metrics, Code Structure, Activity: Static Analysis of a source code, Coverage and Control Flow Graphs, Activity: Calculate Complexity for a given source code, Paths Code Complexity, Activity: Calculate Path Code Complexity for a given source code, Evaluating test adequacy criteria, Case Studies-"Applying the suitable White Box Strategy", Black Box Testing Strategies: Requirements Based Testing, Random Testing, Boundary Value Analysis, Equivalence Class Partitioning, Cause Effect graphing , Activity: Designing test cases for the given requirement specification using Boundary value analysis and Equivalence Class Partitioning, cause effect graphing and developing decision tables	
Unit-3 - Levels of Testing	9 Hour
The need for levels of testing, Unit Testing: Planning, Test Harness , Running the tests Recording Results , Integration Testing: Goals, Design and Plan, Integration Testing: Goals, Design and Plan, Performance Testing, Stress Testing ,Configuration Testing, Security Testing, Recovery Testing, Reliability Testing, Usability Testing, Regression Testing, Alpha, Beta and Acceptance Testing, Role of use cases in testing, Applying Testing Skills: Compatibility testing, Internationalization testing, Testing Documentation plan, Recording test cases, Reporting and Measurement of Success	

Unit-4 - Test Management	9 Hour
Test Management: Choice of Standards, Infrastructure Management, Test People Management, Test Plan Components, Test Plan Attachments, Locating Test Items, Managing Issues, Addressing Perception, Taking team together, Document Uses and Types, Test Analysis report Documentation, Analyze reports and Problem tracking, Controlling and Monitoring Test Progress, Test Metrics and measurements: Role, need and types, Project Metrics with Practice, Progress Metrics with Practice, Productivity Metrics with Practice	
Unit-5 - Software Test Automation	9 Hour
Software Test Automation: Skills and Scope Design, Architecture for Automation, Requirements for a test tool, Process Model for Automation, Selecting the test tool, Demonstration of a Functional Testing Tool, Demonstration of a Web Testing Tool Demonstration of a Unit Testing Tool, Demonstration of an Test Management Tool , Challenges in Automation, The Future: Software Quality Assurance	

Learning Resources	<ol style="list-style-type: none"> 1. Srinivasan Desikan and Gopalswamy Ramesh, "Software Testing – Principles and Practices", Pearson Education, 2006 2. Ron Patton, "Software Testing", Second Edition, Sams Publishing, Pearson Education, 2007. 3. Ilene Burnstein, "Practical Software Testing", Springer International Edition, 2003. 4. Aditya P. Mathur, "Foundations of Software Testing _ Fundamental Algorithms and Techniques", Dorling Kindersley (India) Pvt. Ltd., Pearson Education, 2008 5. Renu Rajani, Pradeep Oak, "Software Testing-Effective Methods, Tools and Techniques", Tata McGraw Hill Education, 2011.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	30%	-	40%	-	40%	-
Level 3	Apply	40%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Shrikant Satyanarayan, Technical Manager LDRA Technology PVT LTD	1. Dr. N. Bhalaji, Associate Professor, SSN Institutions	1. Mrs. Anupama C.G, SRMIST
2. Mr. Girish Raghavan, Senior DMTS Manager, Wipro Technologies		2. Mr. Arun C , SRMIST

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSE275T	Course Name	REQUIREMENTS ENGINEERING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes					
CLR-1:	Identify the sources, collect, organize, and classify the requirements	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3			
CLR-2:	Improve their ability to choose the appropriate Elicitation Techniques for any systems																														
CLR-3:	Familiarize with the various requirements documentation and validation techniques																														
CLR-4:	Familiarize with the various requirements quality drivers, Traceability models and requirements change control techniques																														
CLR-5:	Expose to the Conflicts, Escalation model, Settlements, Analytics of Cost Benefit analysis and tools																														
Course Outcomes (CO):		At the end of this course, learners will be able to:												3	3	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-1:	Acquire the knowledge on identifying the Source, organizing, and classifying requirements	3	3	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3				
CO-2:	Acquire the ability to identify and apply the appropriate Elicitation Techniques for any systems	1	2	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3				
CO-3:	Understand the basic ideas about various requirements documentation and validation techniques	3	3	-	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
CO-4:	Apply the knowledge on various requirements quality drivers, Traceability models and requirements change control techniques for any system	3	3	-	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
CO-5:	Appreciate the concepts of Conflict, Escalation model, Settlements, Analytics of Cost Benefit analysis and requirements engineering tools	3	3	-	3	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3				

Unit-1 - Requirement Engineering	9 Hour
Introduction to Requirements and Requirements Engineering, Requirements Types, Classification of Requirements, Requirements Gathering relevant to Software Life Cycle Models, Stakeholders in the requirements, Requirements Engineering Process Framework, Requirements Engineering Maturity Model process, Generic Process for requirements, Levels of Requirements Engineering, System Model for Requirements Engineering, Representation of Requirements-Data Flow, ER Diagram, View Point Controlled Requirements, Structured Analysis and Design Technique, Viewpoint Oriented Requirements Definition, Object Oriented Methods of Requirements Engineering, Case Study : For the given application identify the stakeholders, gather and classify the requirements according to the types	
Unit-2 - Elicitation	9 Hour
Requirement Inception, sources of requirements, Introduction to requirement Elicitation, Classical Elicitation Techniques-Interview, Questionnaire, Social analysis, Modern Elicitation Techniques- Brainstorming, Modern Elicitation Techniques- Prototyping, Use Centered Design, Modern Elicitation Techniques- Walkthrough, Use case Joint Application Development, Requirement reuse, Feature Oriented Domain Analysis, Case Study: For the given application apply various techniques and Elicitation the requirements	
Unit-3 - Documentation	9 Hour
Introduction to Requirement Document, Structure of Document, Vision, Scope and Elicitation notes, Requirement Specification techniques, Introduction to requirement validation- Classical Requirement Validation techniques-Inspection, Simple Check, . Introduction to requirement validation- Classical Requirement Validation Techniques-Desk Check, Walkthrough, Format review, Prototype & Enactments, Functional test Design, Development of User manual, Case study. For the given application validate and document the specifications	

Unit-4 - Traceability	9 Hour
Business drivers of Quality-components of Integrated Quality approach, Quality improvement techniques, Requirements Quality Assurance, PDCA Cycle, Introduction to Requirement Management- Requirement Identification-Requirements Traceability, Requirement Traceability models, Traceability Matrix- Traceability List & Tree, Introduction to Requirement Traceability- Requirement traceability methods, Advance Traceability, Requirement Change Control	
Unit-5 - Conflicts & Cost Benefit Analysis	9 Hour
Conflict types, Mastering and using detection of the 5 conflicts types on the basis of indication in project, Glasl's conflicts escalation model, Conflicts Settlement techniques, Analytic Methods – Mastering and using Consider All Facts (CAF), Analytic Methods – Plus –Minus- Interesting(PMI), Analytic Methods – Cost Benefit Analysis, Case study : Requirement Engineering Tools	

Learning Resources	<ol style="list-style-type: none"> 1. ElizabethHull,KenJackson,JeremyDick,RequirementsEngineering, Springer,2013 2. RalphR.Young,"TheRequirmentsENGINEERINGHandbook",2004 3. Axelvan Lamsweerde,"Requirements Engineering: From System Goalsto UMLModelsto Software Specifications", Wiley,2014 4. KarlWiegiers, JoyBeatty, Software Requirements (DeveloperBestPractices) (3rdEdition), Microsoft Press, 2014. 5. A. Laplante, Mohamad h. Kassab, Requirements Engineering for Software and Systems, CRC Press, 2022 6. Jeremy Dick, Elizabeth Hull, Ken Jackson, Requirements Engineering, Springer International Publishing, 2018. 7. Requirements Engineering – Springer E-Learning Material, https://www.springer.com/journal/766
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	30%	-	40%	-	40%	-
Level 3	Apply	40%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.Mariappan Vaithilingam, Engineering Leader Amazon, dr.v.m@ieee.org	1. Dr.B. Dhanalakshi, AP-CSE, BS Abdul Rahman Crescent, Chennai.	1. Mrs. Sasi Rekha Sankar, SRMIST
2. Mr. Badinath, SDET, Amzon, sbadhrinath@gmail.com		

Course Code	21CSE276T	Course Name	SOFTWARE QUALITY MANAGEMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn the fundamentals of Software Quality and its standards.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Introduce the concepts of Software Engineering principles.															
CLR-3:	Gain Knowledge on Quality tasks and testing.															
CLR-4:	Become familiar with the elements of the quality management system and quality tools.															
CLR-5:	Learn the basics of TQM and quality systems.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the concepts of software quality factors and its challenges.	3	2	1	-	-	-	-	-	-	-	-	-	-	1	-
CO-2:	Understand the characteristics of Software Quality Assurance.	3	2	2	-	-	-	-	-	-	-	-	-	-	1	3
CO-3:	Solve the issues in quality tasks and testing.	3	1	1	-	-	-	-	-	-	-	-	-	-	2	3
CO-4:	Articulate the elements of quality management system and software quality tools.	3	1	2	-	-	-	-	-	-	-	-	-	-	1	3
CO-5:	Utilize the concepts of TQM and quality systems.	3	2	1	-	-	-	-	-	-	-	-	-	-		2

Unit-1 - Introduction	9 Hour
Software Quality - The Software Quality Factors and Challenges - Quality measurement – Metrics measurement and analysis – Gilb's approach - Demystifying Quality Concepts - Software Quality Processes (Agile Methods) – role of process frameworks - methodologies and tools – CMM and CMML – Seven QC Tools - Six Sigma concepts	
Unit-2 - Software Engineering Principles	9 Hour
Introduction to Software Engineering principles - Software Project Management - Software Processes - Project Metrics - Process Metrics – object-oriented metrics – Software Configuration management – importance of SCM - SCM processes– Identification of objects in SCM – version control – change control – configuration audit – status reporting - SCM Tools - Risk Management -	
Unit-3 - Quality Tasks and Testing	9 Hour
Quality tasks - SQA Activities – defect prevention and defect detection - defect measurement and analysis - Software Testing – Testing strategies—white-box and black-box testing—introducing Usage Based Testing and Coverage Based Testing – Testing Techniques - Partition Based Testing, Testing based on Check-lists, Usage Based Statistical Testing and Coverage Based Testing - Reviews and Inspections – walkthroughs - Fault Tolerance Basics – Fault Tolerance Techniques- Review of SQA activities in the Organization - Analyse cost of SQA activities Vs overall software development effort - trade-offs in cost-of-quality vs cost-of-delivery; Case Study - Testing	

Unit-4 - Software Quality Tools	9 Hour
Tools for Quality – Ishikawa's basic tools – CASE tools – Defect prevention and removal – Quality Planning in Projects - Quality Plan document - Quality Metrics and Base lining - measurement and control in project management - S.M.A.R.T attributes - Software Product Metrics & Defect Propagation - Internal vs. External software attributes - types of product metrics (Static vs. Dynamic) - Reliability models – Rayleigh model – Reliability growth models for quality assessment - Elements of QMS – planning the implementation of QMS - The quality charter – changing the organizational culture – Organizational considerations – development organization considerations – Implementation strategies – SQS improvement - Reliability Growth models for QMS – Complexity metrics and models – Customer satisfaction analysis; Case Study - Software Quality Tools	
Unit-5 - TQM and Quality Systems	9 Hour
Introduction to TQM - Software reuse for TQM - Software testing methods for TQM - Defect prevention and TQM - Zero defect software development - Clean Room Engineering – Benefits of ISO registration – ISO 9000 series of standards – sector specific standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation— Documentation—Internal Audits—Registration. ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 4001—Requirements of ISO 14001—Benefits of EMS - GQM Model - Hierarchical models of Boehm and McCall -- role of process frameworks	

Learning Resources	<ol style="list-style-type: none"> Nitin C Shah, "Software Quality Assurance and Testing for Beginners", 2019. Besterfield Dale H., Besterfield Carol, ET "al., "Total Quality Management (TQM)" 5e by Pearson by 2018. Jeff Tian, "Software Quality Engineering", Wiley India, 2015. Allan C. Gillies, "Software Quality: Theory and Management", Thomson Learning, 2003. (Ul: Ch 1-4 ; UV : Ch 7-8) Stephen H. Kan, "Metrics and Models in Software Quality Engineering", Pearson Education (Singapore) Pte Ltd., 2002. (Ul: Ch 3-4; UIII: Ch 5-8; UIV: Ch 9-11). Watt S Humphery "Managing software process", Addison – Wesley 1998. Roger pressman "Software engineering" 5th edition McGraw hill 1999. G.Gordan Schulmeyer, James "Total Quality Management for software" International Thomson computer press 1998. http://www.sei.cmu.edu/cmmi/ http://www.scs.shtr.org/pcmm1.html http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA512354 http://www.isixsigma.com/new-to-six-sigma/getting-started/what-six-sigma/ http://www.iso.org/iso/catalogue_detail?csnumber=21823 http://www.math.mun.ca/~variyath/7QC.pdf http://www.softwaresixsigma.com/PDFs/0103%20NjSpin1.pdf
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	30%	-	40%	-	40%	-
Level 3	Apply	40%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.R. Durairaj, Clayfin Technologies Private Limited, Chennai	1. Dr.M.S. Bhuvanewari, Asso. Professor, Mepco Schlenk Engineering College, Sivakasi	1. Dr.R. Beaulah Jeyavathana, SRMIST

Course Code	21CSE277T	Course Name	SOFTWARE PROCESS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the basic concepts of software Process	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2:	Discuss various Phases of Software Process and its Economics	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	Acquire Knowledge on Process Workflow and Planning.															
CLR-4:	Understand the knowledge of process metrics and Risk Management															
CLR-5:	Gain knowledge using SPM case studies															

Course Outcomes (CO):	At the end of this course, learners will be able to:	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CO-1:	Acquire the Knowledge of various software process maturity models.	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-2:	Understand the software economics and different phases.	3	-	-	-	-	-	-	-	-	-	-	-	-	2	3
CO-3:	Apply the knowledge of software Process checkpoints and workflows.	3	-	-	-	-	-	-	-	-	-	-	-	-	1	3
CO-4:	Identify the various risks in Process Metrics	3	-	-	2	-	-	-	-	-	-	-	-	-	1	-
CO-5:	Design and Develop software Products using conventional and model principles of SPM.	3	-	-	-	-	-	-	-	2	-	-	-	-	1	3

Unit-1 - Software Process	9 Hour
Maturity Software Maturity Framework, Principles of Software Process Change, Software Process Assessment, The Initial Process, The Repeatable Process, The Defined Process, The Managed Process, The Optimizing Process. Process Reference Models Capability Maturity Model (CMM), CMMI, PCMM, PSP, TS	
Unit-2 - Software Project	9 Hour
Management Renaissance Conventional Software Management, Evolution of Software Economics, Improving Software Economics, The old way, and the new way. Life-Cycle Phases and Process artifacts Engineering and Production stages, inception phase, elaboration phase, construction phase, transition phase, artifact sets, management artifacts, engineering artifacts and pragmatic artifacts, model-based software architectures.	
Unit-3 - Work Flows and Process Planning	9 Hour
Workflows and Checkpoints of process Software process workflows, Iteration workflows, Major milestones, minor milestones, periodic status assessments. Process Planning Work breakdown structures, planning guidelines, cost and schedule estimating process, iteration planning process, Pragmatic planning.	
Unit-4 - Process and Project Metrics	9 Hour
Metrics in the Process and Project Domains, Software Measurements, Metrics for Software Quality, Risk Management: Risk versus Proactive Risk Strategies, Software Risks, Risk Identification, Risk Projection, Risk Refinements, Risk Mitigation Monitoring and Management (RMMM), The RMMM Plan	
Unit-5 - Case Studies	9 Hour
CCPDS-R Case Study and Future Software Project Management Practices Modern Project Profiles, Next-Generation software Economics, Modern Process Transitions	

Learning Resources	1. <i>Managing the Software Process</i> , Watts S. Humphrey, Pearson Education, 1989	5. <i>Software Project Management</i> , Walker Royce, Pearson Education
	2. <i>An Introduction to the Team Software Process</i> , Watts S. Humphrey, Pearson Education, 2000	6. <i>Software Engineering principles and practice</i> - Waman S Jawadekar, The Mc Graw-Hill Companies.
	3. <i>Process Improvement essentials</i> , James R. Persse, O'Reilly, 2006	
	4. <i>Software Engineering, A practitioner's Approach</i> - Roger S. Pressman, 6th edition, Mc Graw Hill International Edition	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.R. Jaya, Data Scientist, Great Learning, Bangalore.	1. Dr.R. Senthilkumar, Associate professor, Dept of CSE, New Horizon college of Engineering, Bangalore.	1. Dr. Dinesh G, SRMIST
	2. Dr.N. Thillai Arasu, Associate Professor, School of CSE &IT, Reva University, Bangalore	

Course Code	21CSE271T	Course Name	PROGRAMMING IN JAVA	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Introduce the fundamental concepts and programming environment.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Outline the Concepts of classes and IO streams															
CLR-3:	Acquire Object oriented concepts like inheritance, reusability, and encapsulation															
CLR-4:	Learn the custom exceptions and employ concurrency concepts															
CLR-5:	Exploit the power of advanced data structures and basic GUI design.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Summarize the knowledge of fundamentals of Java Programming	3	-	1	2	-	-	-	-	-	-	-	-	1	1	-
CO-2:	Determine the type of constructor and class concepts used in OOPS based programming paradigms.	3	2	-	2	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Articulate the different concepts involved in information hiding and reusability techniques.	3	2	1	-	-	-	-	-	-	-	-	-	3	2	-
CO-4:	Understand the different concepts of Exception Handling and Concurrency topics.	3	2	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Acquire the integration of Collection Frameworks and GUI programming to product development.	3	2	-	1	-	-	-	-	-	-	-	1	-	-	-

Unit-1 - Fundamentals of Java Technology and Programming	9 Hour
Java platform features, Java technologies-JSR, JCP, Data types, Key words, and Scoping rules, Automatic Type Conversion, Type Casting and Arrays, Operators Precedence & Associativity, Expression. Flow control, enhanced for loop, switch statements, String handling	
Unit-2 - Classes, Objects and Streams	9 Hour
Class fundamentals: Declaring objects, Assigning object reference variable, Methods & Method Signatures, Method with parameters, Variable arguments, I/O Basics: Byte stream& Character Stream, Getting user input: Reading console input & Writing console output, Reading and Writing files, Command Line arguments, Constructors and its Types, this keyword, Garbage Collector, finalize() method, Overloading methods and constructors, Using object as parameters, returning object in methods, recursion, Access control, static and final keyword, Nested and Inner classes.	
Unit-3 - Information Hiding & Reusability	9 Hour
Inheritance basics, Using super, Method Overriding, Dynamic method dispatch, Abstract class, Using final with inheritance, Default Package, Path & Class Path Environment Variables, Package level access, Importing Packages, Interface: Multiple Inheritance, Extending interface, Wrapper Class, Auto Boxing.	
Unit-4 - Exception, Concurrency, Enumeration and Annotations	9 Hour
Exception handling mechanism, try/catch mechanism, Thread class & Runnable Interface, Inter Thread Communication, Synchronization of threads using Synchronized keyword and lock method, Thread pool and Executors framework, Futures and callable, Fork-Join, Deadlock conditions, Enumeration, Annotations: basics of annotation.	
Unit-5 - Generics, Collections Framework and GUI Programming	9 Hour
Generics: Basics, Collections Interfaces – Set, List, Queue, Collections Classes – Array List, Hash Set, Tree Set. Abstract Map, Hash Map, Tree Map, Introduction to GUI and its component basics	

Learning Resources	7. Herbert Schildt, "The Complete Reference (Fully updated for jdk7)", Oracle press Ninth Edition, 2014.	10. Herbert Schildt, "Java: A Beginner's Guide", Eight Edition, Oracle Press, 2018.
	8. Cay S. Horstmann, "Core Java Volume –I Fundamentals", Prentice Hall, 11th Edition, 2018.	11. https://docs.oracle.com/javase/tutorial
	9. Deitel&Deitel, "Java How to Program", Prentice Hall, 10th Edition, 2016.	12. NPTEL Course: https://onlinecourses.nptel.ac.in/noc22_cs47/preview

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	35%	-	30%	-	30%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	25%	-	30%	-	30%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
2. Mr.Jero Terrence, Assistant Consultant in Tata Consultancy Services, United Kingdom	2. Dr.R.Ganeshan, VIT Bhopal, Madhya Pradesh.	2. Dr.S.Amudha, SRMIST

Course Code	21CSE391P	Course Name	USER INTERFACE DESIGN	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the concepts of design; Utilize by learning various color models	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Learn the fundamental laws in UX design															
CLR-3:	understand the task for requirement gathering															
CLR-4:	Gain guidelines for UI design															
CLR-5:	design on various domains or applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	design the concepts of various color models	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	apply the basic laws in UX design	-	-	2	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Construct the task for requirement gathering	-	-	3		2	-	-	-	-	-	-	-	-	2	-
CO-4:	Adopt the guidelines for UI design	-	-	3	-	-	-	-	-	2	-	-	-	-	-	3
CO-5:	Apply the design on real time applications	-	-	3	-	-	-	-	-	2	-	3	-	-	-	3

Unit-1 - Typography	9 Hour
type properties, baseline, cap height, X-height, ascenders, descenders and weight, Font classifications-Serif, sans serif fonts, handwriting and Display, Readability, letter spacing, line height, Paragraph spacing, power of alignment, Leading and Kerning, Color Models Introduction-RGB, CMYK, Color harmony: monochromatic, analogous, Complementary, triadic, double-complementary.	
Practice:	
1: Creating sample standard webpage for restaurant to order items by satisfying the fonts, colors and spacing	
2: User Interfacing check by applying option buttons/ menus in it using Node JS/ Angular JS	
3: Various color models checking in the developed page	
Unit-2 - Laws of UX Designing	9 Hour
Hicks law, Jakob's law, Fitts's Law, Ockham's Razor, Pareto Principle, Weber's law, Tesler's law, Law of proximity, Law of similarity and human eye	
Practice:	
1: Applying Hicks Law, Jakob's law, Ockham' Razor in a sample ecommerce webpage designed	
2: Applying Weber's law, Tesler's law in the webpage	
3: Variations to be done for demonstrating the law of similarity colors in various designs/buttons and human eye	

Unit-3 - Design	9 Hour
Interaction design task analysis, Data for task requirements, Requirements gathering, Eliciting Qualitative data, analyzing qualitative data, Qualitative metrics User narratives, Scenario implementation and its challenges, Wireframes, Prototypes, UX design for mobile application, Application design example, Responsive Design, Adaptive design and difference with Responsive design	
Practice	
1: Interaction design analysis in the webpage designed, 2: Compatibility check with both Web and Mobile application oriented, 3: Browser independent check along with database connectivity	
Unit-4 - Guidelines	9 Hour
Universal usability, Inclusive interaction, principles of accessibility, Universal design, Font weight, color, Contrast, Screen readers, Alt text using a tool, Introduction to Multifaceted Users, Designing for Multifaceted Users, Guidelines for helping adults	
Practice	
1: Designing a sample chatbot web page and check for lightweight and heavyweight components with various frames in webpage	
2: Design check for Multifaceted users, 3: To check whether the guidelines to adult users are followed	
Unit-5 - Case Study	9 Hour
Tracking APP Introduction, Tracking APP Design guidelines, Tracking APP demo, Introduction of how to Design a new UX, concept to reduce driver distraction, Designing concepts of Driver distraction, Importance of User data in UX designing, Approach to design without user data, Designing concept, Dynamic web pages	
Practice	
1: Building a webpage for vehicle booking with location enabled, 2: Track the Vehicle by its location and display it in your app, 3. Calculate the amount after travel with its tariff	

Learning Resources	1. Jeff Johnson, Kate Finn- "Designing user Interfaces for an aging population towards Universal design- Morgan Kauffman publishers – Elsevier- 2017 2. Elvis Canziba- "Hands-on UX Design for Developers " – PacktBirmingham, mumbai -2018	3. Andrew Rogerson- "User Experience Design" – Smashin media 2012- Freiburg, Germany 4. Barbara Ballard, "Designing the mobile user experience" Wiley publicatoinis 2007 5. https://uxdesign.cc/tagged/case-study
---------------------------	--	---

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	-	20%	-	40%	-	-
Level 2	Understand	40%	-	-	20%	-	40%	-	-
Level 3	Apply	10%	-	-	20%	-	10%	-	-
Level 4	Analyze	10%	-	-	20%	-	10%	-	-
Level 5	Evaluate	-	-	-	10%	-	-	-	-
Level 6	Create	-	-	-	10%	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Joe Antony, Senior Manager, Cognizant	1. Dr.T.Sukumar, Associate Professor, SVCE	1. Dr.S.Karthick, SRMIST
2. Mr.Sasiram, Senior Software Engineer, TCS	2. Dr.P.Sudakar, Associate Professor, Annamalai University	

Course Code	21CSE392P	Course Name	VISUAL PROGRAMMING				Course Category	E	PROFESSIONAL ELECTIVE				L	T	P	C						
																2	1	0	3			
Pre-requisite Courses	Nil		Co- requisite Courses	Nil				Progressive Courses	Nil													
Course Offering Department		School of Computing				Data Book / Codes / Standards			Nil													
Course Learning Rationale (CLR):		The purpose of learning this course is to:						Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Gain knowledge about Visual basics						1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3			
CLR-2:	Utilize object-oriented aspects of C# to develop applications																					
CLR-3:	design Windows applications utilizing forms, menus etc.																					
CLR-4:	create Database applications using ActiveX Data Objects																					
CLR-5:	Utilize web forms to develop Web based applications																					
Course Outcomes (CO):		At the end of this course, learners will be able to:																				
CO-1:	Design and develop concept in visual basic programming						-	-	3	-	1	-	-	-	-	-	-	-	-			
CO-2:	Develop applications using object-oriented aspects of C#						-	-	2	-	2	-	-	-	-	-	-	-				
CO-3:	Design Windows applications						-	-	2	-	-	-	-	2	-	-	-	2	3			
CO-4:	Design Data base applications						-	-	3	-	-	-	-	2	-	-	-	2	3			
CO-5:	Develop Web based applications using ADO .Net						-	-	2	-	2	-	-	-	2	-	3	-	2	3		
Unit-1 - Visual Basic Programming																9 Hour						
Visual Basic Applications – Creating and using Controls – Menus and Dialogs – Managing projects – Programming fundamentals – Objects and instances – Debugging – Responding to mouse events – Using grid control – Creating graphics for application – Displaying and printing information – Interacting with the environment – File system controls - Processing files – Accessing databases with the data controls.																						
Practice:																						
1. Create an Application using VB, 2. Create Menus, Dialogs, and mouse Events, Create and implement to Access databases with the data controls																						
Unit-2 - Introducing C#																9 Hour						
Understanding .NET Framework - Overview of C# - Literals – Variables Data Types – Operators – Constants – Expressions, Program Control Statements: Branching, Program Control Statements: Looping, Casting – Methods, Arrays: Array Class, Array List, String, String Builder, Structures – Enumerations, Class – Objects, Constructors, Inheritance, Indexers and Properties, Polymorphism, Interfaces, Abstract Class, Event Handling, Errors, and Exception Handling.																						
Practice:																						
1. Implementing Visual Studio IDE with Decompiling Code, 2. Create an simple application using C#, Develop an exception handling with polymorphism																						
Unit-3 - Building Windows Application																9 Hour						
Creating Window Forms with Events and Controls, Examples: Window Forms with Events and Controls, Menu and Toolbar, Delegates - Inheriting Window Forms, SDI and MDI application, Dialog Box: Modal and Modeless.																						
Practice:																						
1. Create windows form with menu and Toolbar, 2. Create Windows application using C#, Create Simple SDI and MDI application																						

Unit-4 - ADO .Net	9 Hour
Accessing data with ADO.NET: Dataset, Types Dataset, Data Adapter, and Updating Database using Stored Procedures, SQL Server with ADO.NET, Handling Exceptions, Validating Controls, and Windows Application Configuration.	
Practice:	
1. Create a Database connectivity using SQL Server, 2. Apply Exception handling concept. Create an application using Validation control.	
Unit-5 - ASP.NET	9 Hour
Introduction to ASP.NET, - Working with XML and .NET, Creating Virtual Directory and Web Application, Session Management, Web Services – web.config, Passing Datasets and Returning Datasets from Web Services, Transaction Handling, Exception Handling – Returning Exceptions from SQL Server	
Practice:	
1. Implement a server with session management. 2. Create a dataset with passing and returning with SQL Server., 3. Write a simple ASP.NET program to display the following Web Controls: A button with text “click me”. The button control must be in the center of the form. A label with a text hello, A checkbox. The form name must be Web Controls	

Learning Resources	1. Herbert Schildt, – The Complete Reference: C# 4.0ll, Tata McGraw Hill, 2012. 2. Andrew Troelsen, Philip Japikse, – C# 6.0 and the .NET 4.6 Frameworkll, Seventh Edition, Apress, 2015 3. Christian Nagel et al. – Professional C# 2012 with .NET 4.5ll, Wiley India, 2012.	4. Andrew Troelsen, Philip Japikse , – Pro C# 7 with .NET and .NET Corell, Eighth Edition, Apress, 2017 5. Stephen C. Perry, – Core C# and .NETll, Prentice Hall, 2005
---------------------------	---	---

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	-	20%	-	40%	-	-
Level 2	Understand	40%	-	-	20%	-	40%	-	-
Level 3	Apply	10%	-	-	20%	-	10%	-	-
Level 4	Analyze	10%	-	-	20%	-	10%	-	-
Level 5	Evaluate	-	-	-	10%	-	-	-	-
Level 6	Create	-	-	-	10%	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Naveen Baskaran, ADP Solution Chennai	1. Dr.P.SivaKumar, VIT Chennai	1. Dr.S.Nagendra Prabhu, SRMIST
	2. Dr.Senthil, NHCE Bangalore	

Course Code	21CSE393P	Course Name	MACHINE LEARNING TECHNIQUES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Explore the principles, algorithms, and applications of machine learning.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand machine learning models to perform classification on various applications															
CLR-3:	Familiarize about neural network models to perform classification on various applications															
CLR-4:	Gain knowledge on machine learning models to perform clustering on various applications															
CLR-5:	Understand sequence prediction models															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Evaluate machine learning models and report its performance	-	1	-	-	-	-	-	-	-	-	-	-	-	2	2
CO-2:	Apply linear classifier models for text classification	-	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Design neural network models for image classification	-	3	-	-	3	-	-	-	-	-	-	-	-	3	-
CO-4:	Design clustering models to solve real-world problems	-	3	-	-	-	-	-	-	2	-	3	-	-	3	-
CO-5:	Design and analyze the sequence prediction models using recurrent neural network	-	3	-	-	-	-	-	-	2	-	3	-	-	3	-

Unit-1 - Introduction to machine learning	9 Hour
What and why? supervised learning, unsupervised learning, Parametric vs non-parametric models, overfitting, model selection; Probability – Discrete random variables, Bayes rule, Independence and conditional independence, continuous and random variables, Quantiles, mean and variance, Gaussian Normal distribution	
Practice:	
1. Select any numerical dataset and perform statistical analysis, 2. Perform Exploratory data analysis on the selected dataset	
Unit-2 - Supervised learning	9 Hour
Linear classifiers – Regression – linear regression- ordinary least square, ridge regression - Features –feature representation – Decision tree, Random Forest– K Nearest neighbour – Multi class classification- Naïve Bayes classifier, Support vector machine.	
Practice:	
1. Use linear and ridge regression and perform prediction, 2. Perform classification on the selected dataset using Random Forest, KNN, SVM and Naïve Bayes and analyse its performance	
Unit-3 - Clustering	9 Hour
Curse of Dimensionality – Principal component analysis; K-means clustering, Mixture of Gaussians- maximum likelihood, EM for Gaussian mixtures	
Tutorial:	
1. Perform PCA on a large dataset, 2. Categorize the dataset using K-means clustering and GMM	

Unit-4 - Introduction to Neural Network	9 Hour
feed forward Network function, Network training, Error Backpropagation; Deep learning – Deep generative models, Deep neural networks, Application of deep networks	
Practice:	
1. Handwritten digit classification using DBN, 2. Information retrieval using deep-auto encoders, 3. Learning Image features using 2D convolutional DBN	
Unit-5 - Sequential Data	9 Hour
Markov models, HMM, Recurrent neural network – sequence to sequence RNN – Back propagation through time- forward and back pass- training a language model – LSTM	
Practice:	
1. Develop model for the following applications: Machine translation, 2. video tagging and speech recognition	

Learning Resources	1. Machine Learning: A Probabilistic Perspective, Kevin P Murphy, MIT press, Cambridge, 2012 2. Pattern recognition and Machine Learning, Christopher M Bishop, Springer, 2006.	3. Machine Learning, Tom Mitchell McGraw-Hill (1997 A Course in Machine Learning, Hal Daume III (preprint available online)
---------------------------	--	---

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	-	20%	-	40%	-	-
Level 2	Understand	40%	-	-	20%	-	40%	-	-
Level 3	Apply	10%	-	-	20%	-	10%	-	-
Level 4	Analyze	10%	-	-	20%	-	10%	-	-
Level 5	Evaluate	-	-	-	10%	-	-	-	-
Level 6	Create	-	-	-	10%	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Vaishak P S Staff Engineering Manager/System Intelligence, Samsung Electronics, Bangalore Vaisakh.ps@samsung.com	1. Dr.C. Oswald Assistant Professor, NIT, Trichy swald.mecse@gmail.com	1. Mrs.A. Jackulin Mahariba, SRMIST

Course Code	21CSE312P	Course Name	SOFTWARE ENGINEERING IN ARTIFICIAL INTELLIGENCE	Course Category	E	PROFESSIONAL ELECTIVE										L	T	P	C												
																2	1	0	3												
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil																								
Course Offering Department		School of Computing			Data Book / Codes / Standards		Nil																								
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes													
CLR-1:	Learn the different GPU Components				1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Know to access NGC Containers and docker images																														
CLR-3:	Utilize the Pytorch and Jupyter notebook																														
CLR-4:	Learn the CUDA ecosystem																														
CLR-5:	Explore the DL deployments																														
Course Outcomes (CO):		At the end of this course, learners will be able to:				-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-1:	Distinguish the different components in GPU systems				-	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Create environments to work with different NGC container packages				-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Implement codes using jupyter notebook and pytorch				-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Develop and work with CUDA				-	3	3	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Visualize different DL deployments for various scientific applications				-	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unit-1 - Introduction to System Software Engineering																	9 Hour														
System S/W Platforms: Virtualization, Containerization- Introduction to NVIDIA NGC Cloud, DockerHub																															
T1: Accessing DGX A100																															
T2: Working DOCKER Images and NGC Container																															
T3: Installation and Pulling Specific NGC Packages																															
Unit-2 - Scheduling and Resource Management																	9 Hour														
Introduction to Schedulers/Orchestration Tools - Fundamentals of Ansible/Kubernetes/KubeFlow/SLURM																															
T4: Implementing and executing Kubernetes																															
T5: Working with Ansible																															
T6: Demo Executions on KubeFlow/SLURM																															
Unit-3 - Introduction to IDE / Exploratory Programming																	9 Hour														
Introduction to various IDE like VSCode/PyCharm/Others-Introduction to Jupyter-Ecosystem for Exploratory Programming- Features of Jupyter-Ecosystem for building Python Packages/Scientific Manuscript																															
T7: Working with VScode/ Pycharm																															
T8: Using Jupyter note and PyTorch																															
T9: Run a simple data centric application using Jupyter note.																															
Unit-4 - System Software for Accelerated Computing																	9 Hour														
ML/DL/DS/HPC Workloads-Overview of CUDA Platform: GPGPU Computing Platform - Overview of CUDA-X Platform: cuBLAS/cuDNN/cuTensor [Compute]- Framework for Differential Computation																															

T10: Testing the GPGPU Computing
T11: Testing and working with Tensor (CUDA-X)
T12: Implementing Mixed Precision and Quantization Aware training
Unit-5 – GPU Programming
Distributed Computing Software Stack-Multi-GPU/Multi-Node: [MPI/NCCL/RDMA] Horovod- Accelerating DL Deployments- MLOps: Hands-on
T13: Accelerating Neural Network Inferencing: TensorRT & Triton Inference Server
T14: Monitoring load Balancers & Schedulers
T15: Deployment of various services for monitoring, jupyter environment and other services.

9 Hour

Learning Resources	<p>5. Ekman, M., 2021. Learning Deep Learning: Theory and Practice of Neural Networks, Computer Vision, NLP, and Transformers Using TensorFlow. Addison-Wesley Professional.</p> <p>6. Sanders, J. and Kandrot, E., 2010. CUDA by example: an introduction to general-purpose GPU programming. Addison-Wesley Professional.</p>	<p>7. Christopher Love, Jay Vyas, Core Kubernetes, 2022</p> <p>8. Chollet, F., 2021. Deep learning with Python. Simon and Schuster.</p>
---------------------------	---	---

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	--	15%	-	15%	-	-
Level 2	Understand	25%	-	-	20%	-	20%	-	-
Level 3	Apply	30%	-	-	25%	-	25%	-	-
Level 4	Analyze	30%	-	-	25%	-	25%	-	-
Level 5	Evaluate	-	-	-	10%	-	10%	-	-
Level 6	Create	-	-	-	5%	-	5%	-	-
	Total	100 %		100 %		100 %		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
2. A.G.Rangaraj, Deputy Director (Technical), R&D, RDAF and SRRA Division, National Institute of Wind Energy (NIWE)	2. Dr.I.Joe Louis Paul, Associate Professor, SSN College of Engineering	2. Dr.Kottilingam K, SRMIST

Course Code	21CSE391T	Course Name	OBJECT ORIENTED SOFTWARE ENGINEERING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	The purpose of learning this course is to:	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Acquire the Knowledge of object-oriented software and development methodologies															
CLR-3:	Improve their ability to choose the appropriate Elicitation Technique and document the requirements															
CLR-4:	Familiarize with the various Analysis and design techniques															
CLR-5:	Practice the concepts of implementing high quality software															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Recognize object-oriented software and development methodologies	3	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Identify the appropriate Elicitation Technique and document the requirements	-	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Apply various Analysis and design techniques	-	-	3	-	-	-	-	-	-	-	-	-	-	2	-
CO-4:	Use object-oriented implementation concepts to produce quality software	-	2	3	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Relate the Object-oriented testing and maintenance concepts while doing testing and maintenance of software	2	-	3	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction	9 Hour
Introduction to Software Engineering, Object orientation, Object oriented methodologies, Object oriented modeling, Terminologies used in object-oriented development, Object oriented Software life cycle models, Selection of software development life cycle models	
Unit-2 - Software Requirements and Estimation	9 Hour
Software requirements, Software Requirement Elicitation techniques, Initial Requirement Document, Use case Approach, Characteristics of good requirements, Software Requirement specification document, Object oriented software Estimation: Lorenz and Kidd Estimation method, Use case points method, Object oriented function point, Case Study: For the given application apply use case approach to Elicit the requirements and validate and document the specifications	
Unit-3 - Object Oriented Analysis and Design	9 Hour
Object oriented Analysis-Structured Analysis and object-oriented analysis-Identification of class-Identification of relationships – Identifying state and behavior. Object oriented design-: Interaction diagrams-sequence and collaboration diagrams-Refinement of use case descriptions, refinement of class, Creation of software design document, Generating test cases from use cases, Object oriented design Principles. Case study. For the given application do Analysis and Design	
Unit-4 - Object Oriented Design to Implementation	9 Hour
Activity Diagram, State chart diagram, storing persistent data in database, Implementing the class, Software quality metrics. Case study: For the given application create Activity diagram, State chart diagram	
Unit-5 - Object Oriented Software Testing and Maintenance	9 Hour
Software Testing, Software verification Techniques, Functional Testing, Structural Testing, Class testing, Levels of testing, Testing Tools, Software maintenance, Categories of Software maintenance, Challenges of Software maintenance, Maintenance of object-oriented software, Software Rejuvenation.	

Learning Resources	1. Yogesh Singh, Ruchika Malhotra, " Object Oriented Software Engineering", PHI Learning Private Ltd., Eastern Economy Edition, 2012	3. Gerardus Blokdyk, Object oriented Software Engineering: A complete Guide, ISBN-10 : 1867300230, 2020
	2. Stephen R. Schach, " Object-Oriented and Classical Software Engineering" Eighth Edition, y McGraw-Hill, 2011	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	30%	-	30%	-
Level 2	Understand	40%	-	30%	-	30%	-
Level 3	Apply	20%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Joseph Thankarajan, CTS, Chennai	1. Dr. John T. Mesiah Dhas, Associate Professor, T. John Institute of Technology, Bangalore	1. Dr. T.S. Shiny Angel, SRMIST

Course Code	21CSE392T	Course Name	PYTHON FOR SOFTWARE ENGINEERING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand Software Engineering and Python	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Familiarize about Software Development and Data structures in Python															
CLR-3:	Learn GUI programming and Popular Python packages															
CLR-4:	Design patterns in Python															
CLR-5:	Apply Software Testing using Pytest															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Gain knowledge on the basics of Software Engineering and Python programming language	1	-	2	-	-	-	-	-	-	-	-	-	-	1	1
CO-2:	Acquire knowledge on software design and development using Python	1	-	3	2	-	-	-	-	-	-	-	-	-	1	2
CO-3:	Familiarize working with database, GUIs, and get introduced to popular packages in Python	1	-	3	2	-	-	-	-	-	-	-	-	-	1	3
CO-4:	Recognize different types of design patterns and study popular patterns	1	-	3	3	-	-	-	-	-	-	-	-	-	2	3
CO-5:	Comprehend the use of Pytest to perform software testing	1	-	2	-	3	-	-	-	-	-	2	-	-	-	-

Unit-1 - Introduction	9 Hour
Introduction to Software Engineering and Programming - Software Development Life Cycles - Introduction to Python - Python Setup - Download and install Python - PyCharm IDE - Create Python project in PyCharm - Variables in Programming - Writing Programs in Python - Variables, expressions, and statements - Functions - Conditionals and recursion - Iteration	
Unit-2 - Software Development Using Python	9 Hour
Software Development using Python - Modules - PIP - Try Except Blocks - Date time - Random numbers - Strings - Lists - Tuples - Dictionaries - Linked lists - Stacks - Queues - Trees - Files and exceptions - Classes and objects - Classes and functions - Classes and methods - Inheritance – Case study application	
Unit-3 - Database Operations and GUI Programming in Python	9 Hour
Crud operation Python using MySQL – Linting - GUI in Python - Tkinter Programming - Tkinter Widgets - Standard attributes - Python Tkinter Geometry - Data Visualization in Python - Creating line graph - Pie chart - Bar Graph - Python Packages – GUI and Database operations case study	
Unit-4 - Design Patterns in Python	9 Hour
Pattern Types - Creational Patterns: Singleton - Factory Method - Constructor/Builder - Structural patterns: Adapter - Decorator - Facade - Behavioral Patterns: Observer - Chain of Responsibility - State - Strategy	
Unit-5 - Software Testing Using Pytest	9 Hour
Pytest - Use pytest Using Python - pytest Fixtures - Assertions In pytest - Parametrization In pytest - Decorators In pytest - Run Specific Tests - Example Real world Program	

Learning Resources	1. David M. Beazley, "Python Distilled", Addison-Wesley Professional (2021)	4. Sean Bradley, "Design Patterns in Python: Common GOF (Gang of Four) Design Patterns implemented in Python", (2022)
	2. Allen B. Downey, "Python for Software Design: How to Think Like a Computer Scientist", Cambridge University Press (2009)	5. Brian Okken, "Python Testing with pytest-Simple, Rapid, Effective, and Scalable", Second Edition (2022)
	3. Alan D. Moore, "Python GUI Programming with Tkinter: Design and build functional and user-friendly GUI applications", 2nd Edition (2021)	6. www.python.org

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	30%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	30%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mrs. S. Gokularani, L&T Infotech, Chennai	1. Dr.P.Shanthi Bala, CS, Pondicherry University, Puducherry	1. Dr. M Vimaladevi, SRMIST

Course Code	21CSE393T	Course Name	ANALYSIS OF SOFTWARE ARTIFACTS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Infer software quality metrics	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Articulate Software Analysis and vulnerabilities															
CLR-3:	Examine software testing and tools															
CLR-4:	Attribute Automated test generation															
CLR-5:	Deduce Software Maintenance concepts															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Summarize the knowledge of software quality metrics	-	2	-	2	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Determining procedures of software analysis	-	2	-	2	2	-	-	-	-	-	-	-	-	1	-
CO-3:	Articulate software testing strategies and tools	-	2	-	2	2	-	-	-	-	-	-	-	-	-	3
CO-4:	Analyse the approaches to Automated test generation	-	3	-	2		-	-	-	-	-	-	-	-	1	-
CO-5:	Examine software maintenance models	-	3	-	2	2	-	-	-	-	-	-	-	-	-	3

Unit-1 - Software Quality Metrics	9 Hour
Measurement basics, Analyzing the metric data, Metrics for measuring size and structure, Object-oriented metrics, Software Quality models	
Unit-2 - Software Analysis	9 Hour
Introduction to Static analysis- Static analyzer for finding dynamic programming errors-data flow testing – a procedure to apply data flow testing- examples performance analysis and verification- Security analysis and verification – Software vulnerabilities and exploitation	
Unit-3 - Software Testing	9 Hour
Software verification testing, Functional testing, Structural testing, State-based testing, Mutation testing, and Software testing tools, Case study with Software Testing	
Unit-4 - Automated Test Generation	9 Hour
Approaches to testing data generation, Test data generation using genetic algorithms, and Test data generation tools	
Unit-5 - Software Maintenance	9 Hour
Categories of Software Maintenance, Challenges of Software Maintenance, Maintenance of Object-Oriented Software, Case study: Estimation of Maintenance Effort - Belady and Lehman Model, Boehm Model	

Learning Resources	1. Yogesh Singh & Ruchika Malhotra, Object-Oriented Software Engineering, PHI Learning Private Limited, 2019	4. Tyson R. Browning, "Applying the design structure matrix to system decomposition and integration problems", A review and new directions IEEE Transactions on Engineering Management, Vol. 48, No.3, August 2001.
	2. Yogesh Singh, Software Testing, Cambridge University Press, 2020	5. Neeraj sangal and Frank Waldman "Dependency models to manage software Architecture: Journal of Defense software engineering, November 2005. Online at www.stsc.hill.af.mil
	3. Kshirasagar Naik and Priyadarshi Tripathy "Software Testing and Quality Assurance: theory and practice, edited by copyright John Wiley & sons Inc, 2008.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	30%	-	30%	-
Level 2	Understand	40%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	-	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ruhina Abideen, Assistant Consultant. TCS, ruhina.abideen@tcs.com	1. C Ramesh, Associate professor, CVR College of Engineering, Hyderabad	2. Dr.G. Senthil Kumar SRMIST

Course Code	21CSE396T	Course Name	DESIGN PRINCIPLES OF SMART SPACE MANAGEMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand Space fundamentals and IoT Architecture			1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2:	Learn different Protocols for IoT Design			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	Familiarize the Concepts of smart space design																	
CLR-4:	Build IoT with Raspberry Pi and Arduino for smart space																	
CLR-5:	understand the role of psychology in space making and applying IoT in space design																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Distinguish IoT applications in different domains			3	2	2	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Apply various protocols for design of IoT systems			3	2	2	-	-	-	-	-	-	-	-	-	1	2	-
CO-3:	Illustrate the techniques for smart spaces			3	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Deploy an IoT application using Raspberry Pi/Arduino			3	2	2	-	-	-	-	-	-	-	-	-	1	2	3
CO-5:	Analyze applications of IoT in Real time scenario			3	2	2	-	-	-	-	-	-	-	-	-	1	2	3

Unit-1 - Introduction to Space Design and IoT	9 Hour
Introduction to spatial design, Characteristics of space design aspects, Spatial Requirements, User & function, Standards & Requirements in spatial Design, Introduction to Internet of Things - Characteristics of IoT, IoT Network Architecture and Design, Drivers Behind New Network Architectures, Comparing IoT Architectures – The oneM2M IoT Standardized Architecture, The IoT World Forum (IoTWF) Standardized Architecture, A Simplified IoT Architecture, The Core IOT Functional Stack, IoT Data Management and Compute Stack Hierarchy of Edge, Fog and Cloud, Smart Objects: Things in IOT, Sensors, Actuators, Micro-Electro- Mechanical Systems (MEMS) and Smart objects, Sensor Networks, Wireless Sensor Networks (WSNs)	
Unit-2 - IoT Protocols	9 Hour
Protocol Standardization for IoT, M2M and WSN Protocols, SCADA and RFID Protocols, Unified Data Standards, WPAN Technologies for IoT, Protocols – IEEE 802.15.4, Zigbee Architecture, Wireless HART, Near-field communication (NFC), Z-Wave, Bluetooth Low Energy (BLE), BACnet, Modbus IP Based Protocols for IoT, Network layer – 6LowPAN, CoAP, Edge connectivity and protocols, Cloud Platforms for IOT	
Unit-3 - Smart Space Design	9 Hour
Introduction to smart spaces, Need and Significance of smart space, Example projects for smart space, Presentation, Factors considered for smart space design, Need User profile, Factors considered for smart space design Activity Efficiency required, Application of smart concepts in space Lighting, Application of smart concepts in space Automation Signage, Exercise and Discussion (essential factors and applications)	
Unit-4 - IoT Development Boards	9 Hour
IoT Development Boards: Arduino IDE and Board Types, Building IOT with Raspberry Pi, IoT Systems - Logical Design using Python, IoT Physical Devices & Endpoints, IoT Device -Building blocks - Raspberry Pi – Board-,Linux on Raspberry Pi, Raspberry Pi Interfaces, Programming Raspberry Pi with Python, Other IoT Platforms – Arduino, Interfacing Relay Driver with Arduino Uno, Programming Logic to Control Electrical Devices via Bluetooth using Arduino, Control Electrical Devices via Bluetooth Communication, Check Electrical Device status over Internet, Implementation of Home Automation using Arduino.	
Unit-5 - Psychology and Future Trends	9 Hour
Role of user experience in spatial design, Introduction to Psychology in space making – smart spaces, Impact of Psychology in space making – IQ, Impact of Psychology in space making – EQ, Impact of Psychology in space making – SQ, Applications in smart spatial Design, Examples for Current research and Future trends in smart spatial design, Case Study: Smart Home Automation, Case Study: Smart Lighting.	

Learning Resources	1. David Hanes, Gonzalo Salgueiro, Rob Barton , "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press, 2017 13. Arshdeep Bahga, Vijay Madisetti, –Internet of Things – A hands-on approach, Universities Press, 2015 14. Hakima Chaouchi, – "The Internet of Things Connecting Objects to the Web" ISBN : 978-1- 84821-140-7, Wiley Publications 15. Olivier Hersent, David Boswarthick, and Omar Elloumi, – "The Internet of Things: Key Applications and Protocols", Wiley Publications 16. Juan Carlos Augusto, Chris D Nugent, "Designing Smart Homes", Springer	17. Tom Hargreaves, Charlie Wilson, "Smart Homes and their users", Springer 18. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), –Architecting the Internet of Things, Springer, 2011. 19. https://in.pcmag.com/simplisafe-home-security-system/129484/how-to-set-up-your-smart-home-a-beginners-guide 20. https://www.homebuilding.co.uk/advice/how-to-design-a-smart-home 21. https://www.archdaily.com/936027/psychology-of-space-how-interiors-impact-our-behavior 22. https://sushantuniversity.edu.in/blog/do-you-know-how-psychology-of-space-is-impacting-interior-designing/ 23. https://www.ylighting.com/blog/smart-home-lighting-guide/
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
3. Ar.Apsaran Raja, Kaalo, NID, Chennai	2. Prof. Premkumar, NIT Trichy	5. Dr.R.Annie Uthra, SRMISTL 6. Dr.M.Ferni Ukrit, SRMIST
		7. Mrs.Sri Vallaba, Architecture and Interior Design, SRMIST 8. Dr.A.Alice Nithya, SRMIST

Course Code	21CSE421T	Course Name	BUSINESS INTELLIGENCE AND ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1 :				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1 :	Familiarize with Business Intelligence, Analytics and Decision Support			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2 :	Understand the technologies for Decision making																	
CLR-3 :	Familiarize with predictive modeling techniques																	
CLR-4 :	Familiarize with sentiment analysis techniques																	
CLR-5 :	Understand about Decision making systems																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Gain knowledge on Business Intelligence, Analytics and Decision Support			-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Understand the technologies for Decision making			-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Apply predictive modeling techniques			-	-	-	-	-	-	-	3	-	3	-	-	2	-	-
CO-4:	Apply sentiment analysis techniques			-	-	-	-	-	-	-	3	-	3	-	-	-	-	2
CO-5:	Gain knowledge on Decision making systems			-	-	-	-	-	-	-	3	-	3	-	-	-	1	1

Unit-1 - Introduction: Business Intelligence, Analytics and Decision Support	9 Hour
Information Systems Support for Decision Making - An Early Framework for Computerized Decision Support - The Concept of Decision Support Systems - A Framework for Business Intelligence - Business Analytics Overview - Brief Introduction to Big Data Analytics - Clickstream Analysis – Metrics - Clickstream Analysis - Practical Solutions - Competitive Intelligence Analysis T1: Introduction to Power BI and SSMS T2: Installing Power BI and SSMS T3: Prepare data in Power BI Desktop	
Unit-2 - Decision Making	9 Hour
Decision Making - Introduction and Definitions - Phases of the Decision - Making Process - The Intelligence Phase - Design Phase - Choice Phase - Implementation Phase - Decision Support Systems Capabilities - Decision Support Systems Classification - Decision Support Systems Components T4: Load data in Power BI Desktop T5: Model data in Power BI Desktop part-1 T6: Model data in Power BI Desktop part-2	
Unit-3 - Predictive modeling and sentiment analysis	9 Hour
Basic Concepts of Neural Networks - Developing Neural Network - -Based Systems - Illuminating the Black Box of ANN with Sensitivity - Support Vector Machines - A Process Based Approach to the Use of SVM - Nearest Neighbor Method for Prediction -Sentiment Analysis Overview - Sentiment Analysis Applications - Sentiment Analysis Process - Sentiment Analysis - Speech Analytics T7: Implement data model using SQL in Power BI T8: Create DAX calculations in Power BI Desktop part-1 T9: Create DAX calculations in Power BI Desktop part-2	

Unit-4 - Multi-criteria Decision making systems	9 Hour
Decision Support Systems modeling - Structure of mathematical models for decision support - Decision making under certainty - Uncertainty and Risk - Decision modeling with spreadsheets - Mathematical programming optimization - Decision analysis introduction - Decision tables - Decision Trees - Multi-criteria decision making - Pairwise comparisons	
T10: Design a report in Power BI Desktop part-1	
T11: Design a report in Power BI Desktop part-2	
T12: Create a Power BI dashboard	
Unit-5 - Automated Decision Systems	9 Hour
Automated Decision Systems - The Artificial Intelligence field - Basic concepts of Expert Systems - Applications of Expert Systems - Structure of Expert Systems - Knowledge Engineering - Development of Expert Systems - Location based Analytics - Cloud Computing - Business Intelligence	
T13: Create a Power BI paginated report	
T14: Perform data analysis in Power BI Desktop	
T15: Enforce Row-level security	

Learning Resources	<p>4. Ramesh Sharda, Dursun Delen, Efraim Turban, J.E. Aronson, Ting-Peng Liang, David King, "Business Intelligence and Analytics: System for Decision Support", 10th Edition, Pearson Global Edition, 2013.</p> <p>5. Brett Powell, "Mastering Microsoft Power Bi: Expert techniques for effective data analytics and business intelligence", 2018</p> <p>6. Alberto Ferrari Marco Russo, "Definitive Guide to DAX, The: Business intelligence for Microsoft Power BI, SQL Server Analysis Services, and Excel", Second Edition, By Pearson, 2020</p>
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
2. Mr.V.Selvakumar, Hexaware Technologies, selvakumarv@hexaware.com	2. Dr. T. Veerakumar, Professor, NIT Goa	2. Dr. T. Karthick, DSBS, SRMIST

Course Code	21CSE493T	Course Name	SOFTWARE SECURITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Comprehend the need for Software Security and the threats to software security	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Realize Secure software architecture design and coding															
CLR-3:	Gain basic knowledge on web security principles															
CLR-4:	Acquire risk management and mitigation of risk in software development															
CLR-5:	Learn testing types and strategies for secure software															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Identify security threats and issues in software	-	-	-	3	-	-	-	-	-	-	-	-	-	1	3
CO-2:	Prepare software by incorporating security principles	-	2	3	-	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Predict the issues in web and database security	-	-	2	3	-	-	-	-	-	-	-	-	-	1	-
CO-4:	Apply risk management strategies and risk mitigation strategies in software development	-	-	2	-	-	-	-	-	-	-	-	-	-	1	3
CO-5:	Use testing strategies for secure software development	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction	9 Hour
Introduction to software Security- Software assurance and software security - Threats to Software security - Sources of Software Insecurity - Benefits of detecting software security defects early - Managing Secure software development - Risk Management framework for Software security - Software security practices in the development lifecycle - Properties of secure software - Influencing security properties of software - Building a security assurance case - Incorporating assurance cases into SDLC -Security Requirements Engineering	
Unit-2 - Secure Software Architecture and Design	9 Hour
Software security practices for architecture and design - Software security knowledge for architecture and design - Software characterization - Threat analysis - Architectural vulnerability assessment - Risk likelihood determination - Risk Impact Determination - Risk Mitigation Planning - Security principles - Security guidelines and attack patterns - Secure coding and testing - Code analysis - common software code vulnerabilities - Source code review - Coding practices - Best practices for secure coding	
Unit-3 - Client and Server-Side Security	9 Hour
Browser Security Principles - Defining the same-origin policy - Client-side vs. server-side - Exceptions to the same origin policy- Cross-site scripting- XSS defense- Cross-site request forgery - CSRF defense - Prevent XSS -SQL Injection - SQL Injection effects - Blind SQL Injection - Setting Database Permissions - Stored Procedure Security - SQL Injection in stored procedures, Case study: Application with Client-side Security, Application with server side security.	
Unit-4 - Risk Management	9 Hour
Risk Management framework - Five stages of activity- Applying the RMF- Understanding the business context - Gathering the artifacts, conducting project research, Identifying the business and technical risk, Developing risk questionnaires, interviewing the target project team, Analyzing the research and interview data - Uncovering technical risks - Analyzing software artifacts - Synthesizing and ranking the risk - Reviewing the risk data - Conducting the business and technical peer review - Defining the risk mitigation strategy - Risk Management is a framework for Software security	

Unit-5 - Software Security Testing	9 Hour
About Software Security testing - Contrasting software testing and software security testing - Functional testing - Risk-based testing - Penetration Testing - Security testing consideration throughout the SDLC - Unit testing - Testing Libraries - Testing Executable files- Integration testing - System Testing - Security Failures - Categories of Errors - Attacker Behaviour - Functional and attacker perspectives for Security Analysis -Identity Management and Software development, Case study on Software security Testing.	

Learning Resources	1. Gary McGraw, "Software Security-A guide for Project Managers", Addison-Wesley, Professional,2008,ISBN-13:978-0321509178 2. Andrew Homan, "" Web Application Security Exploitation and Countermeasures for Modern Web Applications", O'Reilly Media, Inc, First edition,2020 3. JamesM.Helfrich, "Security for Software Engineers", CRC Press, Taylor and Francis Group, 2019 4. James Ransome, Anno IMisra," Core Software Security", CRC Press, Taylor, and Francis Group, 2014.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Joseph Thankarajan, TCS Chennai	1. Dr. John T.Mesiah Dhas, Associate Professor, T.John Institute of Technology, Bangalore	1. Dr.T.S.Shiny Angel, SRMIST

Course Code	21CSE495T	Course Name	ARTIFICIAL INTELLIGENCE IN AGILE SYSTEMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Introduce a broad understanding of basic concepts of Artificial Intelligence and Agile systems	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Illustrate the Software design patterns for implementing Agile systems in real world applications															
CLR-3:	Demonstrate the Various Agile AI process and outcomes															
CLR-4:	Analyze the Various Agile design principles in various applications															
CLR-5:	Discuss the Knowledge in Applications of Artificial intelligence and Agile systems in Industry															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Familiarize the concepts of Artificial Intelligence inn Agile systems and planning methods	3	3	-	-	-	-	-	-	-	-	-	-	1	2	2
CO-2:	Understand the various software design patterns for appropriate scenarios	3	2	-	-	-	-	-	-	-	-	-	-	-	2	2
CO-3:	Acquire the knowledge in Agile AI process and outcomes	3	2	2	-	-	-	-	-	-	-	-	-	1	-	3
CO-4:	Gain knowledge on various agile design principles in real world industry	3	2	2	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Categorize the applications of Artificial Intelligence in Agile systems in designing applications	3	2	2	-	-	-	-	-	-	-	-	-	-	2	-

Unit-1 - Introduction to AI and Agile Techniques	9 Hour
Intelligent Agents, Problem Solving with AI, Intelligent Agents, Structure of Agents, Agile Alliance, Principles of Agile Practices, Practices of Extreme Programming, Planning –Initial Exploration, Release Planning, Iteration planning , Task planning, Challenges in Traditional Systems, Real time applications of AI in Agile systems, Test driven development, Acceptance Test, Serendipitous Architecture, Serendipitous decoupling	
Unit-2 – Design Patterns and Applications	9 Hour
Symptoms of poor design, Principles of a good design, Types of design patterns, Strategy design Pattern, Real time Applications of Strategy design Pattern, Mediator design pattern, Real time Applications of Mediator design pattern, Singleton design pattern, Real time Applications of Singleton design pattern, Factory design pattern, Real time Applications of Factory design pattern Façade design Pattern	
Unit-3 – Agile AI Process	9 Hour
Agile Approach, AI process for business today, Agile design Example, Agile approach in AI, Organizing Agile for AI Data Scientist, Organizing Agile for AI Data Engineers, Organizing Agile for AI Business Analysts, Need for Agile in AI, Contrasting Machine Learning and AI, Advantages of Agile AI, Agile Framework for AI Projects, Case study: Identify which pattern is applicable for the given case study and justify, Case Study : Prediction of disease patterns and proactive care	
Unit-4 – Agile Design Principles	9 Hour
Liskov Substitution Principle, Example of a violation of LSP, Real Example of Liskov Substitution Principle, Factoring Instead of Deriving, Heuristics and Conventions Dependency inversion principle, Layering, Dynamic Vs static polymorphism, Interface Segregation principle, Backward force applied by clients on Interfaces, Class interfaces vs Object Interfaces, Case study: Identify which pattern is applicable for the given case study and justify, Case Study : Credit card and loans fraud patterns and utilization	
Unit-5 – Agile in Healthcare	9 Hour

Learning from Real-Time, Big Data Applications of AI in health care, Realizing the Potential of AI in Healthcare, Evolution of Data and Its Analytics, Real time Challenges of Big Data, Impact of Data in Future, Ethics of Artificial Intelligence and Machine Learning, Prediction Ethics, Preventing Algorithms from Becoming Immoral, Real time applications of Agile systems, AI and Agile systems in health care, Future of Health care, Industrial Impact of Artificial Intelligence in health care, Industrial Impact of Artificial Intelligence in Agile System, Case Study : Designing a Document Editor : Design Problems, Document Structure, Case Study : Customer experience: Chat bot to substitute patient/member engagement

Learning Resources	1. Stuart J. Russell, Peter Norvig , Artificial Intelligence –A Modern approach, 3rd Pearson Education, 2016	4. Robert C. Martin, Agile Software Development, Principles, Patterns, and Practices, Pearson Education, 2002
	2. Arjun Panesar, Machine Learning and AI for Healthcare Big Data for Improved Health Outcomes, Apress , 2019	5. Bernhard Rumpe , Agile Modeling with UML Code Generation, Testing, Refactoring, Springer 2017
	3. Carlo Appugliese, Paco Nathan, William Roberts, Agile AI, O'Reilly Media, Inc. 2020	6. Andrew Stellman & Jennifer Greene, Head First Agile, A Brain-Friendly guide, Oreilly , 2017

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.S..Ravikumar , Director , Agile Practise, TEK System, Chennai		1. Dr T R Saravanan , SRMIST
		2. Dr.G.Maragatham , SRMIST

Course Code	21CSE496T	Course Name	DEEP LEARNING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the mathematical building blocks of Deep learning	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Get familiar with tuning of Deep Neural Network and layered approach															
CLR-3:	Understand different architectures of Deep Networks															
CLR-4:	Design and implement CNN for computer vision application using TensorFlow/ Keras															
CLR-5:	Design and implement RNN for text and sequence processing application using TensorFlow/ Keras															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the mathematical building blocks of Neural networks	3	1	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Learn the foundations of Neural network and training them	3	1	3	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Understand Architectural principles of neural network and major architectures of Deep Networks	2	2	3	-	3	-	-	-	-	-	-	-	-	2	-
CO-4:	Implement CNN model for computer vision application using TensorFlow/ Keras	2	2	3	-	3	-	-	-	-	-	-	-	-	3	2
CO-5:	Implement RNN model for text and sequence processing application using TensorFlow/ Keras	2	2	3	-	3	-	-	-	-	-	-	-	-	3	2

Unit-1 - Introduction to Deep Learning	9 Hour
Artificial intelligence - Machine learning - Learning representations from data - Understanding how deep learning works - mathematical building blocks of neural networks - Data representations for neural networks - Scalars - Vectors - Matrices - 3D tensors and higher-dimensional tensors - Key attributes - Vector data - The gears of neural networks: tensor operations - Element-wise operations - Tensor dot	
Unit-2 - Foundations of Neural Network and Deep Learning	9 Hour
Neural Networks – The Biological Neuron – The Perceptron – Multilayer feed forward networks – Training neural networks – Backpropagation Learning – Activation functions – Linear – Sigmoid – Tanh - SoftMax – Loss Functions – Hyperparameters – Learning rate – Regularization – Momentum – Sparsity	
Unit-3 - Fundamentals of Deep Networks	9 Hour
Architectural principles of Deep Networks – Parameters – Layers – Activation functions – Loss functions – Optimization algorithms – Hyperparameters – Building blocks of Deep Networks – RBMs – Autoencoders – Variational Autoencoders – Major architectures of Deep Networks – Deep belief Networks – Generative Adversarial Networks – Convolution Neural Networks – Recursive Neural Networks	
Unit-4 - Deep learning for Computer Vision	9 Hour
Introduction to convnets -The convolution operation - The max-pooling operation-Training a convnet from scratch on a small dataset -The relevance of deep learning for small-data problems - Downloading the data – Building your network - Data preprocessing - Using data augmentation - Using a pre trained convnet - Feature extraction - Fine Tuning - Visualizing what convnets learn - Visualizing intermediate activations - Visualizing convnet filters - Visualizing heatmaps of class activation	

Unit-5 - Deep Learning for Text And Sequences	9 Hour
Working with text data - One-hot encoding of words and characters - Using word embeddings - Putting it all together: from raw text to word embeddings - Understanding recurrent neural networks - A recurrent layer in Keras - Understanding the LSTM and GRU layers - A concrete LSTM example in Keras - Advanced use of recurrent neural networks - A temperature-forecasting problem - Preparing the data - first recurrent baseline - Using recurrent dropout contents to fight overfitting - Stacking recurrent layers - Using bidirectional RNNs - Sequence processing with convnets - Understanding 1D convolution for sequence data -1D pooling for sequence data - Implementing a 1D convnet – Combining CNNs and RNNs to process long sequences	
Case Studies:	
<ol style="list-style-type: none"> 1. Develop a framework to classify facial expression using Convolutional Neural Network. Consider six basic emotional categories of anger, disgust, fear, happiness, sadness, and surprise and classify them without any complex pre-processes 2. NLP models can be used for text classification in order to detect spam-related words, sentences, and sentiment in emails, text messages, and social media messaging applications. Implement an NLP system to classify spam messages 	

Learning Resources	<ol style="list-style-type: none"> 1. Deep Learning A Practitioner's Approach, Josh Patterson & Adam Gibson, published by O'Reilly Media, Inc, First Edition, 2017 2. Deep Learning with Python, FRANÇOIS CHOLLET, published by Manning Publications Co, 2018 3. Better Deep Learning Train Faster, Reduce Overfitting and Make Better Predictions, Jason Brownlee, Machine Learning Mastery, 2019. 	<ol style="list-style-type: none"> 4. Deep Learning for Beginners: A Beginner's Guide to Getting Up and Running with Deep Learning from Scratch Using Python. Dr. Pablo Rivas and Laura Montoya, published by Packt publishing, 2020
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	30%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.A.Vasanthi, Senior Consultant, Slalom · Sydney, New South Wales, Australia	1. Dr.A.Puniitha, Associate Professor, Annamalai University	1. Dr.A.Revathi, SRMIST

Course Code	21CSE497T	Course Name	GAMING AND VIRTUAL REALITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the fundamentals of Virtual Reality	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the basics of perception and human vision															
CLR-3:	Introduce the concepts of motion and tracking in VR tools															
CLR-4:	Understand the basic concepts of game design															
CLR-5:	Develop a game using Unity															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Summarize the concepts of Geometry of Virtual Reality	3	-	-	-	2	-	-	-	-	-	-	1	-	-	-
CO-2:	Explain the basics of visual perception and rendering	3	-	2	-	2	-	-	-	-	-	-	1	-	2	-
CO-3:	Apply the concepts of motion and tracking in VR	3	-	3	-	2	-	-	-	-	-	-	1	-	2	2
CO-4:	Learn the concepts of game designing	3	-	2	-	2	-	-	-	-	-	-	1	-	2	-
CO-5:	Apply the concepts of game designing to develop a game using Unity	3	-	3	-	2	-	-	-	-	-	-	1	-	3	2

Unit-1 - Introduction to. Virtual Reality	9 Hour
Defining Virtual Reality, History of VR, Scientific landmarks Computer Graphics, Basics of Geometric Models, Degree of freedom, Changing the position and Orientation, Introduction to Axis-Angle Representations of Rotation-, Basics of Transformations-Representation of the Virtual World, Virtual environments, Visual Displays, Auditory Displays, Haptic Displays.	
Unit-2 - Visual Perception & Rendering	9 Hour
Human Physiology and Perception, Human Eye, eye movements, Perception of Depth, Perception of Motion, Perception of Color, World Environment, VR Environment, Key Elements of Virtual Reality Experience, Interface to the Virtual World-Input & output, Combining Sources of Information Visual Rendering-Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates	
Unit-3 - VR Tools, Motion & Tracking:	9 Hour
R database, VR toolkits, Software for VR, Tessellated Data, Lights and Camera, Scripts, Graphical User Interface, Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World Mismatched Motion and Vector Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies	
Unit-4 - Introduction to Game Design	9 Hour
Game Design and Paper Prototyping - Game Analysis Frameworks - Inscribed Layer, Dynamic Layer - Cultural Layer, Design Goals - Paper Prototyping, Puzzle Design - The Digital Game Industry, Digital Prototyping - Introducing Development Environment: Unity - Thinking in Digital Systems - Introducing C# - Variables and Components - Boolean Operations and Conditionals - Functions and Parameters	
Unit-5 - Basics of Game Development	9 Hour
Basics of Game Development - Scenes, Game Objects, Components - Working with Unity 2D & 3D - 2D graphics, Camera - Sprites a Texture Atlases – Animation – Scrolling - Overview of vector math - Physics principles - 3D math primer Basics of 3D World, 3D rendering Essentials - Using Unity for 3D development	

Learning Resources	<ol style="list-style-type: none"> 1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016 2. Virtual and Augmented Reality: An Educational Handbook, Zeynep Tacgin , Cambridge Scholars Publishing, 2020 3. Jeremy Gibson, "Introduction to Game Design, Prototyping, and Development: From Concept to Playable Game with Unity and C#" ISBN-10:0321933168. 2014 4. Sanjay Madhav, "Game Programming Algorithms and techniques", Addison-Wesley, 2013 	<ol style="list-style-type: none"> 5. Jonathon Manning, Paris Buttfield-Addison, "Mobile Game Development with Unity: Build Once, Deploy Anywhere", O'Reilly Media Inc., 2017 6. Steve Aukstakalnis , "Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR" 2016, Publisher(s): Addison-Wesley Professional 7. https://nptel.ac.in/courses/106/106/106106138/
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Tejas Gowda, Co-Founder & Chief Data Scientist, TenzAI	1. Dr. T. Senthilkumar, Associate Professor, Amrita School of Engineering, Amrita Vishwa Vidyapeetham	1. Dr. A. Alice Nithya, SRMIST

Course Code	21CSE498T	Course Name	SMART PHONE COMPUTING AND ITS APPLICATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Introduce the basic terminologies of mobile computing, fundamental concepts of mobile programming environment	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand about smartphone energy management, localization techniques, location privacy issues															
CLR-3:	Expertise to Mobile Social Networking															
CLR-4:	Learn about context-awareness and gesture recognition methodologies															
CLR-5:	Exposure to Advanced Mobile Applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand Networking basics and Different MPE	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-2:	Gain Knowledge of Wireless energy and localization	3	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Introduce State of Art research in mobile computing technologies	3	-	-	2	3	-	-	-	-	-	-	-	-	1	2
CO-4:	Gain knowledge in recognition methodologies	3	-	-	-	3	-	2	-	-	-	-	-	-	1	-
CO-5:	Understand Advanced Mobile Applications	3	-	-	2	3	-	1	-	-	-	-	-	-	1	2

Unit-1 - Networking Basics	9 Hour
Wireless LAN, Bluetooth, WIFI Direct, NFC Programming platforms: Overview of different mobile programming environments, Difference with the classical programming practices, Introduction to mobile operating systems, iOS, Android, Windows, Mobile application development. Introduction to IoT: Definition, trend, IoT components, Data cleaning and processing, Social-IoT	
Unit-2 - Wireless Energy Management	9 Hour
Measurement of energy consumption, WiFi Power Save Mode (PSM), Constant Awake Mode (CAM), Different Sleep States, WiFi Energy management Localization: User location and tracking system, Cell tower localization, Spot localization, Logical location, Ambience fingerprinting, War-driving, Localization without war-driving, Indoor localization, Crowdsourcing for localization. Context Sensing: Context-Aware system, Automatic Image Tagging, Safety critical applications Energy-efficient Context Sensing, Contextual Ads and Mobile Apps.	
Unit-3 - Mobility	9 Hour
Overview of Mobility models, Automatic Transit Tracking, Mapping, Arrival Time Prediction, Augmenting Mobile 3G with WiFi, Vehicular WiFi Hotspots, Code Offload Privacy and Security: Authentication on Mobile Phones, Activity based Password, Finger Taps usage as Fingerprints, Location Privacy	
Unit-4 - Mobile Affective Computing	9 Hour
Human Activity and Emotion Sensing, Health Apps Activity and Gesture Recognition: Machine Recognition of Human Activities, Mobile Phones to Write in Air, Crowdsensing based activity recognition, Personalized Gesture Recognition, Content Rating, Recognizing Human without Face Recognition, Phone-to-Phone Action Games, Interface design issues, Touchscreen, Gesture-based Input.	
Unit-5 - Case Studies	9 Hour
Smartphone App game, Determining driver phone use, Smart phone Configuration I Tourism, Network Monitoring using smart phone.	

Learning Resources	1. Smart Phone and Next Generation Mobile Computing" Morgan Kaufmann Series in Networking, PeiZheng, Lionel Ni 1 st Edition ELSEVIER 2005	3. https://ieeexplore.ieee.org/search/searchresult.jsp?newsearch=true&queryText=determining%20driver%20phone%20use
	2. " Principles Of Mobile Computing", Hansmann, LotharMerk, Martin Niclous, Stober, reamtech Press 2006 2 nd Edition	4. https://link.springer.com/book/10.1007/b102605
		5. https://ieeexplore.ieee.org/document/7152220 .

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.R.Jaya,Data Scientist, Great Learning ,Bangalore.	1. Dr.R. Senthikumar, Associate professor, Dept of CSE, New Horizon college of Engineering, Bangalore.	1. Dr.Dinesh G, SRMIST
	2. Dr.N. Thillai Arasu, Associate Professor, School of CSE &IT, Reva University, Bangalore	

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 11D

**(Syllabi for Computer Science and Engineering w/s in
Cloud Computing Programme Courses)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC316J	Course Name	CLOUD ARCHITECTURE AND PROTOCOLS	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Explore cloud computing models and infrastructure for various networks.	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Identify policies, mechanisms and scheduling for resource management, virtualization, and optimization of networks.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	Compare multiple approaches to cloud system design and solve real world problems																											
CLR-4:	Illustrate storage concept and self-organizing capability for different cloud systems																											
CLR-5:	Relate Cloud architecture into business models																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Explore the concepts of cloud infrastructure, for different cloud models	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-												
CO-2:	Monitor the scalability issues and its performance in a distributed environment	3	2	-	-	3	-	-	-	-	-	-	-	3	-	3												
CO-3:	Apply the principle of virtualization, storage, and data management for resource utilization	3	-	-	-	3	-	-	-	-	-	-	-	-	-	3												
CO-4:	Create application by utilizing cloud platforms	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3												
CO-5:	Relate Cloud architecture with maximization of service delivery	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-												

Unit-1 - Introduction	12 Hour
Vision of Cloud Computing, defining a Cloud, Cloud Computing Reference Model, Characteristics and Benefits, Historical Developments, Building Cloud Computing Environments, Computing Platforms and Technologies, Eras of Computing, Parallel vs. Distributed Computing, Elements of Parallel Computing	
Unit-2 – Virtualization Techniques	12Hour
Virtualization and Cloud Architecture, Characteristics of Virtualized Environments, Taxonomy of Virtualization Techniques, Virtualization and Cloud Computing, Pros and Cons of Virtualization, Technology Examples, Xen, VMware, Microsoft Hyper-V, Cloud Reference Model and Architecture, Infrastructure as a Service, Platform as a Service, Software as a Service, Types of Clouds, Economics of the Cloud, Open Challenges in Clouds, Aneka Architecture, Building Private Clouds using Aneka, Cloud Management	
Unit-3 – Application Programming	12 Hour
Cloud Application Programming, Concurrent Computing and Thread Programming, Multithreading with Aneka, Programming Applications with Aneka Threads; High-Throughput Computing and Task Programming, Task-based Application Models, Aneka Task-Based Programming, Task Programming Model, and Developing Applications with the Task Model; Data Intensive Computing: Map-Reduce Programming	
Unit-4 - Applications	12 Hour
Public Cloud Infrastructures and Applications, Amazon Web Services - Compute, Storage, and Communication Services; Google AppEngine – Architecture, Application Life-Cycle, Cost Model; and Microsoft Azure. Scientific Applications - ECG Data Analysis on Cloud, Protein Structure Prediction, Satellite Image Processing; Business and Consumer Applications – CRM, Social Networks, Media Applications, and Multiplayer Online Gaming.	

Unit-5 – Energy Aware Techniques	12 Hour
Advanced Topics in Cloud Computing, Energy efficiency in clouds, Energy-efficient and green cloud computing architecture, Market-based management of clouds, Market-oriented cloud computing, A reference model for MOCC, 3 Technologies and initiatives supporting MOCC, Observations, Federated clouds/Inter Cloud, Characterization and definition, Cloud federation stack, Technologies for cloud federations, Third-party cloud services such as Meta CDN.	

Lab Experiments	
1. Installation of Cloud Simulation 2. Create a datacenter with one host and run one cloudlet on it. 3. Create a datacenter with one host and run two cloudlets on it. The cloudlets run in VMs with the same MIPS requirements. The cloudlets will take the same time to complete the execution. 4. Create a datacenter with two hosts and run two cloudlets on it. The cloudlets run in VMs with different MIPS requirements. The cloudlets will take different time to complete the execution depending on the requested VM performance. 5. Create two datacenters with one host each and run two cloudlets on them. 6. Create two datacenters with one host each and run cloudlets of two users on them. 7. Create scalable simulations	8. EC2 Instance Window virtual machine launch and access using RDP Client from any network/specified network using private keypair 9. AWS Platform: Dashboard Services Study Experiments 10. EC2 Instance Linux virtual machine launch and access using putty application/SSH Client from any network/specified network by private keypair 11. Configure Virtual Private Cloud with single public subnet and launch any virtual machine within the subnet. 12. Configure public Virtual Private Cloud with one public subnet and one private subnet then launch & access any virtual machine within the private subnet 13. Create a Lambda function with the console in AWS Platform 14. Creating a server less application with continuous delivery in the Lambda console Create Application Load Balancer Using AWS Lambda function

Learning Resources	1. Rajkumar Buyya, Christian Vecchiola, and ThamaraiSelvi, Mastering Cloud Computing, McGraw Hill, New Delhi, India, 2013, ISBN-13: 978-1-25-902995-0. 2. Dan C Marinescu: Cloud Computing Theory and Practice. Elsevier (MK), 1 st edition, 2013, ISBN: 9780124046276. 3. Kai Hwang, Geoffrey C. Fox, Jack J Dongarra: Distributed Computing and Cloud Computing, from parallel processing to internet of things. Elsevier (MK), 1 st edition, 2012, ISBN: 978-0-12-385880-1	4. John W Rittinghouse, James F Ransome: Cloud Computing Implementation, Management and Security, CRC Press, 1 st Edition, 2013, ISBN: 978-1-4398-0680-7. 5. Gautam Shroff, "Enterprise Cloud Computing Technology Architecture Applications", Cambridge University Press; 1 edition, [ISBN: 978-0521137355], 2010.
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	20%	-	-	20%	20%	-
Level 3	Apply	20%	-	-	20%	20%	-
Level 4	Analyze	15%	-	-	15%	15%	-
Level 5	Evaluate	15%	-	-	15%	15%	-
Level 6	Create	15%	-	-	15%	15%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sudhakar E P Development Project Leader at American Megatrends International India (P) Ltd	1. Dr. Rajkumar Buyya University of Melbourne, Australia	1. Dr.M.Saravanan, SRMIST,

Course Code	21CSC314P	Course Name	BIG DATA ESSENTIALS	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
Identify the basics of big data and hadoop		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:																
Demonstrate the tools and techniques in big data																
CLR-3:																
Inspect the query language based on big data application																
CLR-4:																
Interpret classification and clustering in big data application																
CLR-5:																
Experiment the Big data Visualization tools																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:		2	-	-	3	-	-	-	-	-	-	-	-	-	-	2
Acquire knowledge on the basics of big data																
CO-2:		-	-	-	3	3	-	-	-	-	-	-	-	-	-	3
Examine the tools and techniques using Hadoop, HDFS, and Map Reduce																
CO-3:		2	-	-	3	-	-	-	-	-	-	-	-	-	-	3
Build any database for the application in big data																
CO-4:		-	-	-	3	-	-	-	-	-	-	-	-	-	-	3
Apply different classification and clustering algorithms using data sets in an application																
CO-5:		2	-	-	3	3	-	-	-	-	-	-	-	-	-	3
Analyze the Visualization techniques in big data																

Unit-1 - Introduction	9 Hour
Introduction to Big Data, Impact of Big Data, Parallel Processing, and Data Parallelism, Tools of Big Data, Introduction to the Hadoop Ecosystem, Introduction to MapReduce, The Hadoop Ecosystem/Common components: Introducing HDFS, Hive, HBase, and Spark, other modules, Installing Hadoop	
Unit-2 – Hadoop Distributed File System	9 Hour
Features of HDFS, HDFS Commands, Retrieving file data from HDFS using Python Snakebite, Deleting files in HDFS using Python Snakebite, Map Reduce and Spark RDD Big Data, Working with HDFS, Working with HBase, Difference between HDFS and HBase, Hadoop Word Count using Map Reduce, Matrix Multiplication using Map Reduce	
Unit-3 – Pig Programming	9 Hour
Introduction to Pig, Parallel processing using Pig, Pig Latin-Input and output, Hive: Introduction, data types and file formats, QL-data definition, data manipulation, QL views, indexes, Hive queries with partitioning.	
Unit-4 - Spark Framework	9 Hour
GPU Computing, CUDA Programming model, Multiplication in CUDA, CUDA Memory model, Shared memory matrix multiplication Writing Spark application, Spark programming in R, Scala, Python, Java, Streaming application, Classification and Clustering in Big data, K-Means clustering, Decision Tree Classification, Naive Bayes Classification.	
Unit-5 – Big Data Visualization	9 Hour
Introduction to big data visualization, Tree Maps, Maps, Gauge, Sunburst, Different visualization tools, Creating Visualization in Tableau, Different visualization methods in Tableau	

Learning Resources	<ol style="list-style-type: none"> 1. Sima Acharya, Subhashini Chellappan," BIG Data and Analytics" Wiley Publication, 2020. 2. Michael Minelli,Michele Chambers, AmbigaDhiraj, "BigData, BigAnalytics - Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publication, 2018. 	<ol style="list-style-type: none"> 3. Thomas Erl, "Big Data Fundamentals-Concepts, Drivers and Techniques", Pearson publication, 2016. 4. Kyle Banker, PiterBakkum, Shaun Verch," MongoDB in Action" Dream tech Press publication 2016. 5. Achari, Shiva "Hadoop Essentials" Birmingham, UK: Packt Publishing. 2015. 6. Tom White, "HADOOP: The Definitive Guide", O Reilly 2012.
---------------------------	---	---

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	-	15%	-	-
Level 2	Understand	25%	-	-	20%	-	20%	-	-
Level 3	Apply	30%	-	-	25%	-	25%	-	-
Level 4	Analyze	30%	-	-	25%	-	25%	-	-
Level 5	Evaluate	-	-	-	10%	-	10%	-	-
Level 6	Create	-	-	-	5%	-	5%	-	-
	Total	100 %		100%		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Kumanan P, Project Manager, CTS, Chennai	1. Dr.V.Vijayarajan, Associate Professor/HOD, Vellore Institute of Technology, Vellore	1. Mrs.V.Vijayalakshmi, SRMIST

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSE261T	Course Name	FUNDAMENTALS OF CLOUD COMPUTING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Review the fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Discover cloud-enabling technologies and get exposure to advanced clouds															
CLR-3:	Employ distributed file system and cloud storage technologies															
CLR-4:	Identify the cloud security threats and protective mechanisms for cloud computing															
CLR-5:	Compare various architectural styles and cloud development models															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe the fundamentals of cloud computing and its applications, benefits, and Challenges	3	-	-	2	-	-	-	-	-	-	-	-	3	-	-
CO-2:	Illustrate concepts in cloud infrastructures to understand the cloud system	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Demonstrate the usage in storage system in cloud	3	-	-	3	-	-	-	-	-	-	-	-	3	-	-
CO-4:	Investigate security issues related to cloud computing	-	2	-	2	-	-	-	-	-	-	-	-	3	-	-
CO-5:	Categorize cloud programming models and apply to solve problems on the cloud.	3	-	-	2	2	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to Cloud Computing	9 Hour
Network-Centric Computing - Origin of Cloud Computing-Evolution of cloud computing - Basic Concepts and Terminology - Goals and Benefits - Risks and Challenges -Roles and Boundaries - Cloud Characteristics - Cloud Deployment Models - Cloud Service Models - Cloud Service Providers and the Cloud Ecosystem -SLA Management in Cloud Computing: A Service Providers Perspective – Overview of Amazon Web Services (AWS)– Tutorial: Creating an account on AWS	
Unit-2 - Cloud enabling technologies	9 Hour
Broadband networks and Internet architecture - Data Center Technology - Web Technology - Multitenant Technology - Service Technology -Virtualization Technology - Virtual Machines -Hypervisors -Full Virtualization and Para-virtualization - Hardware Support for Virtualization - Kernel-Based Virtual Machine– Tutorial: Creating AWS EC2 Instances.	
Unit-3 - Introduction to Cloud Data Storage	9 Hour
The evaluation of storage technology - Storage Models - File Systems and databases - Cloud Object Storage (Amazon S3) - Data Storage for Online Transaction Processing Systems- Disk Locality versus Data Locality in Computer Clouds- Tutorial: Creating a S3 bucket in AWS	
Unit-4 - Fundamental Cloud Security	9 Hour
Basic Terms and Concepts - Threat Agents, Cloud Security Threats - Cloud Security Mechanisms - Encryption – Hashing - Digital Signature - Public Key Infrastructure - Identity and Access Management - Single Sign-On: Kerberos authentication - One-time password, Basic cloud data - security mechanisms - Virtual Machine Security - Security of Virtualization - A Trusted Hypervisor - Mobile Devices and Cloud Security - Tutorial: Creating an IAM in AWS	

Unit-5 - Cloud Application Development and Architectural Styles **9 Hour**

MapReduce Programming Model - Case Study: The Grep – TheWeb Application - Hadoop: Yarn and Tez - SQL on Hadoop: Pig, Hive, and Impala - Current Cloud Applications and New Opportunities - Design approaches with Case Study - Design methodology for IaaS Service Model - Google API, More on AWS EC2 Instances.

Learning Resources	<ol style="list-style-type: none"> 1. Dan C. Marinescu, "Cloud Computing Theory and Practice", Second Edition Copyright © 2018 Elsevier Inc. All https://www.sciencedirect.com/book/9780128128107/cloud-computing 2. Rajkumar Buyya, James Broberg, Andrzej Goscinski, Cloud Computing Principles and Paradigms, Wiley Publications, 2017. 3. Thomas Erl, Zaigham Mahmood, and Richardo Puttini, "Cloud Computing: Concepts, Technology & Architecture", Prentice Hall/Pearson PTR, Fourth Printing, 2014, ISBN: 978013338752. 4. Arshdeep Bahga, Vijay Madisetti, "Cloud Computing: A Hands-On Approach", University Press, 2016, ISBN13: 978-0996025508. 5. K. Chandrasekaran, "Essentials of Cloud Computing", Chapman and Hall/CRC Press, 2014, ISBN 9781482205435
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	10%	-	10%	-	10%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Mohit Kumar, Senior Data Scientist, Verizon, Bangalore, Karnataka, India	1. Dr. K.R. Jothi Associate Professorship of Computational Intelligence, School of Computer Science and Engineering, Department of Information Technology, Vellore Institute of Technology, Vellore	1. Ms. V. Lavanya, SRMIST, KTR

Course Code	21CSE262T	Course Name	COMMUNICATION SYSTEMS ENGINEERING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Illustrate the principles of Communication systems engineering	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Discuss the Knowledge on Communication systems components															
CLR-3:	Apply encoding and decoding techniques															
CLR-4:	Sketch the fundamentals of Fibre Optic Communication															
CLR-5:	Outline the basics of Satellite Communication															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Outline the basic ideas about Communication and its types	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	Identify the applications of Communication systems, information sources and source coding algorithms	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Articulate the concepts of coding for reliable Communication	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-4:	Utilize the skills learned during the design and integration of the fiber optic mode of Communication in any system under development	3	-	-	3	-	-	-	-	-	-	-	-	2	-	-
CO-5:	Demonstrate the design and integration of the satellite mode of Communication in any system under development	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-

Unit-1 – Introduction to Communication System	9 Hour
Introduction – Significance of human Communication, Communication systems, Communication channel, Types of electronic Communication, simplex, Full duplex, half duplex, Analog and Digital signals, Modulation and multiplexing, Baseband transmission, Broadband transmission, Multiplexing, Electromagnetic spectrum, Frequency and wavelength, Optical spectrum, Bandwidth, Channel Bandwidth, Effect of Noise on Analog Communication systems	
Unit-2 – Information Coding	9 Hour
Introduction to information sources and source coding, Modelling of information sources, Source Coding Theorem, Source Coding Algorithms: Huffman source coding algorithm, Lempel-Ziv source coding algorithm, Rate distortion theory: Mutual information, Differential Entropy, Rate distortion function - Quantization, Waveform Coding: PCM, DPCM, Delta modulation, Digital audio transmission and digital audio recording, Digital audio in telephone transmission systems, Digital audio recording	
Unit-3 – Coding for Reliable Communication	9 Hour
Tight bound on error probability of orthogonal signals, The promise of coding, Linear Block Codes, Theorem on Linear code, Hamming Codes, Decoding and performance of linear block codes, Soft decision decoding, Hard decision decoding, Error detection and Error correction, Burst error correcting codes, Cyclic codes, The structure of cyclic codes, The generator matrix, Encoding of cyclic Coupling Losses Equivalent Noise codes, BCH Codes, Reed-Solomon Codes, Convolutional Codes, Basic properties of convolutional codes, Encoding, The transfer function, Catastrophic codes, Optimum decoding of convolutional codes - The Viterbi algorithm.	

Unit-4 - Fibre Optic Communication	9 Hour
Introduction Through Optical Fiber, Electromagnetic Spectrum, Types of Optical Fibres, Propagation of Light, Single Mode Fibre, Multimode Fibre, Losses Within an Optical Fiber: Attenuation Loss, Absorption Loss, Radiation Loss, Dispersion Loss, Rayleigh Scattering Loss, Modal Dispersion Loss, Coupling Losses, Optical Point-to-point Communication Systems: Single Channel System Amplified Single Channel System, Wavelength Division Multiplexing (WDM) Systems	
Unit-5 - Satellite Communication	9 Hour
Introduction, Basic Satellite Transponder Kepler's Laws, Kepler's First Law Kepler's Second Law Kepler's Third Law, Satellite Orbits: Low Earth Orbit Satellite Medium Earth Orbit Satellite, Satellite Orbital Patterns Inclined Orbits Equatorial Orbit, Polar Orbits, Geostationary Satellites, Geosynchronous Satellite, Power Systems, Altitude Control: Spin Stabilized, Spun/de-spun Stabilization Method, Three-axis Stabilized Method, Altitude Control Components: Sensors, Actuators, Satellite System Parameters, Equivalent Noise, Temperature Carrier-to-Noise Density Ratio, Energy of Bit-to-Noise Density Ratio, Satellite System Link Models, Satellite System Link Equation 636 Uplink Power Budget Calculation, Satellite Radio Navigation	

Learning Resources	1. Louis E. Frenzel, Principles of Electronic Communication Systems, 4th Edition, Tata McGraw Hill Education, 2019. (Unit -I) 2. Ohn G. Proakis, Masoud Salehi, Communication Systems Engineering, 2nd edition, Pearson Education International, 2015. (Unit - II & Unit -III)	3. Communication Systems, V. Chandra Sekar, Oxford University Press, 2015 (Unit - IV & Unit-V)
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. J. Dayanithi, Senior Consultant, Verizon Data Services Private Ltd.	1. Dr. V. Vijayarajan, Associate Professor, Vellore Institute of Technology, Vellore	1. Mrs. V. Vijayalakshmi, SRMIST

Course Code	21CSE263T	Course Name	DIGITAL COMMUNICATION SYSTEMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Outline the framework of digital communication systems	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Discover and correlate the digital coding techniques															
CLR-3:	Illustrate and prioritize the various digital modulation schemes															
CLR-4:	Adapt and validate with error control coding methods															
CLR-5:	Assess and classify the significance of multiplexing and multiple access															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Recognize the essentials of digital communication system	2	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	Interpret the concepts on sampling, Quantization, encoding and Signal Compression	2	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Identify the various digital modulation techniques for various signals	2	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-4:	Examine the error Detection and Correction codes	2	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-5:	Analyze the multiplexing and multiple access techniques	2	-	-	-	-	-	-	-	-	-	-	-	3	-	-

Unit-1 - Introduction Digital Communication System	9 Hour
Advantages of Digital Communication-Regeneration of Digital Signals, Power Efficiency of Digital Modulators Bandwidth Compression, - Multimedia: Unification of Signals Performance, Technology -Time and Frequency Representation - Fourier Series, Fourier Transform - Discrete Fourier Transform - Convolution - Correlation - Hilbert Transform - Low-pass and Band-pass Representations - Signals and Systems: Analytic Signals, Low-pass Equivalent Signals - Signal Space Representations: Vector Space	
Unit-2 – Digital Coding Techniques	9 Hour
Digitizing Analog Signals - Sampling - Quantization - Encoding - Signal Compression, Signal Statistics and Redundancy - Companded PCM - Predictive Coding - Transform Coding - Parametric Coding - Perceptual Coding - Application of Digital Coding- Digital Speech - Adaptive Delta Modulation Codec- Pulse Code modulation Codec - Digital Audio: MP3 Coding - Digital Video: Run Length Coding, variable Length Coding - MPEG1	
Unit-3 - Digital Modulation Techniques	9 Hour
Baseband Modulation - Pulse Modulation Systems - Baseband Signalling - Correlative Coding: Duo-Binary Coding, Modified Duo-Binary Coding- Digital Phase Modulation(Phase Shift Keying): Bi-phase shift keying modulation - Quadrature and Offset Quadrature phase shift keying - Digital Frequency Modulation(Frequency Shift Keying), Minimum Shift Keying, Gaussian Minimum Shift Keying, - Continuous Phase Modulation, Baseband Signals, Band-pass Signals - Comparison of Basic Modulations Orthogonal Frequency Division Multiplexing	

Unit-4 – Error Coding and Decoding	9 Hour
Introduction-Types and Measure of Error- Shannon-Hartley Capacity Theorem - Methods of Error Control-Classification of Error-Correcting Codes - Linear Block Codes-Hamming Distance, Weight, Error Detection, Correction - Linear Block Codes-Generator Matrix, Systematic codes, Parity Check Matrix Standard Array - Implementing the decoder Cyclic Codes-Generator Polynomial for cyclic code - Systematic Cyclic code - Polynomial Multiplication and division - Importance of Block Codes-Hamming Codes, Golay-Reed Solomon Codes, Convolutional codes, Convolutional Encoder - Convolutional Decoding, Maximum like hood Decoding, Viterbi algorithm, Sequential Decoding and Fano Algorithm, Practical Applications of Error Correcting codes, Deep Space Communication, Satellite Communication	
Unit-5 – Multiplexing Techniques	9 Hour
Introduction to Multiplexing-Types - Frequency Division Multiplexing, Time Division Multiplexing - Frame Synchronization - Primary Multiplexing in Digital Telephony - Higher Order Multiplexing - Multiple Access-Frequency Division Multiple Access, Time Division Multiple Access, Code Division Multiple Access, Random Access, Carrier Sense Multiple access/Collision Detection, Fixed Assignment Multiple Access, Demand Assignment Multiple Access - Introduction to Pseudo-Noise Sequence - Properties of PN Sequences - Spread Spectrum: Direct Sequence Spread Spectrum(DSSS), Frequency Hopping Spread Spectrum(FHSS), Spread Spectrum Applications	

Learning Resources	<ol style="list-style-type: none"> 1. R.N. Mutagi, Digital Communication – Theory, Techniques and Applications, 2nd Edition, Oxford University Press, 2014. 2. John R. Barry, Edward A. Lee, David G. Messerschmitt, Digital Communication, 3rd Edition, Springer International Edition, Springer, 2011 3. John G. Proakis, Masoud Salehi, Digital Communications, 5th Edition, McGraw Hill Education, 2015 4. Simon Haykin and Michael Moher, "Communication Systems," 5th edition, John Wiley & Sons, 2013 5. Singh. R. P & Sapre. S. D, "Communication Systems: Analog & Digital," 3rd edition, McGraw-Hill Education, Seventh Reprint, 2016. 6. Simon Haykin, "Communication Systems", John Wiley & Sons, 4th Edition, 2008. 7. Bernard Sklar, "Digital Communication, Fundamentals and Application", Pearson Education Asia, 2nd Edition, 2001 8. Taub & Schilling, "Principle of Communication Systems", McGraw Hill Inc, 2nd Edition, 2003. 9. B.P. Lathi, "Modern Digital and Analog Communication System", Oxford University Press, 3rd Edition, 2005. 10. Shu Lin, Daniel Costello, "Error control coding – Fundamentals and Applications", Prentice Hall, Upper Saddle River, NJ, 2nd Edition, 2004.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. V. Lingasamy, ME, PhD, Sr. Technical Lead at Sterlite Technologies Limited, Chennai	1. Dr.K.R. Jothi Associate Professorship of Computational Intelligence, School of Computer Science and Engineering, Department of Information Technology, Vellore Institute of Technology, Vellore	1. Mr.H.Karthikeyan, SRMIST, KTR – NWC

Course Code	21CSE330T	Course Name	CLOUD ARCHITECTURE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Review the fundamentals of cloud architecture	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Infer the technologies used with cloud platforms															
CLR-3:	Discover the advance cloud architecture and storage structures															
CLR-4:	Classify the importance of cloud architecture design															
CLR-5:	Examine virtualization architecture and future trends in cloud structures															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Persist the concept of basic cloud computing paradigms	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Interpret the concepts of Cloud service structures	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Analyze the components of cloud computing and about business agility in an organization	3	-	-	2	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Relate with the market service providers in cloud	3	-	-	2	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Evaluate data center technologies and cloud architecture patterns	3	-	-	2	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction	9 Hour
Introduction to cloud computing fundamental, Cloud Computing definition, Cloud deployment models, Private, Public, Hybrid, community cloud, Cloud services: IaaS, PaaS, SaaS, Enabling technologies of cloud computing, Benefits and challenges of cloud computing, Business Agility: Benefits and challenges to Cloud, architecture. Cloud Applications, Application availability, Performance, Various types of disaster in cloud environment.	
Unit-2 - Service Oriented Architecture	9 Hour
REST, Systems of Systems, Web Services, Publish-Subscribe Model, Basics of Virtualization, Types of Virtualizations, Implementation Levels of Virtualization, Virtualization Structures- Advantages and Disadvantages, Tools and Mechanisms, Virtualization of CPU Memory, I/O Devices, Virtualization Support and Disaster Recovery, Server Virtualization, Parallel Processing, Vector Processing, Symmetric Multiprocessing Systems, Massively Parallel Processing Systems.	
Unit-3 - Cloud Storage Infrastructures	9 Hour
Introduction to cloud storage infrastructures, Concept, planning and Design, Business continuity .Basic concepts of information security, Managing VDC and cloud environments and infrastructures, Securing storage in virtualized and cloud environments, Monitoring and management, Security auditing and SIEM, Storage Network Design, Architecture of storage, analysis and planning, Storage network design considerations, NAS and FC SANs, Hybrid storage networking technologies, iSCSI, FCIP, FCoE, Design for storage virtualization in cloud computing, Host system design considerations, Cloud Applications, Technologies and the processes required for deploying web services.	

Unit-4 – Resource Provisioning	9 Hour
Management of Cloud Services, Reliability, availability and security of services deployed from the cloud, Performance and scalability of services, Tools and technologies used to manage cloud services deployment, Cloud Economics, Cloud Computing infrastructures available for implementing cloud based services, Economics of choosing a Cloud platform for an organization, Runtime Support Services Resource Provisioning and Platform Deployment- Provisioning of Compute Resources (VMs),Resource Provisioning Methods, NIST Cloud Computing Reference Architecture, Demand-Driven, Event-Driven Resource Provisioning, Popularity-Driven Resource Provisioning, Dynamic Resource Deployment Storage-as-a-Service, Advantages of Cloud Storage - Global Exchange of Cloud Resources Application Development. Service creation environments to develop cloud-based applications	
Unit-5 – Data Center Design	9 Hour
Introduction to Cloud Architecture patterns, Horizontally Scaling Compute Pattern- Cloud Significance, Queue-Centric Workflow Pattern Auto-Scaling Pattern, Eventual Consistency Prime, MapReduce Pattern, Database Sharding Pattern, Node Failure Pattern, Network Latency Primer CDN Pattern, Multisite Deployment Pattern, Network connectivity optimization evolution: Top of rack (TOR), end of rack (EOR), connectivity, Stand-alone, blades, stateless, clustering, scaling optimization, virtualization, Limitation of traditional server deployments, Case studies	

Learning Resources	<ol style="list-style-type: none"> 1. Gautam Shroff, "Enterprise Cloud Computing Technology Architecture Applications", Cambridge University Press; 1 edition, [ISBN: 978-0521137355], 2010. 2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach" McGraw-Hill Osborne Media; 1 edition [ISBN:0071626948], 2009 3. Greg Schulz, "Cloud and Virtual Data Storage Networking", Auerbach Publications [ISBN: 978- 1439851739], 2011 4. EMC, "Information Storage and Management" Wiley; 2nd edition [ISBN: 978-0470294215], 2012. 5. Volker Herminghaus, Albrecht Scriba, "Storage Management in Data Centers" Springer; edition [ISBN: 978- 3540850229], 2009. 6. Klaus Schmidt, "High Availability and Disaster Recovery" Springer; edition [ISBN: 978- 3540244608], 2006. 7. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012. 8. Rittinghouse, John W., and James F. Ransome, —Cloud Computing: Implementation, Management and Security, CRC Press, 2017. 9. Silvano Gai, Claudio DeSanti, "I/O Consolidation in the Data Center" Cisco Press; 1st edition [ISBN: 9781587058882], 2009. 10. Bill wilder, Cloud Architecture patterns, 2012
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.PartheepanRudrapathi, CEO, KXE	1. Dr.V.Arulkumar, Associate Professor, SSN College of Engineering	1. Dr.M. Shobana, Assistant Prof., SRMIST

Course Code	21CSE329T	Course Name	SERVICE ORIENTED ARCHITECTURE AND MICROSERVICES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	State the fundamentals XML and AWS	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Develop an application based on XML and XSL															
CLR-3:	Explore the key principles behind SOA															
CLR-4:	Illustrate the web services technology elements for realizing SOA															
CLR-5:	Compare the various web service standards															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Explain the fundamentals of XML and AWS	2	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	Test the applications based on XML	2	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Illustrate the key principles behind SOA	2	-	2	-	-	-	-	-	-	-	-	-	3	-	-
CO-4:	Implement the web services using technology elements	2	3	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-5:	Apply the various web service standards to solve real world problems	2	3	2	-	-	-	-	-	-	-	-	-	2	-	-

Unit-1 - XML	9 Hour
Introduction to XML, Amazon Web Services, XML in Context, Fundamentals of XML, XML Document Structure, XML Content Models, Rules of XML, Structure - Well-formed and valid documents, Linking XML Documents Together, Namespaces, Identifying the Scope of Namespaces, DTD, Structure of a Document, Type Definition, XML Schema, X-Files, Getting started with AWS, AWS Compute, Storage, Networking, Amazon EC2	
Unit-2 – Dynamic Modeling	9 Hour
Parsing XML – using DOM, DOM Traversal and Range, SAX, Working with SAX-Handling Errors, XML, Transformation and XSL, XSLT for Document Publishing, XSL for Business-to-Business (B2B) Communication, XSL Formatting, Modeling Databases in XML, Developing a Data Access Object (DAO), Developing a Servlet for HTTP Access-- Testing the Application- Converting the XML Data to HTML with XSLT, Converting the XML Data to HTML, Converting the XML Data to HTML with XSLT, Java Architecture for XML Binding (JAXB), Data Binding	
Unit-3 – Service Oriented Architecture	9 Hour
Service-Oriented Architecture Concepts, SOA Processes, Principles and Tools, SOA Governance Policies and Processes, SOA Principles and Guidelines, Line of Business Services, Reusable Technical Services, Roots of SOA, Characteristics of SOA, Comparing SOA with Client-Server, Distributed architectures, Benefits of SOA, Technical Benefits, Business Benefits-Increased Business Agility, Better Business Alignment, Principles of Service orientation, Service layers	
Unit-4 – Web Service Description Language	9 Hour
Service descriptions –WSDL– Basic WSD, Syntax, SOAP Binding-Messaging with SOAP –Service discovery, UDDI– Introduction to UDDI, Structure of UDDI Message Exchange Patterns, Orchestration – Choreography –WS Transaction, B- WS-Atomic Transaction – WS – Business Activity, WS-Coordination Framework, WS-Transaction Management	

Unit-5 – Web Service Security	9 Hour
Service Oriented Analysis and Design, – Service Modeling –Design standards, guidelines, Composition, WS-BPEL, WS-Coordination, WS-Policy, WS-Security –WS Trust, WS-Secure Conversation, WS-Federation-Security Assertion Markup Language (SAML), Data-Level Security XML Encryption/XML Signature, SOA support in J2EE	

Learning Resources	<ol style="list-style-type: none"> 1. Ron Schmelzer et al. "XML and Web Services", Pearson Education, 2002. 2. Thomas Erl, "Service Oriented Architecture: Concepts, Technology, and Design", Pearson Education, 2005. 3. Frank P.Coyle, "XML, Web Services and the Data Revolution", Pearson Education, 2002. 4. Eric Newcomer, Greg Lomow, "Understanding SOA with Web Services", Pearson Education, 2005. 5. Sandeep Chatterjee and James Webber, "Developing Enterprise Web Services: An Architect's Guide", Prentice Hall, 2004 6. James McGovern, Sameer Tyagi, Michael E.Stevens, Sunil Mathew, "Java Web Services Architecture", Morgan Kaufmann Publishers, 2003 7. https://docs.aws.amazon.com/whitepapers/latest/aws-overview/compute-services.html#amazon-ec2
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. T.Ananadharaman ,Project Manager, TCS, Chennai	1. Dr.T.Sudalaimuthu, Professor, Hindustan Institute of Science and Technology, Chennai	1. Dr.N.Senthamarai, SRMIST

Course Code	21CSE363T	Course Name	CLOUD SERVICES SOLUTION ARCHITECT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Discuss the concepts of Computing instances and database service in AWS platform	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Articulate of logical, secured Networking groups and applying Cloud Content Delivery in AWS															
CLR-3:	Apply Security measures to protect the resources and understands compliance management in AWS															
CLR-4:	Demonstrate Management and Governance services at cloud deployment model															
CLR-5:	Categorize the different migration service systems and different application integration services															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Demonstrate on Computing instances and database service in AWS	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Implement Networking and Cloud front Content Delivery in AWS	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Examine Security measures and compliance in AWS	2	-	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Interpret management and governance services	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Compare different migration services and application integration services in AWS	-	-	-	3	-	-	-	-	-	-	-	-	-	-	3

Unit-1 – Introduction to AWS	9 Hour
Compute: Amazon EC2, AWS Elastic Beanstalk, Amazon Elastic Container Service (Amazon ECS), Amazon Elastic Kubernetes Service (Amazon EKS), Elastic Load Balancing, AWS Fargate, AWS Lambda. AWS Billing and Cost Management: AWS Budgets and Cost Explorer. Database: Amazon Aurora, Amazon DynamoDB, Amazon DynamoDB Accelerator (DAX).	
Unit-2 – AWS Gateway Services	9 Hour
Networking and Content Delivery: Amazon API Gateway, Amazon CloudFront, AWS Direct Connect, AWS Global Accelerator, Amazon Route 53, AWS Transit Gateway, Amazon VPC (and associated features)	
Unit-3 – Identity and Access Management	9 Hour
AWS Identity and Access Management (IAM), AWS Key Management Service (AWS KMS), AWS Shield, AWS Single Sign-On, AWS WAF	
Unit-4 - Management and Governance	9 Hour
AWS Auto Scaling, AWS Backup, AWS CloudFormation, AWS CloudTrail, Amazon CloudWatch, AWS Config. AWS Organizations, AWS Resource Access Manager, AWS Systems Manager, AWS Trusted Advisor	
Unit-5 - Migration and Transfer	9 Hour
AWS Database Migration Service (AWS DMS), AWS Server Migration Service (AWS SMS), AWS Snowball, AWS Transfer Family. Application Integration: Amazon SNS and SQS	

Learning Resources	1. Piper, B., & Clinton, D. (2020). AWS Certified Solutions Architect Study Guide: Associate SAA-C02 Exam. John Wiley & Sons.	3. https://docs.aws.amazon.com/
	2. Sequeira, A. (2019). AWS Certified Solutions Architect-associate (SAA-C01) Cert Guide. Pearson IT Certification.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	15%	-	15%	-
Level 2	Understand	20%	-	15%	-	15%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	10%	-	15%	-	15%	-
Level 6	Create	10%	-	15%	-	15%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Mohit Kumar, Senior Data Scientist, Verizon,Bangalore,Karnataka,India		1. Dr.M.Saravanan, SRMIST
		2. Ms.V.Lavanya, ,SRMIST

Course Code	21CSE364T	Course Name	DATA CENTRIC NETWORKING AND SYSTEM DESIGN	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Describe various data centric Networking Concepts	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Gain knowledge on the data center architectures & network connectivity.															
CLR-3:	Articulate networking caching policies															
CLR-4:	Understand the security issues in data centric networks.															
CLR-5:	Learn the application of IoT in ICN.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Identify various data centric networking concepts.	-	2	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Distinguish different data center architectures & core network connectivity issues.	-	2	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Design the caching policies in DCN.	-	2	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Protect the Data centric networks from different attacks.	-	2	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Make use of IoT and ML techniques in Data centric networks for more efficient.	-	2	-	3	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction	9 Hour
Introduction to Information-Centric Networks, Data-centric networking from different perspectives, Requirements for modern data centers, Internet architecture, Content Distribution Networks (CDN), Content-Centric Communication, Characteristics of ICN, Design Principles, and Assumptions, Design Principles, Key Building Blocks of ICN and Design Challenges, TRIAD Architecture, DONA Architecture.	
Unit-2 – Data Center Design	9 Hour
Network Information (NetInf) Architecture, Top of rack (TOR) network connectivity, End of rack (EOR) network connectivity, NDN Architecture, Comparative Analysis of ICN Architectures, Software-Defined Networking in ICN, Data Routing Schemes, Realization of Routing in ICN, Stateful Forwarding Paradigm for NDN, OSPF-Based Routing for NDN- NLSR.	
Unit-3 – Computing Architecture	9 Hour
Introduction to server Architectures, clustering in server architectures, Redundant Layer 2 designs, Redundant Layer 3 design, Network Caching, Issues in ICN Caching, Leave Copy Everywhere (LCE), Leave Copy Down, SDN Based Caching, Analysis of Various Caching Methods, Caching policies, Caching with Amazon Elasti Cache.	
Unit-4 – Data Centric Networking Protocols	9 Hour
RSTP protocol, PVST protocol, Monitoring Your Applications and Infrastructure - Working with AWS CloudTrail, MSTP protocol, TRILL protocols Security in DCN, Key Security & Privacy Concerns in ICN Architectures, Attacks in ICN, Naming, routing related attacks, ICN Attributes Leading to Security Threats, Optimization in ICN, Application of ML in Communication Networks, ML in caching, naming, Routing	
Unit-5 – Data Centric Services	9 Hour
State-of-the-Art Work in SDN-Based ICN, CORNET architecture, Recent Trends in ICN Applications, Data-Centric Networks in Internet of Things, Adaptation of Information-Centric Networks for Internet of Things (IoT): Challenges and Opportunities, Design Issues of IoT over ICN, Information-Centric Networks in Wireless, Sensor Networks, ICN-based VANETs, Locator Identifier Separation Protocol (LISP)	

Learning Resources	1. Zhi-Li Zhang, "Information Centric Networks (ICN), Nitul Dutta · Hiren Kumar Deva Sarma, Rajendrasinh Jadeja · Krishna Delvadia, Gheorghita Ghinea, Architecture & Current Trends, 2021	5. Silvano Gai, Tommi Salli, Roger Andersson, "Cisco Unified Computing System" Cisco Press; 1st edition, [ISBN: 9781587141935], 2010.
	2. Mouricio Aragones, "Data Centre Fundamentals", Cisco Press, 2003	6. Information Centric Networks: A New Paradigm for the Internet by Released May 2013 Publisher(s): Wiley ISBN: 9781848214491
	3. Silvano Gai, Claudio DeSanti, "I/O Consolidation in the Data Center" Cisco Press; 1st edition [ISBN: 9781587058882], 2009.	7. Robert W. Kembel, Roger Cummings (Introduction), "The Fibre Channel Consultant" Northwest Learning Assoc; 3rd edition, [ISBN: 0931836840], 1998.
	4. Kevin Corbin, Ron Fuller, David Jansen, "NX-OS and Cisco Nexus Switching: Next-Generation Data Center Architectures" Cisco Press; 1 edition [ISBN: 9781587058929], 2010.	8. Robert W. Kembel "Fiber Channel Switched Fabric" Northwest Learning Associates, inc. [ISBN: 0931836719], 2009.
		9. John L. Hufferd, "ISCSI", Addison-Wesley Boston [ISBN: 978-0201784190], 2003.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. N. Vijaya Sankar Associate Tech Lead MST Solutions	1. Dr. Soundararajan Program Chair, Associate Professor, in the Department of Computer Science and Engineering, Amrita School of Engineering, Amrita Vishwa Vidyapeetham, Chennai. s_sountharajan@ch.amrita.edu	1. Dr. V. Pandimurugan SRM IST

Course Code	21CSE461T	Course Name	CLOUD SECURITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Identify the concept of cloud security	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Compute the issues related to virtualized infrastructure security	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Predict and Gain knowledge on the various issue in cloud security															
CLR-4:	Contrast the methods to improve virtualization security and technologies in security															
CLR-5:	Design the cloud contracting Model and case study of commercial cloud															

Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Demonstrate the main concepts of cloud security	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Illustrate the architecture design of cloud storage	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Classify the cloud security key management Schemes	3	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Categorize the types of attacks and phases of malware	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Summarize the security design for cloud Models	1	-	3	-	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Introduction	9 Hour
Cloud Security Fundamentals- Infrastructure Security- Network level security- Host level security- Application-level security- Data security and Storage- Data privacy and security Issues- Jurisdictional issues raised by Data location- Identity & Access Management- Access Control- Trust, Reputation- Risk.	
Unit-2 - Information Gathering and Footprinting	9 Hour
Layered Cloud Architecture Design- NIST cloud computing Reference Architecture-Public, Private and Hybrid Cloud- IaaS, PaaS, SaaS - Architectural design Challenges- Cloud Storage- Storage-as-a-service- Advantages of Cloud storage- Cloud storage Provider- Storage Provider-S3	
Unit-3 - Web and Database Attacks	9 Hour
Confidentiality, privacy, integrity, authentication, - non-repudiation, availability, access control, defense in depth, least privilege- Cryptographic Systems- Symmetric cryptography- stream ciphers, block ciphers, modes of operation- Public-key cryptography, hashing- digital signatures, public-key infrastructures- key management for IaaS, PaaS, SaaS - Cryptographic key Management Issues and challenges in cloud services.	
Unit-4 - Attacks and Malware Lifecycle	9 Hour
Multi-tenancy software and its issues- IBM security virtual server protection- virtualization-based sandboxing- Cloud Storage- Security- HIDPS- log management- Data Loss Prevention- Security Governance- Cloud security Challenges- Virtual Machine Security- ESX, ESX File system Security Storage considerations- ESIX security- Security Management Standards- SaaS, PaaS, and IaaS Availability management.	
Unit-5 - Wireless Security Technologies	9 Hour
Authentication in cloud computing- Client access in cloud- Cloud contracting Model- Commercial and business considerations- Case Study on Open Source & Commercial Clouds- X.509 certificates, OpenSSL- Eucalyptus- Microsoft Azure- Amazon EC2- Legal and Compliance Issues in Cloud Computing- Examination of modern security standards.	

Learning Resources	1. Rittinghouse, John W., and James F. Ransome, – Cloud Computing: Implementation, Management and Security, CRC Press, 2017.	4. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing – A Practical Approach, Tata Mcgraw Hill, 2009.
	2. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.	5. Tim Mather, SubraKumaraswamy, ShahedLatif, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance" O'Reilly Media; 1 st edition [ISBN: 0596802765], 2009.
	3. Ronald L. Krutz, Russell Dean Vines, "Cloud Security" [ISBN: 0470589876], 2010.	6. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice), O'Reilly, 2009

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.T. Madhan, Team Leader, Tata Consultancy Services, siruseri Campus, Chennai, madhan.tk@gmail.com	1. Dr. S. Janakiraman, Associate Professor, Pondicherry University, sj.dbt@pondiuni.edu.in	1. Dr. R. Naresh, SRMIST
2. Mrs.K.Saranya, IT Analyst, Tata Consultancy Services, siruseri Campus, Chennai, saranya.k6@gmail.com	2. Dr. R.Shyamala, Associate Professor, Anna University College of Engineering Tindivanam, vasuchaaru@gmail.com	2. Dr. C.N.S. Vinoth Kumar, SRMIST

Course Code	21CSE463T	Course Name	CLOUD STRATEGY PLANNING AND MANAGEMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Learn the concepts and technological advances fueling the rapid adoption of cloud computing today.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-2:	Apply the skills and knowledge required to plan and manage a Cloud Computing strategy within an organization.																											
CLR-3:	Interpret the strategic value of Cloud Computing using IT Governance and Compliance																											
CLR-4:	Illustrate the Service Oriented Architecture Services, Databases and Applications																											
CLR-5:	Explore about IT Governance benefits and services along with Asset Management																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Demonstrate how cloud computing enables IT Transformation and business value in an organization.	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3												
CO-2:	Examine the role that cloud computing can play in the business process.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	3												
CO-3:	Appraise how the incorporation of cloud computing in an IT strategy can deliver on strategic business objectives	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3												
CO-4:	Criticize how cloud computing and Service Oriented Architecture (SOA) can deliver business agility.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	3												
CO-5:	Implement IT governance to manage business realization from cloud IT services.	3	-	-	3	-	-	-	-	-	-	-	-	-	-	3												

Unit-1 - Introduction	9 Hour
The four pillars of cloud computing - Cloud applications and platforms providing the cloud infrastructure - Cloud computing - Spectral efficiency - Sensors and perspiration - Strategic inflection points in information Technology - Cloud computing and its slogans -User centered solution and cloud computing - For cloud vendors inflection point Is risk and opportunity - Potential customers of cloud technology - The cloud interests Small and Medium enterprises - Virtual companies and the cloud - Virtual networked objects - Consumer technologies and the cloud - Social networks and multimedia messaging	
Unit-2 – Infra Structure Design	9 Hour
Moving to a cloud architecture and strategy to achieve business value - BPM, IS, Porter's Value chain model and BPR as a means of delivering business value - Developing Business Strategy: Investigate business strategy models to gain competitive advantage for organizations - SWOT/PEST, Economies of scale, Porter's 3 Strategies and 5 Competitive Forces, D'Aveni's hyper competition models - Emphasize the roles of the strategic IS/IT leaders such as Chief Information Officer (CIO) - The Chief Technology Officer (CTO) in planning and managing IT Strategic development in the organization - Budgeting for cloud computing - Service level agreements - Outsourcing, Infrastructural inter dependencies, and the cloud - Human resources at the CIO level - The transition from legacy to competitive system	
Unit-3 – Design Strategies	9 Hour
Develop an IT strategy to deliver on strategic business objectives in the business strategy - IT Project planning in the areas of IaaS is essential in delivering a successful strategic IT Plan - IT Project planning in the areas of SaaS is essential in delivering a successful strategic IT Plan - IT Project planning in the areas of PaaS is essential in delivering a successful strategic IT Plan - IT Project planning in the areas of IaaS is essential in delivering a successful strategic IT Plan - Searching for an open architecture - Infrastructure as a Utility - Cloud System Architecture and its primitives - The User Organizations Business Architecture - Financial Services Applications Architecture	

Unit-4 – Cloud Service Management	9 Hour
Shared services delivered by a Service Oriented Architecture (SOA) in a Private or Public Cloud - Services, Databases and Applications on demand - The effect on Enterprise Architecture and its traditional frameworks such as Zachman).- The Open Group Architecture Framework (TOGAF) - Customer Relationship Management - Enterprise Resource Planning - Just-in-Time Inventories - Machine-to-Machine and RFID Communications - Challenges Presented by Organization - Challenges Presented by Commercial vision	
Unit-5 – Governance and Asset Management	9 Hour
Benefit Realization and IT Governance - Managing resources (people, process, technology), to realize benefit from Private/Public Cloud IT services - Gartner's 5 pillars of benefit realization - IT governance as a service in measuring the delivery of IT Strategy from Cloud IT Services using Sarbanes Oxley (CobIT) and other commonly-used approaches - High Technology for private banking and Asset Management - Cloud Software for Private Banking - Leadership is based on Fundamentals - Cloud Software For Asset Management - Cloud Technology can Improve Fund Management - Criteria of Success in Asset Management Technology	

Learning Resources	1. Dimitris N. Chorafas: <i>Cloud Computing Strategies</i> , CRC Press, 2011. 2. Arnold J Cummins, "Easiest Ever Guide to Strategic IT Planning" http://strategicitplanningguide.com/ . 3. David S. Linthicum, "Cloud Computing and SOA Convergence in Your Enterprise", Addison Wesley [ISBN: 0136009220], 2009. 4. Charles Babcock, "Management Strategies for the Cloud Revolution", 1st Ed., Tata McGraw/Hill [ISBN:0071740759], 2010.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sudhakar E P Development Project Leader at American Megatrends International India (P) Ltd	1. Dr.Khanna Nehemiah H, Professor, Ramanujan Computing Centre, Anna University	1. Mrs.V.Lavanya, SRMIST

Course Code	21CSE464T	Course Name	FOG COMPUTING ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Annotate the concepts of fog and edge computing	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Relate simulation tools of fog computing															
CLR-3:	Understand the component, architecture and working model															
CLR-4:	Examine different security methods and use cases															
CLR-5:	Utilize big data analytics for fog computing															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Express the knowledge on the concepts of fog and edge computing	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Infer simulation tools of fog computing	3	-	-	-	3	-	-	-	-	-	-	-	-	-	3
CO-3:	Interpret the component, architecture and working model	2	-	-	-	3	-	-	-	-	-	-	-	-	-	3
CO-4:	Correlate different security methods and use cases	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Identify the role of big data analytics in fog computing	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Edge and Fog Computing Techniques	9 Hour
Introduction to Edge Computing, Infrastructure of edge computing, Benefits of Edge computing, Edge devices and Edge Services, Applications of Edge technology AWS IoT, AWS Outposts, Introduction to Fog Computing, Characteristics of fog Computing, Reason for fog Computing, Challenges, Advantages and disadvantages, Fog services, Application scenarios –Health care, Sensors and Fog nodes, Difference between edge and fog computing, AWS Local zones, AWS Wavelength	
Unit-2 - Modeling and Simulation Tools	9 Hour
Working procedure of fog computing, Software Systems, Components of fog computing, Modeling and Simulation, Simulation tools, Ifogsim, Characteristics of ifogsim, Working of ifogsim, Contiki – Characteristics, MAC protocol, Routing protocol simulation in contiki, Working procedure, MobFogsim – Protocols, Implementation of MobFogsim, AWS Infrastructure and services, Comparison of different simulator, AWS Device defender, AWS Device management IoT Events, AWS IoT Events	
Unit-3 - Fog Data Analytics for IoT	9 Hour
Fog Protocol, JSON based protocol, Fog interfaces with IoT, Fog interfaces with Cloud, Fog Networking, SDN, NFV, Other fog networking, Protocol Optimization, Fog kit, Fog kit-framework, Fog hardware framework, Fog software framework, Proximity Detection protocols, DDS/RTPS computing protocols, AWS IoT Greengrass, Amazon EC2	
Unit-4 - Fog Data Analytics: Security and Privacy	9 Hour
Quality of Service (QoS) and Management, Computation Offloading, Resource Provisioning, Security and Privacy, Security attacks on fog computing, Trust and authentication, Network security, Secure and Private Data Computation, Intrusion Detection, Multimedia fog computing, Case study, Smart Traffic Light System, Wearable Sensing devices, Smart Home, Security services on AWS, Resource allocation in AWS, Compare cloud and Fog resource allocation – AWS	

Unit-5 - Fog Computing for Big Data Analytics	9 Hour
Big Data analytics, Benefits of Big data analytics, A Typical Big Data Analytics Infrastructure, Big Data Analytics in the Cloud, Data Analytics in the Fog, Fog analytics, Smart management of Big Data in Fog, System Architecture, Fog engine, Data analytics using Fog engine, Architecture of Fog-engine, Challenges and issues, Fog-engine prototype, Configuration of fog engine, AWS IoT Analytics, Comparison of Fog-engine and cloud data analytics, Application of Big Data, Amazon kinesis data analytics	

Learning Resources	1. Fog and Edge Computing: Principles and Paradigms. United Kingdom: Wiley, 2019. 2. Fog Data Analytics for IoT Applications: Next Generation Process Model with State of the Art Technologies. Germany: Springer Singapore, 2020.	3. Fog Computing: Theory and Practice, Assad Abbas, Samee U. Khan, Albert Y. Zomaya, Wiley, 2020 4. https://staff.cdm.s.westernsydney.edu.au/~bjavadi/papers/Chapter11_javadi.pdf
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Pratheepan Rudrapati, CEO, Knowledge Xchange Community	1. Dr. S.Venkatesan, Associate Professor, Department of Information Technology, IIIT Allahabad	1. Dr. Savaridassan.P, SRM IST

Course Code	21CSE465T	Course Name	CLOUD APPLICATION DEVELOPMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Explore different cloud services	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Compare different security aspects in cloud deployment models															
CLR-3:	Describe different virtualization techniques in cloud deployment models															
CLR-4:	Articulate cloud applications in various platform															
CLR-5:	Design real-time cloud applications using cloud services															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Summarize the different cloud services and deployment platforms	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Appraise different cloud security services in deployment models	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Interpret different virtualization platforms	-	-	-	-	2	-	-	-	-	-	-	-	-	-	3
CO-4:	Categorize different cloud services.	-	-	3	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Develop and deploy cloud applications using cloud services	-	-	3	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Cloud computing concepts and Services	9 Hour
Introduction to cloud computing – Cloud deployment models – Business drivers for cloud computing – Cloud computing Delivery Models – Cloud computing Services – Challenges of cloud computing – Cloud infrastructure: Cloud storage and cloud Compute in Amazon – HP Cloud System Matrix – Microsoft Windows Azure – Microsoft Windows Azure services - Google App Engine, cloud platform as a service – Apache Hadoop, Mashups – CRM as a service – Social Computing Services – Document Services – Scalable Data Storage Techniques – Map Reduce Revisited – Rich Internet Applications.	
Unit-2 - Challenges, Security and Managing Cloud	9 Hour
Addressing the cloud challenges – Scaling Computation – Scaling Storage – Multi-Tenancy – Availability – Design cloud security – Cloud security requirements and Best practices – Security Design Patterns- Security Architecture standards – Managing the cloud – IaaS, PaaS, SaaS – Cloud Scale Management Systems – Open Source Private cloud software – Amazon cloud formation – Windows Azure Active Directory	
Unit-3 - Virtualization	9 Hour
Server Virtualization – Hypervisor-based Virtualization – Techniques for Hypervisor – Hardware support for virtualization – VMware virtualization software – XenServer virtual machine monitor – Storage virtualization – File virtualization – Example – Block virtualization – Examples – Grid Computing – Grid Technologies – Comparing Grid and Cloud – Cloud-related technologies – Creating sample hello world application in Open Shift Example	
Unit-4 - Application Development	9 Hour
Amazon Web Services: EC2 Instances – Connecting Clients to Cloud Instances through Firewalls – Security Rules for Application Layer & Transport Layer protocols in EC2 – How to launch an EC2 Linux Instance and connect to it – S3 in Java – Manage SQS Services in C# – Install the simple notification service on ubuntu – Example – Creating an EC2 Placement Group –Use MPI – Hadoop Ecosystem – Install Hadoop on Eclipse on a Windows System – Cloud Based Simulation of a Distributed Trust Algorithm – A cloud service for adaptive data streaming – cloud-based optimal FPGA synthesis	

Unit-5 - Applications	9 Hour
Cloud Application Design – Design considerations for cloud applications – Reference architectures for cloud applications – Cloud applications design methodologies – Data storage approaches – Web application framework – Django – RESTful Web API – Cloud Application Development, Design Approaches – Design methodology for IaaS & PaaS model – Image Processing App – Big Data Analytics – Recommendation systems – Multimedia cloud – Live video streaming app – Streaming protocols – Video Transcoding app	

Learning Resources	<ol style="list-style-type: none"> 1. Dinkar Sitaram, Geetha Manjunath, <i>Moving To The Cloud: Developing Apps in the New World of Cloud Computing</i>, Syngress, 2013. 2. Arshdeep Bahga, Vijay Madiseti, "Cloud Computing A Hands-on Approach", 2014 3. Edward Hughes, John Hiley, Keith Brown, Ian McKenzie Smith, <i>Hughes Electrical and Electronics Technology</i>, Pearson Education, 12th ed., 2016 4. Scott Adkins, John Belamaric, Vincent Giersch, "OpenStack Cloud Application Development", Wiley publisher, 2016 5. David E.Y. Sarna, "Implementing and Developing Cloud Applications", CRC Press 2011 6. Dan C. Marinescu, "Cloud Computing: Theory and Practice", Morgan Kaufman, 2013 7. Michael P. McGrath, <i>Understanding PaaS: Unleash the Power of Cloud Computing</i>, O'Reilly Media, 2012, Charles Alexander, Matthew Sadiku, <i>Fundamentals of electrical circuits</i>, McGraw-Hill Education; 5th ed., 2012 8. Richard Rodger, "Beginning Mobile Application Development in the Cloud", John Wiley & Sons Inc., 2012.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.Nagaveer, CEO, Campus Corporate Connect, nagaveer@campuscorporateconnect.com	1. Dr. Srinivasa Rao Bakshi, IITM, Chennai, sbakshi@iitm.ac.in	1. Dr.S.Thenmalar, SRMIST

Course Code	21CSE466T	Course Name	NETWORK DESIGN AND MANAGEMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Grasp knowledge on the types of Networks and the Network Management basics	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the Network Management Standards															
CLR-3:	Familiarize with the working of Simple Network Management Protocol and its various versions															
CLR-4:	Discern on the working of Remote Monitoring Systems															
CLR-5:	Deduce on various Network Management Applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Acquire knowledge on networks and network management	2	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	Interpret Information on various Network Protocols	2	-	-	3	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Gain knowledge on the working of SNMP protocol and its various applications	2	-	-	3	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Examine the network management tools and gather information from the network	2	-	-	3	-	-	-	-	-	-	-	-	2	-	-
CO-5:	Familiarize with the working of various management applications	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-

Unit-1 – Introduction to Network Management	9 Hour
Telephone Network Management, Distributed Computing Environment, TCP/IP Based Networks, Communication Protocols and Standards, Protocol Layer and Services, Challenges of IT Managers, Network Management, Network and System Management, Network Management System Platform, Current status and future of Network Management, Network Management Standards, Network Management Model - Organizational model, Information Model, Management Information Trees, Communication Model, ASN.1, Terminology, Symbols and Conventions, Functional Model	
Unit-2 – Network Protocols	9 Hour
Introduction to SNMP, SNMP v1 model, Organization Model, System overview, SNMP v1 Information model, Structure of Management Information, Managed Objects, MIB-Object Group, System Group, Interfaces Group, Address Translation group, IP Group, ICMP Group, TCP Group, UDP Group, SNMP, MIB, User-Based Security Model, Access Control	
Unit-3 – Network Monitoring Tools	9 Hour
Remote Monitoring, RMON SMI and MIB, RMON1, RMON2, System Utilities for Management Tool, Network Statistics Measurement Systems, Traffic Load, Protocol Statistics, Data and Error Statistics, Network Management System, Components, Requirements, System Management, Network Management Applications, Configuration Management, Inventory Management, Performance Management Tools	
Unit-4 – Configuration Management	9 Hour
Network Management Applications, Fault Management -Architecture, Fault location, Fault isolation Algorithm, Self-healing, avoiding failures, Configuration setting, Configuration discovery and Change Control, Configuration Management Applications, Patch Management, Approaches for Performance Management, Performance Monitoring and Reporting, Performance trouble shooting, Capacity Planning, Account Management, Report Management System and User Reports, Policy Management, Service Level Management	

Unit-5 - Network Design and Planning	9 Hour
Network Design for Enterprise Network, Network Design Process, Data Collection, Data Generation, Traffic Generators, Cost Generators, Topology, Architecture, Graph, Link, Algorithms, Network Design Techniques, Performance Analysis, Queuing Essentials, Loss and Delay, Reliability, Network Cost	

Learning Resources	1. Greg Tomsho, Ed Tittel, David Johnson, "Guide to Network Essentials", Eight Edition, Cengage Learning, 2019 2. Teresa C.Piliouras, "Network Design Management and Technical Perspectives", Second Edition 2015	3. Mani Subramanian "Network Management Principles and Practice", Second Edition, Pearson Publication, 2012. 4. Dinesh Chandra Verma, "Principles of Computer Systems and Network Management", Springer, 2009.
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Vijay Aravind .S Manager, Accenture, BengaluruEmail:vijayaravin@gmail.com	1. Dr. Zayaraz Godandapani, Professor, Dept. of CSE, Pondicherry Engineering College	1. Dr.A.Vijay Vasanth, SRM IST

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 11E

**(Syllabi for Computer Science and Engineering w/s in
Computer Networking Programme Courses)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC311J	Course Name	WIRELESS NETWORKS	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Identify the concepts of modulation and transmitters in analog communication	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Relate frequency modulation and amplitude modulation in digital communication															
CLR-3:	Transfer knowledge on wireless communication and its parameters															
CLR-4:	Relate various wireless network topologies and its operations															
CLR-5:	Appraise the concepts of information on GPRS applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Recognize the concepts of modulation and transmitters in analog communication	3	-	2	-	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Correlate the information on frequency modulation and amplitude modulation in digital communication	3	-	-	-	-	-	2	-	-	-	-	-	-	-	3
CO-3:	Articulate knowledge on wireless communication and its parameters	3		-	-	-	-	2	-	-	-	-	-	-	-	3
CO-4:	Devise wireless network topologies and its operations	3	-	2	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Defend the concepts of information on GPRS applications	3	-	2	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Analog Communication	12 Hour
Introduction to communication system, Need for modulation. - classification- - Amplitude Modulation, Definition, Time domain and frequency domain description, . Square law Modulator, Square law detector, Envelope detector. Radio Transmitters-Classification of Transmitters.	
Unit-2 - Digital Communication	12 Hour
Frequency Modulation: Narrow band FM, Wide band FM, FM Wave -Comparison of FM & AM - Detection of FM Waves: Phase locked loop, Foster Seeley Discriminator.	
Unit-3 - Wireless Communication	12 Hour
An Introduction to the Wireless Channel – Noise, Multipath Propagation Large scale path loss – Small scale fading- Parameters of mobile multipath channels – Time dispersion parameters-Coherence bandwidth – Doppler spread & Coherence time, Classification of fading.	
Unit-4 - Wireless Network Planning and Operation	12 Hour
Wireless networks topologies, cellular topology, cell fundamentals signal to interference ratio calculation, capacity expansion techniques, cell splitting, cell sectoring, micro cell method, overload cells, channel borrowing techniques, DCA, mobility management, radio resources and power management securities in wireless networks.	
Unit-5 - Wireless LAN	12 Hour
Mechanism to support a mobile environment, IS-95 CDMA forward channel, IS – 95 GPRS and higher data rates, Historical overviews of the LAN industry, evolution of the WLAN industry, wireless home networking, IEEE 802.11. The PHY Layer, MAC Layer-Wireless Network Application-Case Study.	

Lab Experiments	
1. Implement Amplitude modulation and demodulation. 2. Implement Frequency modulation and demodulation. 3. Design TDM and FDM 4. Design PAM and PPM 5. Implement Propagation Path loss Models (Indoor & Outdoor) 6. Design Spread Spectrum – DSSS Modulation & Demodulation 7. Study CSMA/CD protocol and its performance	8. Design Global System for Mobile Communication (GSM) 9. Configuration of simple network with point-to-point link 10. Design Star topology 11. Study of cell splitting and cell sectoring. 12. Study Token bus protocol and the performance 13. Study Token ring protocol and the performance. 14. Study Zigbee and Blue-tooth technologies 15. Study WiFi and LiFi technologies.

Learning Resources	1. Rappaport.T.S. "Wireless Communications: Principles and Practice", 2nd Edition, Pearson, 2011. 2. John D Kraus, Ronald J Marhefka, Ahmed S Khan "Antenna and Wave Propagation", 4th Edition, Tata McGraw Hill, 2010 3. Constantine Balanis. A, "Antenna Theory: Analysis and Design", 3rd Edition, John Wiley, 2012. 4. Andreas.F. Molisch., "Wireless Communications", Wiley, 2nd Edition-2005, Reprint-2014	5. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, Aug 2005 6. Schiller, "Mobile Communications", Pearson Education Asia Ltd., Reprint 2012 7. Lee W.C.Y., " Mobile Communications Engineering: Theory and Applications", McGraw Hill, New York, 2nd Edition, 1998

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	30%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. J Dr.Madan Lakshmanan, Senior Scientist, CEERI, CSIR, Chennai (R&D Industry)	1. Dr. K.Selvakumar, Professor & Head, Annamalai University, Chidambaram, Tamilnadu, India	1. Dr.P.Visalakshi, SRMIST
2. Mr. Anuj Kumar, Bombardier Transportation, Ahmedabad, kumaranuj.anii@gmail.com	2. Prof. Subra Ganesan. Professor, Electrical and Computer Engineering, Oakland University, USA	2. Arun.A, SRMIST
3. Mr. Hariharasudhan - Johnson Controls, Pune, hariharasudhan.v@jci.com	3. Dr.M.D. Selvaraj, Professor, Head of the Department, ECE, IITM, Kancheepuram, Technology, Chennai	3. Dr.K.Kalimuthu, SRMIST

Course Code	21CSC312J	Course Name	MOBILE ADHOC NETWORKS	Course Category	C	PROFESSIONAL CORE										L	T	P	C
																2	0	2	3
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil												
Course Offering Department		School of Computing			Data Book / Codes / Standards			Nil											
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes	
CLR-1:	Understand the design issues in ad hoc and sensor networks					1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3	
CLR-2:	Relate the architecture and protocols of wireless sensor networks																		
CLR-3:	Categorize the different types of MAC protocols																		
CLR-4:	Examine the different types of adhoc routing protocols																		
CLR-5:	Correlate the QoS issues in adhoc networks																		
Course Outcomes (CO):		At the end of this course, learners will be able to:																	
CO-1:	Understand the use of network devices in data Communication					3	-	-	-	-	-	-	-	-	-	-	-	3	
CO-2:	Practice various MAC protocols in Adhoc Wireless Networks					3	-	-	-	-	-	-	-	3	-	-	-	3	
CO-3:	Categorize the routing protocols used in Adhoc and Wireless sensor networks					-	-	-	-	-	-	-	-	3	-	-	-	3	
CO-4:	Relate the transport layer design and network security issues and the various prevention techniques					3	-	-	-	-	-	-	-	-	-	-	-	3	
CO-5:	Sketch the QoS design in Adhoc and Wireless sensor networks					3	-	-	-	-	-	-	-	3	-	-	-	3	
Unit-1 - Introduction to MANET and WSN																		12 Hour	
Origin of packet radio networks, Components of packet radio networks, Mobile Ad hoc Networks (MANETs) and wireless sensor networks (WSNs): concepts and architectures, Issues in adhoc network, Design Challenges in Ad hoc and Sensor Networks, Applications of Ad Hoc and Sensor networks.																			
Unit-2 - MAC Protocol																		12 Hour	
Ad Hoc Wireless Networks: Introduction, Cellular and Ad Hoc wireless Networks, Ad Hoc Wireless Internet, MAC Protocols for Ad Hoc Wireless, Design Goals of MAC protocol, Classification of MAC Protocols, MAC Protocols for Wireless Sensor Networks, Schedule based protocols – LEACH, IEEE 802.15.4, BLUETOOTH, ZIGBEE.																			
Unit-3 - Network Routing Protocol																		12 Hour	
Design issues, goals, and classification. Proactive Vs reactive routing, Link State Routing Protocol, Distance Vector Multicast Routing Protocol, Overview of hybrid routing protocol, energy aware routing algorithm, hierarchical routing, QoS aware routing.																			
Unit-4 - Transport Layer Protocol & Network Security																		12 Hour	
Issues in designing transport layer protocol, Design goals of a transport layer protocol, Classification of transport layer solutions, TCP over adhoc networks, Security in mobile adhoc network, Network security requirement, Issues and challenges in security provisioning, Network security attack, Key management, Secure routing in adhoc network.																			
Unit-5 - Cross Layer Design & Quality of Service																		12 Hour	
Cross layer Design: Need for cross layer design, Cross layer optimization, Parameter optimization, Cross layer cautionary perspective. Integration of adhoc with Mobile IP networks, Issues, and challenges in providing QoS in adhoc network, Characteristics of QoS solutions, Qos Model, QoS resource reservation signaling, SWAN.																			

Lab Experiments	
Lab1: Study on Sample wireless topology Lab2: Design of simple Mobile Ad-hoc networks Lab3: Create simple sensor networks using NS-2 Lab4: Study on various MAC protocols, Lab5: Implement LEACH protocol, Lab6: Implement ZIGBEE, RFID protocol. Lab7: Implement unicast routing protocol	Lab8: implement multicast routing protocol Lab9: implement QoS aware routing protocol Lab10: Implement transport layer protocol Lab11: Implement TCP, Other transport layer protocols Lab12: Study on User Datagram Protocol Lab13: Implement cross layer optimization Lab14: Study on integration of adhoc with Mobile IP network Lab15: Implement QoS model in MAC layer

Learning Resources	1. C. Siva Ram Murthy, and B. S. Manoj, "Ad Hoc Wireless Networks: Architectures and Protocols", Prentice Hall Professional Technical Reference, 2008.	3. Kazem Sohraby, Daniel Minoli, & Taieb Znati, "Wireless Sensor Networks Technology, Protocols, and Applications", John Wiley, 2007.
	2. Dargie, Waltenegus, and Christian Poellabauer. Fundamentals of wireless sensor networks: theory and practice. John Wiley & Sons, 2010.	4. Anna Hac, "Wireless Sensor Network Designs", John Wiley, 1 Edition, 2003. 5. Savo G. Glisic, "Advanced Wireless Networks: Technology and Business Models", John Wiley, 1 Edition, 2016

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	25%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. J. Aravind Kumar, Senior Architect, JDA Solutions, Bangalore	1. Dr. K. Selvakumar, Professor & Head, Annamalai University, Chidambaram, Tamilnadu, India	1. Dr.N. Krishnaraj, SRMIST
2. Dr.R. Lenin Babu, Conversight.Ai, Indiana, United States of America	2. Dr. K. G. Srinivasa, Professor, Department of Data Science and Artificial Intelligence, IIIT- Naya Raipur, Raipur, Chhattisgarh, India	2. Dr. Praveena Akki, SRMIST

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSE273T	Course Name	DISTRIBUTED OPERATING SYSTEMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Recognize the essential concepts of distributed system	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Relate the communication systems that takes place in Distributed systems															
CLR-3:	Discover the necessity of synchronization, consistency, and Fault tolerance in a Distributed System															
CLR-4:	Categorize different processors and process management approaches															
CLR-5:	Use distributed shared memory schemes to access data in the distributed systems.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Characterize the fundamental hardware and software concepts of distributed systems	2	-	3	-	-	-	-	-	-	-	-	-	3	-	3
CO-2:	Categorize layered protocols and comprehend the communications in distributed systems	2	-	3	-	2	-	-	-	-	-	-	-	3	-	3
CO-3:	Implement synchronization of distributed systems using various algorithms.	2	-	3	-	-	-	-	-	-	-	-	-	3	-	3
CO-4:	Demonstrate process scheduling and fault tolerance of distributed systems.	2	-	3	-	2	-	-	-	-	-	-	-	3	-	3
CO-5:	Illustrate the concepts of distributed shared memory systems.	2	-	3	-	-	-	-	-	-	-	-	-	3	-	3

Unit-1 - Introduction to Distributed System	9 Hour
Distributed Systems- Goals of Distributed Systems, Hardware Concepts- Bus-based Multiprocessors- Switched Multiprocessors, - Bus-based Multicomputers- Switched Multicomputers, Software Concepts-Network Operating System - True Distributed Systems- Multiprocessors- Time Sharing Systems- Design Issues-Distributed Systems. Case Study: Mach OS System Architecture	
Unit-2 - Fundamentals of Communication systems	9 Hour
Layered Protocols, ATM networks, Client Server model - Blocking Primitives, Non-Blocking Primitives, Buffered Primitives, Unbuffered Primitives, Reliable primitives, Unreliable primitives, Message passing and its related issues, Remote Procedure Call and its related issues, Case Studies: Communication in Mach OS.	
Unit-3 - Synchronization in Distributed Systems	9 Hour
Fundamentals of Clock Synchronization, Logical clock, Physical clock, Algorithms for Clock synchronization, Mutual Exclusion-Centralized Algorithm, Distributed Algorithm, Token Ring Algorithm, Comparison of all three algorithms, Importance of Election Algorithm, Bully Algorithm, Ring Algorithm, Atomic Transaction- Introduction Transaction Model, Concurrency Control, Deadlock in Distributed Systems, Distributed Deadlock Detection. Synchronization in Mach OS.	
Unit-4 - Processes and Processors in Distributed Operating Systems	9 Hour
Threads, Design issues of Threads package, Workstation Model, System Model – Introduction, Using Idle Workstations, Processor Pool Model, Hybrid Model, Processor Allocation – Allocation Model, Design issues for processor Allocation Algorithms, Example of processor Allocation Algorithms, Scheduling in Distributed Systems, Load Balancing and Sharing Approach, Fault Tolerance- Fault tolerance Using Active Replication, Primary-backup, Real Time Distributed Systems- Communication, Real Time Scheduling. Case study - Process Management in Mach OS	

Unit-5 - Distributed Shared memory	9 Hour
Introduction, Bus-Based Multiprocessors, Switched Multiprocessors, Ring-based Multiprocessors, Numa Multiprocessors, Consistency Models – Strict Consistency, Casual Consistency, PRAM Consistency, Weak Consistency, Release Consistency, Entry Consistency, Page Based Distributed Shared Memory – Replication, granularity, Finding the Owner, Finding the Copies, Page Replacement, Synchronization, Shared – Variable Distributed Shared memory, Object Based Distributed Shared memory, Case Study – Memory Management in Mach OS	

Learning Resources	1. Andrew S. Tanenbaum, <i>Distributed Operating Systems</i> , Pearson Education, 2011. 2. Pradeep K. Sinha, <i>Distributed Operating Systems Concepts and Design</i> , PHI, 2012. 3. Mukesh Singhal, Niranjana G Shrivatri, <i>Advanced concepts in Operating Systems</i> , Mc Graw Hill International, 2017. 4. Erciyes, Kayhan, <i>Distributed real-time systems: theory and practice</i> , Springer, 2019. 5. http://www.cs.iit.edu/~sun/cs550.html 5.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Uma Parvathy S, Associate Consultant TCS. umaparvathy.s@tcs.com	1. Dr. S. Geetha, Assistant Professor, Pondicherry University, geethareddy@pondiuni.ac.in	1. Dr. K. Deepa Thilak, SRMIST

Course Code	21CSE274T	Course Name	PERVASIVE COMPUTING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understanding the basics of pervasive computing and its application	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Categorize the fundamental elements of pervasive computing.															
CLR-3:	Connect voice enabling technology with pervasive computing															
CLR-4:	Relate the design process Human-Computer Interface															
CLR-5:	Illustrate Pervasive Mobile Transaction															

Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the fundamental elements of pervasive computing and its solutions	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Relate hardware, software and implementing security aspects involved in pervasive computing	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Voice Technology connection in Pervasive Computing	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-4:	Discover the functionalities and components of Human-Computer Interface	2	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-5:	Demonstrate about Pervasive Mobile Transaction	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-

Unit-1 - Pervasive Computing	9 Hour
Past, Present and Future Pervasive computing, Pervasive Computing Market, m-Business, Application examples: Retail, Application examples: Airline check-in and booking, Healthcare, Tracking, Car information system, Sales Force Automation, Email access via WAP and voice, A Pervasive System for Volcano Monitoring, A Pervasive Computing Platform for Individualized Higher Education, Device Technology, Hardware, Human machine interface, Biometrics, Operating systems, Java for pervasive devices	
Unit-2 - Device connectivity	9 Hour
Protocols, Security, Device management, WAP and beyond: Components of the WAP architecture, WAP infrastructure, WAP security issues, Wireless Markup language, WAP Push, Products	
Unit-3 - Voice Technology	9 Hour
Basic of speech recognition, Voice Standard, Speech application, Speech and pervasive computing, Security, Personal digital assistants: Device categories, Personal digital assistant operating systems, Device characteristics, Software components Standards Mobile application Personal digital assistant browser	
Unit-4 - Human-Computer Interface (HCI) in Pervasive Environments	9 Hour
HCI interface in Pervasive Environments: HCI Service and Interaction Migration, Context- Driven HCI Service Selection, Scenario Study: Video Calls at a Smart Office, A Web Service- Based HCI Migration Framework	
Unit-5 - Pervasive Mobile Transaction	9 Hour
Mobile Transaction Framework, Context-Aware Pervasive Transaction Model, Dynamic Transaction Management, Formal Transaction Verification, Evaluations. Case Studies: iCampus Prototype, IPSpace: An IPv6-Enabled Intelligent Space.	

Learning Resources	1. JochenBurkhardt, Horst Henn, Stefan Hepper, Thomas Schaech & Klaus Rindtorff, —Pervasive Computing, Technology and Architecture of Mobile Internet ApplicationsII, Pearson Education, 2012.ISBN-13: 978-0201722154, 2012	3. Gupta, Deepak, and Aditya Khamparia, eds. Fog, Edge, and Pervasive Computing in Intelligent IoT Driven Applications. John Wiley & Sons, 2020.
	2. S. Poslad, — Ubiquitous Computing: Smart Devices, Environments, and Interactions, II Wiley, 2009	4. Bhargava, Deepshikha & Vyas, Dr Sonali. (2019). Pervasive Computing: A Networking Perspective and Future Directions. 10.1007/978-981-13-3462-7.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Charan Ramaswamy Senior Administrator, Wipro Technologies Australia Pty Ltd	1. Dr. N.Kumaratharan Professor, Electronics & Communication Engineering Sri Venkateswara College of Engineering Pennalur, Sriperumbudur - 602 117 Tamil Nadu, INDIA.	1. Dr. Rajaram V, SRM IST

Course Code	21CSE347T	Course Name	NETWORK PROTOCOLS AND PROGRAMMING	Course Category	E	PROFESSIONAL ELECTIVE										L	T	P	C		
																2	1	0	3		
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil														
Course Offering Department		School of Computing			Data Book / Codes / Standards			Nil													
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes			
CLR-1:	Describe the importance of various network and transport layer protocols				1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3				
CLR-2:	Demonstrate the basics of different socket programming concepts and functions																				
CLR-3:	Examination of application layer protocols and Multicasting protocols with its characteristics																				
CLR-4:	Summarizes the latest IPV6 technology and addressing schemes																				
CLR-5:	Appraise the WAN protocols and MPLS protocols																				
Course Outcomes (CO):		At the end of this course, learners will be able to:																			
CO-1:	Determining the basics of different types of network and transport layer protocols				-	-	2	-	3	-	-	-	-	3	-	-	3				
CO-2:	Experimenting network connections through socket programming and summarizing application layer protocols				-	-	2	-	3	-	-	-	-	3	-	-	3				
CO-3:	Demonstrate the Application layer protocols, Multicasting Protocols and its characteristics				-	-	2	-	3	-	-	-	-	-	-	-	3				
CO-4:	Experimenting the latest IPV6 address in real time.				-	-	-	-	3	-	-	-	-	-	-	-	3				
CO-5:	Categorizing WAN Protocols with MPLS technology.				-	-	2	-	3	-	-	-	-	-	-	-	3				
Unit-1 - Network and Transport Layer Protocols																	9 Hour				
OSI Model, IP Header, ARP, RARP, ICMP, UDP Data gram and its characteristics, TCP Header & Connection Establishment Process, IP Fragmentation, ARP, RARP, ICMP, UDP Data gram and its characteristics, TCP Header & Connection Establishment Process																					
Unit-2 - Socket Programming																	9 Hour				
Byte Ordering Conversion Functions, man page, System Calls used with sockets, Iterative and Concurrent Server, Socket Interface, Remote Procedure Call, TCP Client Server Program, UDP Client Server Program																					
Unit-3 - Application Layer Protocols																	9 Hour				
DNS, TELNET, FTP, HTTP, WWW, DHCP, SMTP, POP3 Multicasting Protocols BGMP, IGMP, MBGP, MOSPF, PGM, PIM-DM PIM-SM																					
Unit-4 - Ipv6 Protocol																	9 Hour				
IPV6 Features, IPV6 Header, IPV6 Address Types, IPV6 Routing Protocols, IPV4 to IPV6 Tunneling and Translation Techniques																					
Unit-5 - WAN Protocols																	9 Hour				
DSL and Cable technology, Frame Relay, ATM, PPP, HDLC, MPLS, CR-LDP, LDP, RSVP-TE																					

Learning Resources	1. Forouzan, Behrouz A. TCP/IP protocol suite. McGraw-Hill Higher Education, 2002.	4. Dong, Jieli. "Network Protocol Handbook." (2007).	
	2. Beej's Guide to Network Programming Using Internet Sockets Brian "Beej Jorgensen" Hall v3.1.9, Copyright © November 16, 2022.	5. https://people.scs.carleton.ca/~lanthier/teaching/COMP1406/Notes/COMP1406_Ch12_NetworkProgramming.pdf .	
	3. Stevens, W. Richard, Andrew M. Rudoff, and Bill Fenner. Unix network programming volume 1: the sockets networking API. Vol. 3. Boston: Addison-Wesley Professional, 2003.	6. https://www.geeksforgeeks.org/types-of-network-protocols-and-their-uses/	
		7. https://internalpointers.com/post/network-programming-beginners-overview	
		8. https://people.scs.carleton.ca/~lanthier/teaching/COMP1406/Notes/COMP1406_Ch12_NetworkProgramming.pdf .	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.S.Venkata prasad, TCS, chennai-venkataprasad.s@tcs.com.	1. Dr. T Veera kumar, NIT, Goatveerakumar@nitgoa.ac.in	1. Dr S Murugaanandam, SRMIST .
2. Mr. J. Hariprasam, HCL Technologies, Chennai.hariprasad@hcl.com	2. Dr. Bhavana Rudhra, NIT, Karnataka.bhawanarudra@nitk.edu.in	

Course Code	21CSE348T	Course Name	NETWORK ROUTING ALGORITHMS				Course Category	E	PROFESSIONAL ELECTIVE				L	T	P	C						
																2	1	0	3			
Pre-requisite Courses	Nil		Co- requisite Courses	Nil				Progressive Courses	Nil													
Course Offering Department		School of Computing				Data Book / Codes / Standards				Nil												
Course Learning Rationale (CLR):		The purpose of learning this course is to:						Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the basics about Routing in Networks						1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3			
CLR-2:	Relate the categories of Routing Algorithms																					
CLR-3:	Explore the Routing Protocols																					
CLR-4:	Explore the Distance Vector Routing Family																					
CLR-5:	Explore the Router Architecture and Design																					
Course Outcomes (CO):		At the end of this course, learners will be able to:																				
CO-1:	Identify and define Network categories and corresponding Routing Schema						-	-	3	-	-	-	-	-	-	-	-	-	3			
CO-2:	Examine the categories of Routing Algorithms						-	-	2	-	-	-	-	-	-	-	-	-	3			
CO-3:	Analyze the Routing Protocols						-	-	2	-	3	-	-	-	-	-	-	-	3			
CO-4:	Analyze the Distance Vector Routing Family						-	-	2	-	-	-	-	-	-	-	-	-	3			
CO-5:	Analyze the Router Architecture and Design						-	-	2	-	2	-	-	-	-	-	-	-	3			
Unit-1 - Routing Foundations																9 Hour						
Introduction to Networking and Network Routing - IPV4 Addressing, Protocol Stack Architecture - Router Architecture - Network Topology Architecture - Network Management Architecture - Global Telephone Network - Communication Technologies - Standards Committees.																						
Unit-2 - Routing Algorithms: Shortest Path, Widest Path, and Spanning Tree																9 Hour						
Bellman-Ford Algorithm: Centralized View - A Distance Vector Approach: Distributed View – Dijkstra’s Algorithm: Centralized Approach – Dijkstra’s Algorithm: Distributed Approach – Widest Path Algorithm: Dijkstra-Based Approach - Widest Path Algorithm: Distance Vector-Based Approach – Spanning Tree: Breadth First Search and Depth First Search - Minimum Spanning Tree - Steiner Tree Algorithms - k-Shortest Paths Algorithm																						
Unit-3 - Routing Protocols: Framework and Principles																9 Hour						
Routing Protocol, Routing Algorithm, and Routing Table – Routing Information Representation and Protocol Messages – Distance Vector Routing Protocol: Illustration – Distance Vector Routing Protocol: Times – Babel Routing Protocol – Link State Protocol: In-Band Hop-by-Hop Dissemination – Link State Protocol: In-Band Based on End-to-End Session – Path Vector Routing Protocol - Link Cost																						
Unit-4 - IP Routing and Distance Vector Protocol Family																9 Hour						
Routers, Networks, and Routing Information – Routing Table – Communication of Routing Information – Static Routes – Routing Information Protocol, Version 1 (RIPv1) : Communication and Message Format– RIPv1 General Operation – Routing Information Protocol, Version 2 (RIPv2) - Interior Gateway Routing Protocol (IGRP) - Enhanced Interior Gateway Routing Protocol (EIGRP)																						
Unit-5 - Router Architecture and Design																9 Hour						
Router Architectures – Functions of a Router - Types of Routers – Elements of a Router – Packet Flow – Packet Processing: Fast Path Versus Slow Path - Router Architectures, Impact of Addressing on Lookup - Longest Prefix Matching																						

Learning Resources	1. Deepankar Medhi, Karthik Ramasamy, Network Routing Algorithms, Protocols, and Architectures Morgan Kaufmann Publishers, Second Edition, 2017.	3. Yoram Orzach, Deepanshu Khanna, Network Protocols for Security Professionals, Packt Publishers, First Edition, 2022.
	2. James Aweya, IP Routing Protocols, CRC Press, First Edition, 2021.	4. James H. Baxter, Wireshark Essentials, Packt Publishers, First Edition, 2017

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.R.Lenin Babu, Conversight.Ai, USA, leninbabur@conversight.ai	1. Dr.K.Selvakumar, Professor, Annamalai University, kskaucse@gmail.com	1. Dr.C. Rajesh Babu, SRMIST
2. Mr.U.Aravind Kumar, JPA Solutions, Bangalore, uaravinda@gmail.com	2. Dr.K.G.Srinivasa, Professor, NITTR Chandigarh, kgsrinivasa@nitttrchd.ac.in	

Course Code	21CSE349T	Course Name	OPTICAL NETWORKS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand a basic foundation of Optical Networks	1	2	3	4	5	6	7	8	9	10	11	12	PO-1	PO-2	PO-3
CLR-2:	Relate the details about propagation and Dispersion of light	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	Correlate the different Components of Optical Networks															
CLR-4:	Analyze the Optical Network															
CLR-5:	Appraise about the Optical Network Management Techniques															

Course Outcomes (CO):	At the end of this course, learners will be able to:	1	2	3	4	5	6	7	8	9	10	11	12	PO-1	PO-2	PO-3
CO-1:	Acquire the basic knowledge Multiplexing and Fiber characteristics	-	-	-	-	2	-	-	-	-	-	-	-	3	-	-
CO-2:	Illustrate the effects of Light energy	-	-	-	-	2	-	-	-	-	-	-	-	3	-	-
CO-3:	Categorize the Various Components of Optical Networks	-	-	-	-	3	-	-	-	-	-	-	-	3	-	-
CO-4:	Articulate about SONET and WDM	-	-	-	-	3	-	-	-	-	-	-	-	3	-	-
CO-5:	Appraise the Network management functions and Access Networks	-	-	-	-	3	-	-	-	-	-	-	-	3	-	-

Unit-1 - Introduction to Optical Networks	9 Hour
Introduction: Network Architecture - Services, Circuit Switching, Packet Switching - First- and second-generation optical networks – Optical Layer - Transmission basics: Wavelength, Frequencies, Channel Spacing - Network evolution: Single Mode Fiber, Multi-Mode Fiber.	
Unit-2 - Propagation of Light	9 Hour
Propagation of light energy in optical fibers: Loss and Bandwidth windows – Intermodal dispersion: Geometrical Optics Approach, Bit Rate–Distance Limitation - Chromatic dispersion: Chirped Gaussian Pulses, Controlling the Dispersion - nonlinear effects: Stimulated Brillouin Scattering, Stimulated Raman Scattering, Self-Phase Modulation, Cross-Phase Modulation	
Unit-3 - Network Components	9 Hour
Couplers, Isolators and Circulators, Multiplexers and Filters: Fiber gratings – Fabry Perot Filters – MZ interferometers – Arrayed waveguide grating – optical amplifiers: SOA, EDFA and Raman Amplifier – switches.	
Unit-4 - Optical Networks	9 Hour
SONET/ SDH, Architecture of Optical transport networks (OTNs), Generic Framing Procedure, Optical Transport Network, Ethernet, IP, Multiprotocol Label Switching, Resilient Packet Ring, Storage-Area Networks -WDM: Terminals, Amplifiers, Multiplexers, Cross connects	
Unit-5 - Network Management	9 Hour
Network Management functions: Management Framework, Information Model, Management Protocols - Optical Layer services and Interfacing - Performance and fault management - Configuration Management - optical safety	

Learning Resources	1. Partha Parthim Sahu, " Fundamentals of Optical Networks and Components" CRC Publications, 2020	3. Uyless Black, "Optical Networks – Third generation transport systems", 1 st edition, Pearson, 2002
	2. Rajiv Ramaswamy, Kumar N. Sivarajan and Galen H. Sasaki, "Optical Networks – A practical perspective", 3 rd edition, Elsevier, 2010	4. C. Siva Ram Murthy and Mohan Gurusamy, "WDM Optical Networks: Concepts Design, and Algorithms", PHI, EEE, 2001

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.M.Vivekanandan,Nokia	1. Mr.Karthikeyan.C.M.T, Govt College of Engg,Bargur	1. Ms.G.Parimala, SRMIST
2. Mr.Santhosh Kumar,CTS	2. Dr.Syedthouheed,Reva University, Bangalore	2. Dr.S.Thanga Revathi, SRMIST

Course Code	21CSE350T	Course Name	PRINCIPLES OF CLOUD COMPUTING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1: Understand the fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2: Articulate cloud enabling technologies and get exposure to advanced clouds																
CLR-3: Correlate cloud storage technologies and relevant distributed file systems, NoSQL databases and object storage																
CLR-4: Appraise the cloud security threats and protective mechanism for cloud computing																
CLR-5: Participate in team-based peer reviews to analyze the security development life cycle and mitigate risks and vulnerabilities																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1: Explain the fundamentals of cloud computing and its applications, benefits, and Challenges		3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2: Apply fundamental concepts in cloud infrastructures to understand the cloud system, network and virtualization and outline their role in enabling the cloud computing system model.		-	-	-	2	-	-	-	-	-	-	-	-	3	-	-
CO-3: Analyze the fundamental concepts of cloud storage and demonstrate their use in storage systems		-	-	-	-	2	-	-	-	-	-	-	-	3	-	-
CO-4: Appraise the security issues related to cloud computing and handle the security threats and construct different cloud delivery design models.		-	-	-	2	-	-	-	-	-	-	-	-	3	-	-
CO-5: Analyze various cloud programming models and apply them to solve problems on the cloud.		-	-	-	2	-	-	-	-	-	-	-	-	3	-	-

Unit-1 - Introduction to Cloud Computing	9 Hour
Introduction - Evolution of cloud computing- Network-Centric Computing - Network-Centric Content -Origin of Cloud Computing -Basic Concepts and Terminology - Goals and Benefits - Risks and Challenges -Roles and Boundaries - Cloud Characteristics - Cloud Deployment Models - Cloud Service Models - Cloud Service Providers and the Cloud Ecosystem -SLA Management in Cloud Computing: A Service Providers Perspective.	
Unit-2 - Cloud Technologies	9 Hour
Cloud enabling technologies-Broadband networks and Internet architecture - Data Center Technology - Web Technology - Multitenant Technology - Service Technology -Virtualization Technology - Virtual Machines - Full Virtualization and Para-virtualization - Hardware Support for Virtualization - Kernel-Based Virtual Machine - Hypervisors.	
Unit-3 - Cloud Data Storage	9 Hour
Introduction to Cloud Data Storage - The evaluation of storage technology - Storage Models - File Systems and databases - Cloud Object Storage (Amazon S3) - Data Storage for Online Transaction Processing Systems - Disk Locality versus Data Locality in Computer Clouds.	

Unit-4 - Cloud Security	9 Hour
Fundamental Cloud Security - Basic Terms and Concepts - Threat Agents, Cloud Security Threats - Cloud Security Mechanisms - Encryption – Hashing - Digital Signature - Public Key Infrastructure - Identity and Access Management - Single Sign-On: Kerberos authentication - One-time password, Basic cloud data - security mechanisms - Virtual Machine Security - Security of Virtualization - A Trusted Hypervisor - Mobile Devices and Cloud Security.	
Unit-5 - Cloud Application Development	9 Hour
Cloud Application Development and Architectural Styles - MapReduce Programming Model - Case Study: The Grep The Web Application - Hadoop: Yarn and Tez - SQL on Hadoop: Pig, Hive, and Impala - Current Cloud Applications and New Opportunities - Design approaches with Case Study - Design methodology for IaaS Service Model - Google API, More on AWS EC2 Instances.	

Learning Resources	<ol style="list-style-type: none"> 1. Dan C. Marinescu, "Cloud Computing Theory and Practicell, Second Edition" Elsevier Inc. 2018 2. Rajkumar Buyya, James Broberg, AndrzejGoscinski, "Cloud Computing Principles and Paradigms", Wiley Publications, 2017. 3. Thomas Erl, ZaighamMahmood, and RichardoPuttini, "Cloud Computing: Concepts, Technology & Architecture", Prentice Hall/PearsonPTR, Fourth Printing, 2014, ISBN: 978013338752. 4. K. Chandrasekaran, "Essentials of Cloud Computing", Chapman and Hall/CRC Press, 2014, ISBN 9781482205435 5. Arshdeep Bahga, Vijay Madiseti, "Cloud Computing: A Hands-On Approach", University Press, 2016, ISBN13: 978-0996025508.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. SuriyadeepanRamamoorthy Research Engineer at Saama Technology Puducherry, Puducherry, India Information Technology and Services.	1. Dr.E. Ilavarasan Professor, CSE Pondicherry Engineering College.	1. Dr. Manickam.M, SRMIST
		2. Ms.V.Lavanya, SRMIST

Course Code	21CSE450T	Course Name	NETWORK SECURITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basic concepts of networking devices	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Appraise knowledge on the working of IP security															
CLR-3:	Categorize various methods and protocols to maintain E-mail security															
CLR-4:	Validate the knowledge on the various methods and protocols to maintain web security															
CLR-5:	Assess various security measures for wireless and cell phone Communications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Acquire the knowledge of network devices used in data Communication	-	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Examine the working of IP security and acquire the ability to identify IP security attack	-	-	-	-	3	-	-	-	-	-	-	-	-	-	3
CO-3:	Appraise Email security and use the knowledge to detect the attacks in e-mail	-	3	-	-	-	-	-	1	-	-	-	-	-	-	3
CO-4:	Grade the knowledge to prevent against Web security attack	-	-	-	-	3	-	-	-	-	-	-	-	-	-	3
CO-5:	Assess wireless network security issues and the various prevention techniques	-	-	-	-	3	-	-	-	-	-	-	-	-	-	3

Unit-1 – Introduction to Network Security	9 Hour
Networking Devices (Layer1,2), Networking Devices (Layer 3), Different types of network layer attacks, Firewall- ACL, Packet Filtering, DMZ, Alerts, Audit Trails, IDS, Advantages and Disadvantages of IDS (Need of IPS), Advantages of IPS over IDS, IPS, IPS Types- Signature based, Anomaly based, Policy based, IPS Types - Honey pot based, Applications, Malicious Software	
Unit-2 – Overview of IPSEC	9 Hour
Security Associations, Security Policy databases, AH and ESP, Tunnel and Transport mode, IP header Protection, IP and IPv6, IPV4 and IPV6 header, Authentication Header, Mutable, Immutable and Mutable but predictable, Encapsulation Security Payload (ESP), Internet Key Exchange, Phases of IKE, Phase I IKE- Modes and key types, Phase I IKE Protocols, Phase II IKE, ISAKMP/IKE Encoding	
Unit-3 – Security Services	9 Hour
Security Services for E-mail, Establishing keys, Establishing Public and secret keys, Privacy, End-to-end Privacy, Privacy with distribution List Exploders, Authentication of the source, Based on public key technology and secret keys and with distribution list, Message Integrity, Non-repudiation, Introduction and Overview of PGP, Efficient Encoding, Certificate and key revocation, Signature types, Private key, Anomalies, Object Format,S/MIME	
Unit-4 – Transport Layer Security	9 Hour
SSL/TLS Basic Protocol, computing the keys, client authentication, PKI as deployed by SSL, SSL Attacks fixed in v3, Exportability, Encoding, Encrypted Record, Handshake messages, Change cipher spec and Alerts, SET	
Unit-5 – Application Layer Security	9 Hour
Wireless Security: IEEE 802.11 Wireless LAN, Authentication, Authentication and Confidentiality, Cellphone Security,GSM(2G)Security,Security in UMTS(3G),Wireless LAN Vulnerabilities, Phishing, Buffer Overflow,Format String Attacks,Cross-site Scripting (XSS),SQL Injection,Case Studies:Secure Inter-branch Payment Transactions,Virtual Elections	

Learning Resources	1. William Stallings, "Cryptography and Network Security - Principles and Practice", 8 th edition, Pearson Publication, 2017	3. Charlie Kaufman, Radia Perlman, Mike Speciner, "Network Security, Prentice Hall of India", 2 nd edition, 2002.
	2. Bernard Menezes, "Network Security and Cryptography", Cengage Learning, 2 nd edition, 2012	4. Atul Kahate, "Cryptography and network security", Tata McGraw-Hill Education, 4 th edition, 2019

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.M.Vivekanandan,Nokia	1. Mr.Karthikeyan.C.M.T, Govt College of Engg,Bargur	1. Ms.D.Saveetha, SRMIST
2. Mr.Santhosh Kumar,CTS	2. Dr.Syedthouheed,Reva University, Bangalore	

Course Code	21CSE466T	Course Name	NETWORK DESIGN AND MANAGEMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Grasp knowledge on the types of Networks and the Network Management basics	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the Network Management Standards															
CLR-3:	Familiarize with the working of Simple Network Management Protocol and its various versions															
CLR-4:	Discern on the working of Remote Monitoring Systems															
CLR-5:	Deduce on various Network Management Applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Acquire knowledge on networks and network management	2	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	Interpret Information on various Network Protocols	2	-	-	3	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Gain knowledge on the working of SNMP protocol and its various applications	2	-	-	3	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Examine the network management tools and gather information from the network	2	-	-	3	-	-	-	-	-	-	-	-	2	-	-
CO-5:	Familiarize with the working of various management applications	2	3	-	-	-	-	-	-	-	-	-	-	2	-	-

Unit-1 – Telecommunication Network Management	9 Hour
Telephone Network Management, Distributed Computing Environment, TCP/IP Based Networks, Communication Protocols and Standards, Protocol Layer and Services, Challenges of IT Managers, Network Management, Network and System Management, Network Management System Platform, Current status and future of Network Management, Network Management Standards, Network Management Model - Organizational model, Information Model, Management Information Trees, Communication Model, ASN.1, Terminology, Symbols and Conventions, Functional Model	
Unit-2 – Network Management Protocol	9 Hour
Introduction to SNMP, SNMP v1 model, Organization Model, System overview, SNMP v1 Information model, Structure of Management Information, Managed Objects, MIB-Object Group, System Group, Interfaces Group, Address Translation group, IP Group, ICMP Group, TCP Group, UDP Group, SNMP, MIB, User-Based Security Model, Access Control	
Unit-3 – Remote Monitoring Protocol	9 Hour
Remote Monitoring, RMON SMI and MIB, RMON1, RMON2, System Utilities for Management Tool, Network Statistics Measurement Systems, Traffic Load, Protocol Statistics, Data and Error Statistics, Network Management System, Components, Requirements, System Management, Network Management Applications, Configuration Management, Inventory Management, Performance Management Tools	
Unit-4 – Network Management and Application Protocol	9 Hour
Network Management Applications, Fault Management -Architecture, Fault location, Fault isolation Algorithm, Self-healing, avoiding failures, Configuration setting, Configuration discovery and Change Control, Configuration Management Applications, Patch Management, Approaches for Performance Management, Performance Monitoring and Reporting, Performance trouble shooting, Capacity Planning, Account Management, Report Management System and User Reports, Policy Management, Service Level Management	

Unit-5 - Network Design and Planning		9 Hour
Network Design for Enterprise Network, Network Design Process, Data Collection, Data Generation, Traffic Generators, Cost Generators, Topology, Architecture, Graph, Link, Algorithms, Network Design Techniques, Performance Analysis, Queuing Essentials, Loss and Delay, Reliability, Network Cost		
Learning Resources	1. Greg Tomsho, Ed Tittel, David Johnson, "Guide to Network Essentials", Eight Edition, Cengage Learning, 2019	3. Mani Subramanian "Network Management Principles and Practice", Second Edition, Pearson Publication, 2012.
	2. Teresa C.Piliouras , "Network Design Management and Technical Perspectives", Second Edition 2015	4. Dinesh Chandra Verma, "Principles of Computer Systems and Network Management", Springer, 2009.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Vijay Aravind .S Manager, Accenture, BengaluruEmail:vijayaravin@gmail.com	1. Dr. ZayarazGodandapani Professor, Dept. of CSE, Pondicherry Engineering College	1. Dr. A. Vijay Vasanth, SRM IST

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 11F

**(Syllabi for Computer Science and Engineering w/s in
Cybersecurity Programme Courses)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC308T	Course Name	SECURITY RISK MANAGEMENT PRINCIPLES	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the fundamental knowledge about Security Risk.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the various analysis on Security Risk Management															
CLR-3:	Understand the demand for IS Audit.															
CLR-4:	Understand the IT audit and its activities.															
CLR-5:	Understand the techniques for implementing security in audit.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Acquire the knowledge on the fundamentals of Risk management	-	3	-	-	-	-	-	-	-	-	-	2	-	-	-
CO-2:	Acquire the ability to apply various techniques for data collection	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
CO-3:	Utilize the principles of data analysis	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Acquire the ability to apply IS audit	-	3	-	-	-	-	-	-	-	-	-	2	-	-	3
CO-5:	Apply the knowledge gained on auditing methodologies	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 – Introduction to Risk	9 Hour
Introduction to Risk, Elements of risk, Information Security Risk Management Overview, Information Risk Management Activities, Risk Management and the Security Program, Drivers, Laws, Regulations, Threat Source Leveraging a Vulnerability, Federal Information Security Management Act of 2002 (FISMA), Gramm-Leach-Bliley Act (GLBA), Health Insurance Portability and Accountability Act (HIPAA), ISO 27001, ISO 27005, Risk Management Frame work, Practical Approach.	
Unit-2 – Data Collection and Planning	9 Hour
Introduction to data collection, Planning – the essential element, The Sponsors, Characteristics of a good project sponsor, the project team, Factors that decide upon the size of the project team, Data collection mechanisms, Collectors and Containers, Executive interviews, Questionnaire, Document requests, List of documents for the assessor, IT Assets inventory, Asset Scoping, Asset Scoping – Requirements, Techniques involved in asset scoping, Profile survey, Control survey	
Unit-3 – Data Analysis	9 Hour
Introduction to data analysis, Compiling Observations, Compiling Observations from Organizational Risk Documents, Format to collect your observations. List of the documents to encounter, Threat Catalog, List of threat catalogs that can be used as references, Sample Threat Catalog, Vulnerability Catalog, Vulnerability Catalog types, Documentation process, Threat Vulnerability Pairs, Sample Threat and Vulnerability Pairs, Confidentiality, Confidentiality Determination Matrix, Analyzing Confidentiality Determination Matrix, Developing Sample Confidentiality Determination Matrix.	
Unit-4 – Information Security Audit	9 Hour
Demand for IS audit, Auditor Role, Auditee Role, Process of auditing information system, Preplanning the audit, Audit process Perform audit, Hierarchy of internal controls, gathering audit evidence, conducting audit evidence, Reporting audit evidence, Strategy planning for organizational control, Issues register, Risk management tools, Distinct types of risk tools, Planning Performance	

Unit-5 - Information Security Audit Analysis	9 Hour
Detailing Information Security Audit, Purpose of IS Audit, Expectation from IS Auditor, Steps to Conduct IS Audit, Classification of Audit, Traditional Audit, Difference Between Audit and Assessment, Relationship Between Auditor, Auditee and Client; Their Duties, SLA Introduction, SLA Components, Auditing Firm Organizational Chart, Auditing Firm functionalities, Policy Vs Procedures Standard Vs Guideline, Basic Types of Measurement Metrics, Members of Auditing Committee, Skills Matrix, Example, Audit Evidence, Examples, Direct and Indirect Evidence.	

Learning Resources	1. Evan Wheeler, "Security Risk Management", Syngress ISBN: 97815, 2011 2. Bruce Newsome, "A Practical Introduction to Security and Risk Management", 2013	3. David L. Cannon, "CISA Certified Information Systems Auditor Study Guide", John Wiley & Sons, ISBN: 978-0-470-23152-4, 2009.
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Arun.A

Course Code	21CSC310J	Course Name	MALWARE ANALYSIS	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the fundamentals of static and dynamic analysis.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Gain knowledge about running malware in virtual environment.															
CLR-3:	Study about disassembly constructs and its structures.															
CLR-4:	Study about new processors and file types using the IDA SDK															
CLR-5:	Explore popular plug-ins that make writing IDA scripts easier, allow collaborative reverse engineering															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Gain knowledge about the different forms of malware.	-	2	-	-	-	-	2	-	-	3	-	3	-	-	-
CO-2:	Set up a safe virtual environment to analyze malware.	-	2	-	-	-	-	-	-	-	-	-	3	-	-	3
CO-3:	Navigate, comment, and modify disassembly.	-	2	-	-	-	-	-	-	-	3	-	-	-	-	3
CO-4:	Use code graphing to quickly make sense of cross references and function calls	-	-	-	-	-	-	2	-	-	-	-	3	-	-	3
CO-5:	Use debugger to tackle hostile and obfuscated code.	-	-	-	-	-	-	2	-	-	3	-	-	-	-	-

Unit-1 - Introduction to Malware	12 Hour
What is Malware Analysis? -Why Malware Analysis? -Types of Malware Analysis-Basic Static Analysis- Determining the File Type- Fingerprinting Malware- Anti-Virus Scanning- Extracting Strings- Determining File Obfuscation- Inspecting PE Header Information- Comparing and Classifying Malware- Lab: Setting up and configuring Windows and Linux VM.	
Unit-2 - Dynamic Analysis	12 Hour
System and Network Monitoring- Process Inspection with Process Hacker- System Interaction with Process Monitor- Logging system using Noriben- Capture Network Traffic with Wire shark- Simulating services with INetSim- Analyzing Malware Executable- Analyzing DLL using runll32.exe- Lab: Perform dynamic analysis on different families of Windows Malware.	
Unit-3 - Static Analysis	12 Hour
Advanced Static Analysis- Understanding Computer Basics- Level of Abstraction- Reverse Engineering- X86 Architecture- Main Memory- Instructions- Opcodes and Operands- Registers- Simple Instructions- The Stack- Conditionals- Branching – REP Instructions- C Main Methods-. Global Vs Local Variables- Disassembling Arithmetic Operations- Understanding Functional Calls- Disassembling Arrays- Identifying Struts- Analyzing Linked List Traversal. Lab: Perform shell code analysis in x86 architecture.	
Unit-4 - Advanced Dynamic Analysis	12 Hour
Debugging- OLLYDBG- Loading Malware- OllyDbg Interface- Memory Map- Rebasng- View Threads and Stacks- Executing Code- Breakpoints- Loading DLLs- Tracing- Exception Handling- Patching- Reversing application using x64dbg- Debugging a Binary using IDA Pro. Lab: Analyze malware binary using debugging tools.	
Unit-5 - Malware Functionalities	12 Hour
Malware Behavior- Downloader- Backdoor- Credential Stealer- Persistent Mechanism- Privilege Escalation- Covering Tracking. Lab: Covert Malware Launching	

Learning Resources	1. Michael Sikorski, <i>Practical Malware Analysis – The Hands-On Guide to Dissecting Malicious Software</i> , Kindle Edition, No Starch Press; 1 edition (1 February 2012), ISBN: 1593272901.	3. Chris Eagle, <i>the IDA Pro Book</i> , 2nd Edition, No Starch Press, 2011. ISBN-10: 1-59327- 289-8.
	2. Monnappa K A, <i>Learning Malware Analysis: Explore the concepts, tools, and techniques to analyze and investigate Windows malware</i> , Packt Publishing; 1st edition (29 June 2018)	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Karthik Expert Member from k7 Computing	1. Dr Bhawana Rudra Assistant Professor (Grade II) National Institute of Technology, Warangal	1. Mr. V. Joseph Raymond, SRMIST

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSE229J	Course Name	CHECK POINT SYSTEM ADMINISTRATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	Describe the basic functions of the Gaia operating system and Understand how SmartConsole is used by administrators to give user access.												
CLR-2:	Understand licensing and contract requirements for Check Point security products.												
CLR-3:	Describe the essential elements of a Security Policy and Understand the Check Point policy layer concept, how to enable the Application Control and URL Filtering software												
CLR-4:	Describe how to configure manual and automatic NAT.												
CLR-5:	Identify tools designed to monitor data, determine threats and recognize opportunities for performance improvements and Articulate how the Intrusion Prevention System is configured, maintained and tuned.												
Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	Describe the key elements of Check Point's unified security management architecture.												
CO-2:	Understand Check Point Licensing and creation of various security policies.												
CO-3:	Gain insight on how Check Point security features are enabled and policies applied for inspection of various applications.												
CO-4:	Understanding Network Address Translation and User Access Management												
CO-5:	Learn how Check Point firewalls are managed and network traffic is monitored and threat prevention.												

Program Outcomes (PO)												Program Specific outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Check Point Technology and Management Operations	12 Hour
Introduction to checkpoint Technology - Checkpoint security architecture, Controlling network traffic. Introduction to checkpoint deployment – Check point deployment options, Deployment considerations, Deployment options, Introduction to Gaia operating system. Install the Primary Security Management Server - Installing the Gaia Operating System, Installing the Security Management Server Software, Installing smart Console. Configure a Security Gateway – Powering on the security gateway, Configuring the security gateway. Check Point Security Management Operations - Network Communication, Smart Console, Smart Console Applications, Administration. Establishing Secure Internal Communication – Creating Gateway Objects in Smart Console, Testing SIC status to the Gateway. Managing User Access – Creating new administrators and Assigning profiles, Testing Administrator Profile Assignments – Managing Concurrent Administrator sessions, Taking over an administrator session.	
Unit-2 - Check Point Licensing and Creating Various Security Policies	12 Hour
Check Point Licensing – Licensing overview, Smart Update. Manage Licenses – Verifying the status of Existing Licenses in Smart Console, Attaching a License Using Smart Console, and Creating a License Report. Security Policy Management – Introduction to the Security Policy, Rule base, Global Properties, Publishing Policy, Policy Packages, and Install Policy. Creating the Alpha Standard Security Policy – Creating Policy Objects, Creating a standard security policy, Installing the Standard Security Policy, Testing the Standard Security Policy. Creating the Bravo Security Policy – Establishing SIC to B-GW, Adding a License to B-GW, Enabling Security Zones on B-GW, Creating B-GW Security Zones Policy, Testing Internet Connectivity.	
Unit-3 - Check Point Policy Layers	12 Hour
Policy Layers – Policy Layers Concept, Traffic Inspection, Managing Layers. Configure Order Layers – Adding Two New Order Layers to be Shared, Configuring the New Ordered Layers Rule, Using the Shared Layer on Bravo Policy, Testing the Shared APPI+URL Layer on Bravo Gateway, Testing Shared Data Control Layer on Bravo Gateway. Configure a Shared Inline Layer – Creating Shared DMZ Layer, Sharing the	

Inline DMZ Layer with Bravo-Policy, Testing the Shared Inline DMZ Layer. Application Control & URL Filtering - Application Control & URL Filtering, Application Control, URL Filtering, Configuring Application Control & URL Filtering. Configure a Unified Policy – Creating a Unified Policy Layer, Updating the Appi URL Layer, Creating a Unified Policy. Configure HTTPS Inspection Policy – Enabling HTTPS Inspection, Creating an HTTP Inspection Rule, Deploying the Security Gateway Certificate, Testing Unified-Policy with HTTPS Inspection.

Unit-4 - Network Address Translation, User Management and Configure Identity Awareness **12 Hour**

Network Address Translation – Understanding Network Address Translation, Manual and Automatic NAT. Configuring Network Address Translation – Configuring Automatic NAT on Network Objects, Configuring Manual Static NAT Rules, Configuring Manual Proxy ARP, Testing the Automatic Hide NAT Configuration, Testing the Static NAT Configuration. User Access Management – Overview of User Access Management, Methods for Acquiring Identities, Identity Sharing, Distinguished Name, Using Multiple LDAP Servers, Retrieving Information from a User Directory Server, Managing Users on a User Directory Server. Configure Identity Awareness – configuring the Security Policy for Identity Awareness, Defining the User Access Role, Testing Identity Awareness Connection.

Unit-5 - Traffic Visibility, Monitoring and Threat Prevention **12 Hour**

Traffic Visibility – Using Smart Console, Analyzing Logs. Generate and View Traffic – Configuring Log Management on the Security Management Server, Viewing Logs and Performing Searches to gather Historic Data. Monitoring System States – Monitoring Traffic and Connections. Monitor System States – Enabling the Monitoring Blade, Monitoring Status with Smart View Monitor, Configuring Alerts in Smart View Monitor, Configuring Suspicious Activity Rules. Threat Prevention – Threat Prevention, Autonomous Threat Prevention, Intrusion Prevention system, IPS Profile Setting and Protections, IPS Tuning and Maintenance, Anti-Malware, Threat Emulation and Threat Extraction, Internet of Things Protections. Configuring Threat Prevention – Enabling Autonomous Threat Prevention, Testing Anti-Virus Threat Prevention

Learning Resources	1. Check Point Certified Security Administrator (CCSA), Student and Lab Manual, Check Point Secure Academy, Check Point Software Technologies Ltd, 2022. (https://read.kortext.com/reader/pdf/2003557/11)	6. Multi-Domain Security Management, R80, Administration Guide, 30 March 2016.
	2. https://www.checkpoint.com/mind/self-study-resources/ 3. http://supportcontent.checkpoint.com/documentation_download?ID=46577 4. Firewall, Pre-R80 Security Gateways with R80 Security Management, 28 March 2016, Check Point Software Technologies Ltd. 5. Check Point Security Management R80 Administration Guide, 15 January 2017.	7. CCSA™ NG: Check Point Certified Security Administrator Study Guide, Justin Menga, San Francisco, SYBEX Inc., Alameda, CA, www.sybex.com. 8. Security Administration, Student & Lab Manual, © 2019 Check Point Software Technologies Ltd. R80.20 v1. 9. Check Point Certified Security Administrator (CCSA R80): 156-215.80 Exam.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Dr. Vigneshwaran P, SRMIST
		2. Dr. C.N.S. Vinoth Kumar, SRMIST
		3. Dr. S. Thanga Revathi, SRMIST

Course Code	21CSE281T	Course Name	CRYPTOGRAPHY AND NETWORK SECURITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
The purpose of learning this course is to:		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2: Acquire fundamental knowledge on the concepts of finite fields, number theory and cryptography																
CLR-3: Describe the various block cipher algorithms and public key cryptosystems																
CLR-4: Utilize the principles of hash functions and digital signature																
CLR-5: Acquire the knowledge on firewall and security applications.																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1: Implement the Classical Encryption Techniques.		2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2: Implement the various block cipher algorithms and public key cryptosystems		2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3: Apply the principles of hash functions and digital signature		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4: Demonstrate the configuration of Firewall and the concepts of WLAN Security.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-5: Apply the knowledge gained in various security applications in real-time problems		2	2	-	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to Security and Number Theory	9 Hour
Basics of Security – CIA Triad – Threats, Attacks and Services – Classical Cryptography – symmetric and asymmetric cipher- Substitution – Transposition – Cryptanalysis. Tutorial 1: Substitution techniques. Number Theory: Groups, Rings, Fields- Modular Arithmetic – Euclidean Theorem – Extended Euclidean Theorem – Galois Field – Tutorial 2: Implement Euclid and extended. Prime Numbers – Fermat's Theorem – Euler's totient function – Euler's Theorem – Chinese Remainder theorem – Primitive Roots-Discrete Logarithms-Elliptic curve arithmetic -Tutorial 3: Implement Chinese Remainder Theorem	
Unit-2 - Block Cipher and Public Key Cryptography	9 Hour
Block Cipher – Feistel Ciphers – Data Encryption Standard (DES) – DES Structure – Key Generation – Simplified DES – Advanced Encryption Standard (AES) – Basic Structure – Transformations – Key Expansions Process – Tutorial 4: Implement SDES - Modes of operation. Public Key Cryptosystems – RSA Algorithm – Tutorial 5: Implement RSA algorithm - ElGamal Cryptosystems – Diffie-Hellman key exchange – Elliptic curve cryptography- Quantum Cryptography – Threshold Cryptography - Tutorial 6: Implement Diffie-Hellman Key exchange algorithm	
Unit-3 - V Hash Functions and Digital Signatures	9 Hour
Message authentication requirements- Message Authentication functions -Hash Functions-Hash Algorithms: MD5- Tutorial 7: Implement MD5 - Secure Hash Algorithm- Tutorial 8: Implement SHA - Digital signatures: Digital signature requirements- Digital Signature scheme- Elgamal Digital signature scheme- Schnoor Digital signature scheme- User Authentication protocol- Kerberos - Tutorial 9: Implement Elgamal Digital signature scheme.	
Unit-4 - Introduction to Network Security	9 Hour
Networking Devices (Layer1,2,3)- Different types of network layer attacks -Buffer Overflow and Malicious Software – Tutorial 10: Discussions on Buffer overflow attack - Password Management – Introduction to Firewall– Firewall Generations – Tutorial 11: Discussions on Firewall configurations - Intrusion Detection System – Types of IDS – Intrusion Prevention System – Wireless LAN – Wireless LAN Security – Network Access Control and Cloud Security- Tutorial 12: Discussions on IDS.	

Unit-5 - Security Applications	9 Hour
Digital Certificate – Key Management – Kerberos – Key Agreement and Distribution – PKI – X.509 Certificate – E-Mail Security – PGP – S/MIME – Tutorial 13: Discussions on E-mail security - IP security – IPSEC protocol suite – functionalities – Transport mode – Authentication Header – Introduction to Encapsulation Security Payload - IKE Phase I, II - Virtual Private Network (VPN) – Tutorial 14: Discussions on VPN - Web Security – Secure Socket Layer (SSL) –Transport Layer Security – Secure Electronic Transaction (SET) – Blockchain - Tutorial 15: Discussions on SSL	

Learning Resources	1. William Stallings, "Cryptography and Network Security", 3rd Edition, Pearson Education, 2003. 2. Charlie Kaufman, Radia Perlman, Mike Speciner, "Network Security", Prentice Hall, 2nd edition, ISBN-10: 0130460192, ISBN-13: 978-0130460196, 2002. 3. Charles Pfleeger, "Security in Computing", Prentice Hall, 4th Edition, ISBN-10: 0132390779, ISBN-13: 978-0132390774, 2006. Earl Gose, Richard Johnsonbaugh, Steve Jost, "Pattern Recognition and Image Analysis", Prentice Hall of India Private Ltd., New Delhi – 110 001, 1999.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	-	10%	-	10%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	20%	-	20%	-	20%	-
Level 6	Create	10%	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. S. Sajiv, Technical Leader, CISCO	1. Dr. A. Balaji, School of Computing Science and Engineering (SCSE), VIT Bhopal University	1. Ms.G. Sujatha, SRMIST KTR
2. Mr. Varun Subramanian, QA Automation Tester, Likewize		

Course Code	21CSE282T	Course Name	INFORMATION SECURITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing		Data Book / Codes / Standards	Nil	

[illegible]

Unit-1 - Introduction	9 Hour
History, What is Information Security? Critical Characteristics of Information, NSTISSC Security Model, Components of an Information System, Securing the Components, Balancing Security and Access, The SDLC, The Security SDLC	
Unit-2 - Security Investigation	9 Hour
for Security, Business Needs, Threats, Attacks, Legal, Ethical and Professional Issues - An Overview of Computer Security - Access Control Matrix, Policy-Security policies, Confidentiality policies, Integrity policies and Hybrid policies	
Unit-3 - Security Analysis	9 Hour
Risk Management: Identifying and Assessing Risk, Assessing and Controlling Risk - Systems: Access Control Mechanisms, Information Flow and Confinement Problem	
Unit-4 - Logical Design	9 Hour
Blueprint for Security, Information Security Policy, Standards and Practices, ISO 17799/BS 7799, NIST Models, VISA International Security Model, Design of Security Architecture, Planning for Continuity	
Unit-5 - Physical Design	9 Hour
Security Technology, IDS, Scanning and Analysis Tools, Cryptography, Access Control Devices, Physical Security, Security and Personnel	

Learning Resources	1. Michael E Whitman and Herbert J Mattord, — Principles of Information Securityll, Vikas Publishing House, New Delhi, 2021	3. Micki Krause, Harold F. Tipton, — Handbook of Information Security Managementll, Vol 1-3 CRCPress LLC, 2019
	2. Matt Bishop, — Computer Security Art and Sciencell, Pearson/PHI, 2021	4. Stuart McClure, Joel Scrambray, George Kurtz, — Hacking Exposedll, Tata McGraw- Hill, 2019

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	-	10%	-	10%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	20%	-	20%	-	20%	-
Level 6	Create	10%	-	10%	-	10%	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.M. Vivekanandan,Nokia	1. Karthikeyan.C.M. T,Govt College of Engg,Bargur	1. D.Saveetha, SRMIST
2. Mr. Santhosh Kumar,CTS	2. Syedthouheed, Reva University, Bangalore	

Course Code	21CSE283T	Course Name	CYBER LAW	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
CLR-1:	Understand the basics of cyber law and cyber security	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	familiarize the issues those are specific to amendment rights															
CLR-3:	Become aware on copyright issues in software's															
CLR-4:	Understand the Cyber-crimes and Cyber Frauds															
CLR-5:	Understand the Legal Framework															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Gain in-depth knowledge on information on cyber security and issues specific to amendment rights	-	-	-	-	2	-	2	-	-	-	-	-	-	-	3
CO-2:	Apply the knowledge on copyright issues within software packages	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Comprehend ethical laws of computer for various countries	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Defines the Cyber-crimes and frauds	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
CO-5:	Apply the knowledge of Legal framework	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-

Unit-1 - Introduction	9 Hour
History of Internet and World Wide Web - Need for cyber law - Cyber-crime on the rise - Important terms related to cyber law - Cyber law in India - Need for cyber law in India - History of cyber law in India - Information Technology Act, 2000 - Overview of other laws amended by the IT Act, 2000 - National Policy on Information Technology 2012	
Unit-2 - Overview of The Information Technology Act, 2000	9 Hour
Applicability of the Act - Scheme of the Act - Important provisions of the Act - Digital Signature under the IT Act, 2000 - E-Governance - Attribution, Acknowledgement and Dispatch of Electronic Records - Certifying Authorities - Controller of Certifying Authorities (CCA) - Security Guidelines for Certifying Authorities - Electronic Signature Certificates - Duties of Subscribers - Penalties and Offences Intermediaries - RULES ISSUED UNDER THE IT ACT, 2000	
Unit-3 - Cyber-crimes / Cyber Frauds	9 Hour
Definition of cybercrime - First Cyber-crime- Types of cyber frauds - Cyber frauds in India - Preventive measures - Cyber-crimes - Who commits cyber-crimes? - Penalties and offences under the IT Act, 2000 - Offences under other legislations - Investigation of cyber-crimes in India - Regulatory Authorities	
Unit-4 - Cyber Crimes& Legal Framework	9 Hour
Cyber Crimes against Individuals, Institution and State – Hacking - Digital Forgery -Cyber Stalking/Harassment - Cyber Pornography -Identity Theft & Fraud - Cyber Terrorism - Cyber Defamation - Right to Privacy and Data Protection on Internet -Concept of privacy - Self-regulation approach to privacy -Ingredients to decide confidentiality of information -Intellectual Property Issues in Cyber Space -Interface with Copyright Law -Interface with Patent Law - Trademarks &Domain Names Related issues -Dispute Resolution in Cyberspace	

Unit-5 - Cyber Security	9 Hour
Network and website Security Risks –Hacking -E-business Risk management issues –Firewall -Security framework –Cryptocurrency -Blockchain –Technology Stack: Protocol, Currency -Crowd Funding -Bitcoin -rediction Markets -Smart Property -Smart Contract -Decentralized Governance Services -E Payments -Digital Token based E payment systems -E Wallet - Online financial services in India -Law to Protect online financial service fraud	

Learning Resources	1. Justice Yatindra Singh, Cyber Laws, Universal Law Publishing Co, New Delhi, (2012). 2. Verma S, K, Mittal Raman, Legal Dimensions of Cyber Space, Indian Law Institute, New Delhi, (2004) 3. S. R. Bhansali, Information Technology Act, 2000, University Book House Pvt. Ltd., Jaipur (2003). 4. Blockchain, Blueprint for a new Economy, Melanie Swan, 2017 –O'Reilly	5. SudhirNaib, The Information Technology Act, 2005: A Handbook, OUP, New York, (2011) 6. Upadhyaya and A. Upadhyaya, Material Science and Engineering, Anshan Publications, 2007 7. Vasu Deva, Cyber Crimes and Law Enforcement, Commonwealth Publishers, New Delhi, (2003). 8. Essential CyberSecurity Science, Josiah Dykstra, 2017 –O'Reilly
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	10%	-	10%	-	10%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	20%	-	20%	-	20%	-
Level 6	Create	10%	-	10%	-	10%	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Venkata Prasad S, TATA consultancy services, svenkataprasad, @yahoo. com	1. Dr. Abhishek Srivastava, asrivastava@iiti.ac.in, CSE, IIT, Indore.	1. Dr.S. Murugaanandam, SRMIST
	2. Dr. A. Amuthan, amuthan@pec.edu, Pondicherry Engineering College, Pondicherry.	

Course Code	21CSE381T	Course Name	FORENSICS AND INCIDENT RESPONSE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
Gain knowledge on the basics of procedures for identification, preservation of electronic evidence		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:																
Understand the purpose and usage of various forensic tools																
CLR-3:																
Gain knowledge on how scientific evidence collection/extraction during investigation																
CLR-4:																
Acquire knowledge on file systems and its working																
CLR-5:																
Understand the windows and Linux investigation procedures																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:		-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Acquire the knowledge on basics of procedures for identification, preservation of electronic evidence																
CO-2:		-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
Acquire the ability to identify the purpose and usage of various forensic tool																
CO-3:		-	-	2	-	-	-	-	2	-	-	-	-	-	-	3
Understand how scientific evidence collection/extraction during investigation																
CO-4:		-	-	-	-	-	-	-	2	-	-	-	-	-	-	3
Appreciate the concepts of file systems and its importance in forensic science.																
CO-5:		-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
Apply the knowledge of windows and Linux investigation procedures																

Unit-1 – Introduction to Incident	9 Hour
Goals of Incident Response-Introduction to Incident Response Methodology (IRM)- Steps in Incident Response Methodology-IRM: Pre-incident preparation-IRM: Detection of incidents-IRM: Initial Response-IRM: Formulate a Response Strategy-IRM: Investigate the Incident-IRM: Reporting-Creating response toolkit – Windows-Volatile Data Collection – Windows-In-depth data collection – Windows-Storing collected data – Windows-Creating response toolkit – Unix-Volatile Data Collection – Unix-In-depth data collection – Unix-Storing collected data – Unix	
Unit-2 – ACPO Principles	9 Hour
Introduction to ACPO Principles-ACPO Principles of Computer Based Evidence-Introduction to computer Storage Formats-Understanding Storage Formats for Digital Evidence-Forensic Duplication-Forensic Duplication tools-Forensic Duplicate creation of HDD-Qualified Forensic Duplicate creation-Restored Image-Mirror Image-Forensic Duplication Tool Requirements-Creating a Forensic Duplicate of a Hard Drive-Evidence Handling-Types of Evidence-Challenges in Evidence Handling-Overview of Evidence Handling Procedure.- Evidence Handling Procedure-Evidence Handling reports	
Unit-3 – File System Analysis	9 Hour
Introduction to File System Analysis-What is a File System? - Five Data Categories-FAT Concepts-FAT Analysis-FAT - The Big Picture-Introduction to NTFS-Files in NTFS-MFT Concepts-MFT Attribute Concepts-Other MFT Attribute Concepts-Indexes in NTFS-NTFS Analysis - File System Category-NTFS Analysis - Content Category-NTFS Analysis - Metadata Category-NTFS Analysis - File Name Category-NTFS Analysis - Application Category-NTFS - The Big Picture	
Unit-4 – Investigating Systems	9 Hour
Introduction to Investigating Systems-Investigating Windows Systems-Where Evidence resides on Windows Systems-Conducting a Windows Investigation I-Conducting a Windows Investigation II-File Auditing-Theft of Information-Handling the departing employee-Investigating Unix Systems-Overview of steps - Unix Investigation-Reviewing pertinent logs-Performing keyword searches-Reviewing relevant files-Identifying unauthorized user accounts/groups-Identifying rogue processes-Checking for unauthorized access points-Analysing trust relationships-Detecting loadable kernel modules	

Unit-5 – Investing Hacker Tools	9 Hour
Investigating Hacker Tools-What are the goals of tool analysis?- How are files compiled?- Static Analysis of Hacker Tools I-Static Analysis of Hacker Tools II-Dynamic Analysis of Hacker Tools I-Dynamic Analysis of Hacker Tools II-Evaluating Computer Forensics Tools-Types of Forensic Tools-Tasks performed by Forensic Tools-Tool comparisons-Computer Forensics Software Tools-Computer Forensics Hardware Tools-Validating and Testing Computer Forensics Software-Introduction to Forensic Report Writing-Understanding the Importance of Reports-Guidelines for Writing Reports-A Template for Computer Forensics Reports	

Learning Resources	1. Kevin Mandia, Chris Prosise, Incident Response and computer forensicsll, Tata McGrawHill, 2006. 2. Bill Nelson, Amelia Philips, and Christopher Steuart, –Guide to computer forensics and investigationsll, course technology, CengageLearning;4thedition, ISBN:1-435-49883-6,2009	3. Eoghan Casey,"Hand book Computer Crime Investigation's Forensic Tools and Technology", Academic Press, 1st Edition, 2001. 4. Brian Carrier, – File System Forensic Analysisll, Addison-Wesley Professional; 1st edition 2005, ISBN13: 978-0321268174
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.M. Vivekanandan,Nokia	1. Karthikeyan.C.M. T,Govt College of Engg,Bargur	1. D.Saveetha, SRMIST
2. Mr. Santhosh Kumar,CTS	2. Syedthouheed, Reva University, Bangalore	

Course Code	21CSE382T	Course Name	SECURITY MANAGEMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:				1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Outline various security management policies, principles, the various plans for security management.			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Explain risk management identification, risk assessment and risk identification techniques.																	
CLR-3:	Illustrate various types of analysis such as vulnerability analysis, penetration testing, audit trail analysis, system and network monitoring, and configuration management.																	
CLR-4:	Demonstrate the knowledge and skills for risk analysis and assessment of enterprise systems using various practical and theoretical tools.																	
CLR-5:	Manage detailed enterprise-wide security plans and policies.																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	identify fundamentals of security management policies and plans.			-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	obtain knowledge from risk assessment and risk identification techniques.			-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	gain information from vulnerability analysis, penetration testing, audit trail analysis, system, and network monitoring.			-	-	-	-	2	-	-	-	-	-	-	-	-	-	3
CO-4:	analysis and assess the enterprise systems using various tool.			-	-	-	-	2	-	-	-	-	-	-	-	-	-	3
CO-5:	enhance their knowledge of obtaining enterprise-wide security plans and policies.			-	-	2	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Security Management	9 Hour
Overview of security policies, models and mechanisms, Security Management Principles, Models and Practices, Security Planning and Asset Protection, Developing Security Programs and Disaster Recovery Plans	
Unit-2 - Principles of Risk and Risk Management	9 Hour
Introduction and identification, risk analysis and evaluation, Practice of Risk Management, Risk Assessment- Types and sources of risk information, Risk identification techniques, Risk Treatment-Evaluating and selecting risk control mechanisms, Identifying, allocating, and resourcing risk controls.	
Unit-3 - Security Analysis and Safeguards	9 Hour
Vulnerability analysis, Penetration testing, Protection Mechanisms, and Incident handling- Access Control and Authentication architecture, Auditing systems and audit trail analysis, Configuration Management	
Unit-4 - Network defense and countermeasures	9 Hour
Intrusion Detection Systems (SNORT), Architectural configurations and survivability issues, Firewall configurations and network design, Virtual private networks, Dial-up security, Computer, and network forensic, Privacy Protection, Case studies on OS and application software (e.g., SELinux, Unix and Windows).	
Unit-5 - Standards and Security Certification Issues	9 Hour
Rainbow Series, Common Criteria, Security Certification Process, Case studies, National and International Security Laws and Ethical Issues	

Learning Resources	1. <i>Management of Information Security</i> , M. E. Whitman, H. J. Mattord Cengage Learning, 2016.	5. <i>Security Engineering: A Guide to Building Dependable Distributed Systems</i> , Ross Anderson, Wiley, John & Sons, Incorporated, 2001.
	2. <i>Guide to Disaster Recovery</i> 1st Edition by Michael Erbschloe.	6. <i>Software Security: Building Security In</i> (by Gary McGraw)
	3. <i>Guide to Network Defense and Countermeasures</i> Paperback – Import by Greg Holden, 2003	7. <i>The Art of Software Security Assessment: Identifying and Preventing Software Vulnerabilities</i> (by Mark Dowd, John McDonald, Justin Schuh)
	4. <i>Security in Computing</i> , 2nd Edition, Charles P. Pfleeger, Prentice Hall, 2005.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. T Ravichandran, Product Manager, Servis2 IT Team, Chennai.		1. Dr. P. Balamurugan, SRMIST
2. Dhanvanth Kesavan, NTT Data Cyber security analyst, Chennai.		

Course Code	21CSE383T	Course Name	SECURITY GOVERNANCE, RISK AND COMPLIANCE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Analyze the expanding role of IT governance and its effect on organizations.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Be aware of management issues in IT governance.															
CLR-3:	Analyze the role of risk to an organization and ways to identify key risk factors.															
CLR-4:	Evaluate various risks and appropriate actions.															
CLR-5:	Develop naming conventions for the resources in a system.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Having an overview of IT governance	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Undergo an risk assessment	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Describe legal and ethical considerations related to the handling and management of enterprise information assets.	-	-	-	2	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Specify what constitutes admissible evidence in a legal proceeding and how to acquire and maintain this information	-	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Create a set of policies that implement a specified organizational objective.	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-

Unit-1 – Introduction to IT Governance	9 Hour
Introduction to IT Governance, IT Risk Management Life Cycle, IT Risk framework, IT Risk identification, IT Risk Security Governance, IT Risk assessment, IT Risk evaluation, IT Risk response, IT Risk monitoring and reporting.	
Unit-2 - Standards	9 Hour
overview of Industry Best Practice Standards, Model and Guidelines covering some aspect of IT governance, principles of Business/IT Alignment Excellence, principles of Program/Project Management Excellence, principles of IT Service Management and Delivery Excellence, principles of Vendor Management, Outsourcing Excellence, critical success factors, Case Study.	
Unit-3 – Security Design Principles	9 Hour
Security mind-set, Design principles, System/security life-cycle, Security implementation mechanisms, Information assurance analysis model, Disaster recovery, Forensics, threats, vulnerabilities, attacks, countermeasures	
Unit-4 – Security Trends and Audit	9 Hour
Trends, Auditing, Cost / benefit analysis, Asset management, Standards, Enforcement, Legal issues, Disaster recovery, security related issues and incidents.	
Unit-5 – Security Policies	9 Hour
Creation of policies, Maintenance of policies, Prevention, Avoidance, Incident response, Domain integration, social engineering, Protocol attacks, Security awareness	

Learning Resources	1. Iannarelli, J. G., & O'Shaughnessy, M. O. (2015). <i>Information governance and security: Protecting and managing your company's proprietary information</i> . Waltham, MA: Butterworth Heinemann, Elsevier.	3. <i>Legal Issues in Information Security</i> , Joanna Lyn Grama, 2015. Jones & Bartlett Learning, Second Edition, ISBN: 978-1-284-05474-3.
	2. Van Wyk, K. R., Graff, M. G., Peters, D. S., & Burley, D. L. (2015). <i>Enterprise software security: A confluence of disciplines</i> . Upper Saddle River, NJ: Pearson Education.	4. <i>Ethics of Big Data</i> , Kord Davis, 2012. O'Reilly Media, ISBN: 978-1449311797

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Kesawan HCL Technologies	1. Dr. Surendran Rajendran AMA International University Bahrain	1. Arun.A, SRMIST
2. Mr.Celeian, Symantec		

Course Code	21CSE384J	Course Name	SECURITY AUDIT AND RISK ASSESSMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Outline the fundamentals of security audit components and process.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Illustrate various security audit phases and methods to audit the resources															
CLR-3:	Outline the process of data collection for security risk assessment.															
CLR-4:	Explain how the collected risky data are analyzed to find the final risk score															
CLR-5:	Introduce the concepts of risk assessment methodology															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe the concepts of Security audit components and process.	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Apply the various security audit phases and methods to audit the resources	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Demonstrate the process of data collection for security risk assessment.	-	-	2	-	-	-	-	2	-	-	-	-	-	-	3
CO-4:	Evaluate the risk score using risk data analysis techniques.	-	-	-	-	-	-	-	2	-	-	-	-	-	-	3
CO-5:	Assess the risk with different risk assessment methodology	-	-	2	-	-	-	-	2	-	-	-	-	-	-	-

Unit-1 - Basics of Information Security	12 Hour
Security Metrics and Reporting, Common Issues and Variances of Performance Metrics, Introduction to Security Audit, Need, Steps in Security Audit. Auditable resources in an organization, Servers and Storage devices, Infrastructure and Networks, Communication Routes, Lab1: Working with Trojans, Backdoors and sniffer for monitoring network communication System, Information Security Methodologies (Black-box, White-box, Grey-box), Phases of Information Security Audit and Strategies, Ethics of an Information Security Auditor. Lab2: Understanding Data Packet Sniffers, Security Audit Part I- Auditing PC-based Accounting System, Auditing Operating Systems, Auditing Networks, Auditing Electronic Data Interchange, Controlling and auditing Database Management Systems. Lab 3: Windows Hacking – NT LAN Manager, Secure 1 password recovery	
Unit-2 - Security Audit	12 Hour
Pre-audit checklist, Information Gathering, Vulnerability Analysis, Lab 1: UDP Scan Using nmap, TCP Connect Scan Using nmap, TCP SYN Scan Using nmap External Security Audit, Internal Network Security Audit, Firewall Security Audit, Lab 2: Vulnerability Identification and Prioritization, IDS Security Auditing, Social Engineering Security Auditing, Web Application Security Auditing, Information Security Audit Deliverables & Writing Report, Result Analysis, Post Auditing Actions, Report Retention etc. Lab 3: Web Application Security Configuration	
Unit-3 - Fundamentals of Risk	12 Hour
What is Risk? –Information Security Risk Assessment Overview Drivers, Laws, and Regulations- Risk Assessment Frame work – Lab1: Risk assessment with NIST framework. Phases of Security Risk Assessment, Data Collection: The Sponsors- The Project Team- Data Collection Mechanisms, Executive Interviews- Document Requests- IT Assets Inventories, Lab2: Data Collection using Container method, Profile & Control Survey-Consolidation, Lab3: Survey Consolidation of the collected data.	

Unit-4 - Risk Analysis	12 Hour
Compiling Observations-Data Analysis: Preparation of catalogues- Lab1: Prepare an automated Threat-vulnerability pair matrix, System Risk Computation, Designing Impact Analysis Scheme-Confidentiality, Integrity and Availability, Impact Score, Lab2: Preparation of an automated impact score, designing control analysis, Designing Likelihood Analysis: Exposure, Frequency, Controls, Computing Final Risk Score, Lab3: Preparation of an automated Likelihood score and final risk score.	
Unit-5 - Risk Classification and Prioritization	12 Hour
Stem Risk Analysis-Risk Classification, Risk Ranking, Individual Risk Reviews, and Lab1: Prepare the Risk Analysis with individual system risk review and threat and vulnerability risk review, Organization risk Analysis, Risk Prioritization- Organization and System Specific Risk prioritization and Treatment, Lab2: Prepare an automated Organization and system specific risk prioritization and treatment template. Risk Assessment Methodologies- Result- Risk Registers-Process summary-post mortem. Lab3: Prepare the risk register.	

Learning Resources	<ol style="list-style-type: none"> 1. Mark Talabis, "Information Security Risk Assessment Toolkit: Practical Assessments through Data Collection and Data Analysis", Syngress; 1 edition, ISBN: 978-1-59749-735-0, 2013. 2. Whitman, Michael E., and Herbert J. Mattord. Management of information security. Cengage Learning, 2013. 3. Andrew Vladimirov Michajlowski, Konstantin, Andrew A. Vladimirov, and Konstantin V. Gavrilenko. Assessing information security: strategies, tactics, logic, and framework. IT'S Governance Ltd, 2010. 4. https://www.sans.org/reading-room/whitepapers/threats/implementing-vulnerability-management-process-34180 5. http://csrc.nist.gov/publications/nistpubs/800-40-Ver2/SP800-40v2.pdf
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts

Course Code	21CSE385J	Course Name	ADVANCED MALWARE ANALYSIS	Course Category	E	PROFESSIONAL ELECTIVE										L	T	P	C		
																	2	0	2	3	
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil														
Course Offering Department		School of Computing			Data Book / Codes / Standards			Nil													
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes			
CLR-1:	Understand the purpose of malware analysis.				1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3				
CLR-2:	Gain knowledge about taxonomy of malware and infection vectors.																				
CLR-3:	Gain knowledge about protective mechanisms and dependencies.																				
CLR-4:	To analyze different malware families and perform static and dynamic mechanisms.																				
CLR-5:	Explore popular plug-ins that make writing OllyDbg debugger easier, allow collaborative reverse engineering																				
Course Outcomes (CO):		At the end of this course, learners will be able to:																			
CO-1:	Gain knowledge about the different forms of malware.				-	2	2	-	2	-	-	-	-	-	-	-	-				
CO-2:	Set up a safe virtual environment to analyze malware.				-	-	2	-	-	-	-	-	-	-	-	-	-				
CO-3:	Navigate, comment, and modify malware samples.				-	-	-	-	2	-	-	-	-	-	-	-	-				
CO-4:	Use tools and perform static and dynamic analysis.				-	2	-	-	-	-	-	-	-	-	-	-	3				
CO-5:	Use debugger to tackle hostile and obfuscated code.				-	-	-	-	2	-	-	-	-	-	-	-	3				
Unit-1 - Malware Analysis and Reverse Engineering																	12 Hour				
blueprint- Malware Analysis and Reverse Engineering- Types and purpose of Malware Analysis- Limitation- Effective Malware Analyst- Lab: Basic static analysis using python																					
Unit-2 - Malware Taxonomy and Deployment																	12 Hour				
Malware Classes- Malware Infection Vectors- Types of Infection Vector- Potential Infection Vector- Lab: Setting up lab for dynamic analysis																					
Unit-3 - Protective Mechanisms and Dependencies																	12 Hour				
States of Malware- Static and Dynamic – Dependency Types- Malware Collections- Malware Inspection- PE File – Handle Files – Inspecting Static Malware – Inspecting Dynamic Malware - Malware Analysis Use Case- Tools of the trade-Lab: Dynamic analysis of Downloader, Dropper , Fake AV and Ransomware																					
Unit-4 - Reverse Engineering																	12 Hour				
OllyDbg- Memory Map- Viewing thread and stack- Execution code- Breakpoints- Loading DLL's- Tracing- Exception Handling- Patching- Analyzing shell code- Understanding x64 debugger – Lab: Reverse applications using x64 debugger																					
Unit-5 - Advanced Functionalities																	12 Hour				
Launcher's- Process Injection – Process Replacement- Hook Injection- APC Injection- Simple Cipher's- Custom Encoding- Decoding- Lab- Use IDA Pro and look for potential encoding in given malware sample																					

Learning Resources	1. Michael Sikorski, <i>Practical Malware Analysis – The Hands-On Guide to Dissecting Malicious Software</i> , Kindle Edition, No Starch Press; 1 edition (1 February 2012), ISBN: 1593272901. 2. Monnappa K A, <i>Learning Malware Analysis: Explore the concepts, tools, and techniques to analyze and investigate Windows malware</i> , Packt Publishing; 1st edition (29 June 2018).	3. Christopher C. C. Elisan, <i>Advanced Malware Analysis</i> , 1st Edition, Kindle Edition, ISBN-13: 978-0071819749
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Karthik Expert Member from k7 Computing	1. Dr Bhawana Rudra Assistant Professor (Grade II) National Institute of Technology, Warangal	1. Mr. V. Joseph Raymond, Department of Networking and Communications SRMIST

Course Code	21CSE386J	Course Name	PENETRATION TESTING AND VULNERABILITY ASSESSMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	study fundamental concepts in Vulnerability Assessment and Penetration Testing.	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	experiment with Penetration testing framework - Metasploit & its Usage.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	exploit vulnerability detection & explore various other social engineering techniques provided by Social Engineering Toolkit.																											
CLR-4:	perform a penetration test using Metasploit.																											
CLR-5:	execute a penetration test with integrated Metasploit services.																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	study fundamental concepts in Vulnerability Assessment and Penetration Testing.	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-												
CO-2:	experiment with Penetration testing framework - Metasploit & its Usage.	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-												
CO-3:	exploit vulnerability detection & explore various other social engineering techniques provided by Social Engineering Toolkit.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-												
CO-4:	perform a penetration test using Metasploit.	-	-	-	-	2	-	-	-	-	-	-	-	-	-	3												
CO-5:	execute a penetration test with integrated Metasploit services.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3												

Unit-1 - Need for Vulnerability Assessment	12 Hour
The life cycles of Vulnerability Assessment and Penetration Testing -Introduction to Nessus - Installing Nessus on different platforms -prerequisites - Policy configuration - Scan configuration -Implementation of scanning the IT infrastructure using Nessus tool - Report interpretation - False positive analysis - Vulnerability analysis & Vulnerability exploiting -Performing scan results analysis, which will cover false positive analysis, vulnerability analysis, exploiting vulnerabilities, and so on.	
Unit-2 - Vulnerability assessment versus penetration testing	12 Hour
The need for a penetration testing framework - Introduction to Metasploit - Setting up Your Environment – Metasploit - Metasploit components -Playing around with msfconsole - Variables in Metasploit - Browse through the directory structure of the Metasploit Framework &try out some of the common console commands - Information gathering and enumeration - Password sniffing - Advanced search with shodan - Try to explore and execute the Shodan auxiliary module to find out various internet connected devices	
Unit-3 - Vulnerability Hunting with Metasploit	12 Hour
Managing the database – NMAP - Post exploitation - Using any auxiliary module that can be used for vulnerability detection & explore various features of meterpreter. - Need of client-side attacks with Metasploit - The msfvenom utility - Social Engineering with Metasploit - Explore various other social engineering techniques provided by Social Engineering Toolkit & Get familiar with various parameters and switches of msfvenom - Web Application Scanning with Metasploit - Web application scanning using WMAP - Metasploit Auxiliaries for Web Application - enumeration and scanning - Find and exploit vulnerabilities in the following vulnerable applications: DVWA, Mutillidae, OWASP Webgoat	

Unit-4 - Organizing a penetration test	12 Hour
Conducting a penetration test with Metasploit -Case study - diving deep into an unknown network - Perform post-exploitation on the Windows 7 system and identify five best post exploitation modules - The absolute basics of exploitation - Exploiting stack-based buffer overflows with Metasploit - Bypassing DEP in Metasploit modules - Implementation Metasploit exploit module for DEP bypass - Performing a penetration test with integrated Metasploit services - Exploiting the Active Directory (AD) with Metasploit - Generating manual reports -Perform a penetration test on a network using OpenVAS built-in connectors and various Metasploit extensions, and how a proper report of the test can be generated	
Unit-5 - Vulnerability Management Plan	12 Hour
The Six Stages of Vulnerability Management - Measuring the Performance of a Vulnerability Management Program - Demonstration of any windows based Vulnerability Management Tools - Vulnerability Management Tools - Evaluating Vulnerability Management Tools - Open Source and Free Vulnerability Management Tools - Demonstration of any open source Vulnerability Management Tools - Patch Management - Building a Patch Test Lab- Patch Distribution and Deployment - Demonstration of any Patch Management Software	

Learning Resources	<ol style="list-style-type: none"> 1. Himanshu Kumar - Learning Nessus for Penetration Testing_ Master how to perform IT infrastructure security vulnerability assessments using Nessus with tips and insights from real-world challenges. 2. Sagar Rahalkar, Nipun Jaswal - The Complete Metasploit Guide_ Explore effective penetration testing techniques with Metasploit-Packt Publishing (2019) 3. Steve Manzuik, Andre Gold, Chris Gatford - Network Security Assessment_ From Vulnerability to Patch-Syngress (2006) 4. Thomas R. Peltier, Justin Peltier, John A. Blackley - Managing A Network Vulnerability Assessment- Auerbach Publications (2003)
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	25%	25%	-
Level 3	Apply	30%	-	-	30%	30%	-
Level 4	Analyze	30%	-	-	30%	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. S. Sajiv, Technical Leader, CISCO	1. Dr. A. Balaji, School of Computing Science and Engineering (SCSE), VIT Bhopal University	1. Dr. S. Prabakeran, SRMIST, KTR
2. Mr. Varun Subramanian, QA Automation Tester, Likewise		

Course Code	21CSE387J	Course Name	HACKER TECHNIQUES, TOOLS, AND INCIDENT HANDLING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2:		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:																
CLR-4:																
CLR-5:																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:		-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:		-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:		-	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-4:		-	-	-	-	2	-	-	-	-	-	-	-	-	-	3
CO-5:		-	-	-	-	2	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction	12 Hour
The Next Generation - TCP/IP Review, Cryptographic Basics, Symmetric and Asymmetric Encryption - Purpose of Public Key Infrastructure - Hashing - Physical Security - Lab 1: Cloud Investigations for the steps for conducting a cloud security incident investigation and with essential cloud logging assets for incident response. Data collection and isolation for compromise assessment, applying cloud recovery and remediation following an incident, Complete cloud compromise incident response walkthrough. Lab 2: Assessing and Securing Systems on a Wide Area Network (WAN) Lab 3: Applying Encryption and Hashing Algorithms for Secure Communications.	
Unit-2 - Information Gathering and Footprinting	12 Hour
Technical Overview of Hacking - The Information-Gathering Process, The Information on a Company Web Site, Discovering Financial Information, Google Hacking, Exploring Domain Information Leakage, Tracking an Organization's Employees, Exploiting Insecure Applications, Using Basic Countermeasures. Port Scanning - Determining the Network Range, Identifying Active Machines, Mapping Open Ports, OS Fingerprinting, Mapping the Network, Analyzing the Results Lab 4: Data Gathering and Footprinting on a Targeted Website Lab 5: Using Ethical Hacking Techniques to Exploit a Vulnerable Workstation Lab 6: Attacking a Vulnerable Web Application and Database	

Unit-3 - Web and Database Attacks	12 Hour
Enumeration and Computer System Hacking -Windows Basics, Commonly Attacked and Exploited Services, Enumeration, System Hacking, Types of Password Cracking, Using Password Cracking, Using PsTools, Rootkits, Covering Tracks, Wireless Vulnerabilities - The Importance of Wireless Security, A Brief History of Wireless Technologies, Working with and Securing Bluetooth, Working with Wireless LANs, Threats to Wireless LANs, Wireless Hacking Tools, Protecting Wireless Networks, Web and Database Attacks - Attacking Web Servers , Examining an SQL Injection, Examining an SQL Injection, Vandalizing Web Servers, Database Vulnerabilities Lab 7 : Password Guessing Attacks with Hydra, Password Cracking with John the Ripper, Password Cracking with Hashcat. Lab 8: Domain Password Audit Tool, Cloud Bucket Discovery, The Many Uses of Netcat. Lab 9 - Metasploit Attack and Analysis, Client-side Exploitation with the Browser Exploitation Framework (BeEF), Windows System Resource Usage Database Analysis, Command Injection Attack, Cross-Site Scripting Attack, SQL Injection Attack, Server-Side Request Forgery (SSRF) and Instance Metadata Service (IMDS) Attack	
Unit-4 - Attacks and Malware Lifecycle	12 Hour
Sniffers session Hijacking and Denial of Service attacks - Malware-viruses and they function-worms and how they function works-significance of Trojans-Detection of Trojan and viruses, Trojan tools, distribution methods-Trojan constructionkits-backdoors-convertcommunication-spyware-adware-scareware-rensomware-Lab 10 Identifying and Removing Malware on a Windows System.Lab11: Analyzing Network Traffic to Create a Baseline Definition Lab12 :Auditing a Wireless Network and Planning for a Secure WLAN Implementation	
Unit-5 - Eless Security Technologies	12 Hour
Defensive Technologies and incident response - Defence in depth, Intrusion detection system-the purpose of firewalls- Honeypots Honeynets- the role of controls- security best practices- incident response and defensive technologies- incident response- incident response plans- planning for disaster recovery- evidence handling and administration- requirements of regulated industries Lab 13: Investigating and Responding to Security Incidents Lab14: Securing the Network with an Intrusion Detection System (IDS) Lab15: Defense Plan to Prevent Attacks	

Learning Resources	1. Hacker Techniques, Tools, and Incident Handling, 3rd Edition. By Sean-Philip Oriyan and Michael G. Solomon. Released August 2020. Publisher(s): Jones & Bartlett Learning. 2. Joshua Wright Hacker Techniques Training Incident Handling Course SANS SEC504 2019	3. Digital forensics and incident response, johansen 4. Hacker Techniques Training Incident Handling Course SANS SEC504 5. Hacking Exposed: Network Security Secrets and Solutions, Mcclure(Stuart), Scambray(Joel)
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.T.Madhan, Team Leader, Tata Consultancy Services, siruseri Campus, Chennai, madhan.tk@gmail.com	1. Dr. S. Janakiraman, Associate Professor, Pondicherry University, sj.dbt@pondiuni.edu.in	1. Dr. R. Nares, SRMIST
2. Mrs.K.Saranya, IT Analyst, Tata Consultancy Services, siruseri Campus, Chennai, saranya.k6@gmail.com	2. Dr. R.Shyamala, Associate Professor, Anna University College of Engineering Tindivanam, vasuchaaru@gmail.com	2. Dr. C.N.S. Vinoth Kumar, SRMIST

Course Code	21CSE399J	Course Name	COMPREHENSIVE LINUX FOR ALL	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Introduce the key role of an Linux Operating system	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Insist the File system Management of a Linux Operating system															
CLR-3:	Emphasize the importance of Server Management concepts of an Enterprise Linux Operating system															
CLR-4:	Realize the significance of GIT repositories and databases															
CLR-5:	Comprehend the need of Security vulnerability in Linux Operating system															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Identify the need of an Linux Operating system	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Know the Process management functions of an Linux Operating system	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Understand the need of Users and Group Management in Linux Operating system	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Find the significance of GIT repositories and databases	-	-	-	2	3	-	-	-	-	-	-	-	-	-	-
CO-5:	Recognize the essentials of File Management part of an Linux Operating system	-	-	-	2	3	-	-	-	-	-	-	-	-	-	-

Unit-1 - Starting with Linux	12 Hour
Understanding What Linux is- Exploring Linux History- Understanding How Linux Differs from Other Operating Systems- Understanding How Linux Distributions Emerged- Creating the Perfect Linux Desktop- Lab: Ubuntu OS Installation on Virtual Machines- Starting With the Ubuntu Desktop Live Image- Handling Ubuntu Desktop- Using the Desktop- Understanding the Importance of Threads- Lab: Understanding Basic Desktop Application Management in Ubuntu- Adding an Application Launcher- Managing Files and Folders-- Installing and Managing Additional Software- Lab: Knowing Advanced Desktop Application Management in Ubuntu- Using Tools- Lab: Configuring Basic Tools in Ubuntu OS- Working with Shell in Ubuntu- Lab1: Getting Acquainted with Different Types of Shell- Lab3: Basic Shell Management	
Unit-2 - Gaining Access	12 Hour
Using the Root User Account-Exploring Administrative Commands, Configuration Files, and Log Files- Using Other Administrative Accounts- Lab: Implementing Privilege Escalation- Using Shell Variables, Expanding Arithmetic Expressions Expanding Variables- Lab: Manipulating Environmental / Shell Variable- Getting Information About Commands and Help- Managing User Accounts in Ubuntu- User Management- Lab: Managing Regular User Account-Group Management-Lab: Group Management- Moving Around the File system Ubuntu- File Management- Lab: Working with Basic File System- Permission Management- Lab: Working With File System Permissions- Access Control Lists- Lab: Managing User and Group Permissions- Working with Text Files in Ubuntu	
Unit-3 - File Manipulations	12Hour
Lab: Editing Text Files from Shell Prompt- Managing Running Processes- Process Management-Lab: Monitoring Process Activity- Writing Simple Shell Scripts- Understanding Shell Scripts- Lab: Implementing Basic Shell Programs- Understanding Server Managing in RHEL - Install the Server RHEL - Lab: RHEL 8 Installation on Virtual Machine- Initial Server Configuration- Lab: Configuring and Verifying the Initial Server Settings- Remote Server Management- Lab: RHEL Remote Server Management-Initial Server Configuration- Lab: Configuring and Verifying the Initial Server Settings-Remote Server Management-Lab: RHEL Remote Server Management- File Transfer-Lab: Securely Coping Files Between Servers-Log Management- Lab1: Monitoring System Logs-Lab2: Recording and Managing Server Logs- Server Monitoring- Lab: Monitoring the Health of the Server	

Unit-4 - Managing Software in RHEL		12 Hour
Lab: System Software and Package Management- Administering Networking in RHEL - Lab: Examining and Configuring Network in Server- Starting and Stopping Services in RHEL - Lab: Managing Daemons and Services in RHEL - Configuring a Web Server in RHEL- Lab: Managing a Basic Webserver- Advance Webserver Management-Lab: Advance Webserver Management- Secure Webserver-Lab: Securing the Webserver Effectively- Managing Disks and File systems-Lab: Making Simple Partitions- Logical Volume Management- Lab: Implementing Logical Volume Management (LYM)- Configuring Samba Server in RHEL - Lab: Deploy A Samba Share Directory- Configuring an NFS File Server In RHEL - Lab: Deploy a NFS Share Export- Introducing Container Technology		
Unit-5 - Introduction to GIT		12Hour
Getting Started With GIT and its Architecture- Lab: Installing and Configuring GIT in RHEL - Remote Repositories- Lab: Exploring GIT Remote Repository- Branching and Merging- Lab: Learning and Exploring Branches in GIT - Configuring Databases in Linux- Lab: Maria DB (MySQL) Installation and Configuration in RHEL -Mongo DB-Lab: Mongo DB Installation and Configuration in RHEL -Understanding Linux Security OS- Lab: Kali Linux Installation on Virtual Machine- Description About Different Security Tools in Kali Linux-Hands-on Study on NMAP And METASPLOIT-Lab: Gathering Information Using NMAP - METASPLOIT - Lab: Vulnerability Management Using METASPLOIT - Knowing Linux as Cloud Workhorse- Amazon Web Service (AWS)- Lab: Operating and Managing an Ec2 Instance in AWS Cloud		
Learning Resources	1. Christopher Negus, <i>Linux® BIBLE</i> , John Wiley & Sons, Inc., Indianapolis, Indiana, Canada, 2020, 10 th edition	
	2. SUSE LLC, <i>SUSE Linux Enterprise server 12 SPA Administration Guide</i> , 2021, version 1.3	
	3. Adrian Andrade, Fiona Allen, Victor Costea, Hervé Quatremain, Snehangshu Karmakar, Marc Kesler, Ed Parenti, Saumik Paul, Dallas Spohn, Red Hat Enterprise Linux 8.2 RH199 RHCSA Rapid Track	
	4. Technical Content Development Team, <i>Comprehensive Linux for IT Professionals</i> , 2022, 1 st edition	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Stanley Raj M, IT solution Architect	1. Mr. Abdul Majeet Khan, Red Hat Certified Architect – Level V	1. Dr.G.Maragatham, SRMIST
2. Mr. SathishBabu R Cloud Architect		2. Ms. Aruna S, SRMIST

Course Code	21CSE485T	Course Name	DATABASE SECURITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Demonstrate understanding of Fundamentals of Security in database technology with its security architecture in modern computer systems in a typical enterprise.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Formulate a working definition of data warehouse and various geospatial models.															
CLR-3:	Identify hazards and vulnerabilities in matrix models.															
CLR-4:	Demonstrate the knowledge and skills for administration & protection of the active databases.															
CLR-5:	Manage database security and reliability on secured software designs.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Identify fundamentals of security issues, requirements & Authentication.	-	2	-	-	2	-	-	2	-	2	-	-	-	-	3
CO-2:	Obtain knowledge from data warehouse and different geospatial models.	-	2	-	-	2	-	-	2	-	2	-	-	-	-	3
CO-3:	Gain information from different matrix models.	-	2	-	-	2	-	-	2	-	2	-	-	-	-	3
CO-4:	Design different models & protection of the active databases.	-	2	-	-	2	-	-	2	-	2	-	-	-	-	3
CO-5:	Enhance their knowledge of obtaining security software designs.	-	2	-	-	2	-	-	2	-	2	-	-	-	-	3

Unit-1 – Security Issues in Database	9 Hour
Polyinstantiation, Integrity Lock, Sensitivity Lock, Security Models, Access Control (Grant & Revoke Privileges), Distributed Database Security, Outsourced Database and security requirements, Query Authentication Dimension, Condensed RSA & Merkle Tree	
Unit-2 - Security in Data Warehouse & OLAP	9 Hour
Star Schema, Snowflake Schema, Multi-Dimension range query, Data cube - Data leakage in Data Cube, Geospatial Database Security, Geospatial data models, Geospatial Authorization, Access Control Models: Geo-RBAC & Geo- LBAC, Database Watermarking & Attacks on Watermarking	
Unit-3 - Introduction to Access Matrix Model	9 Hour
Take Grant Model, Acten Model PN Model, Harston Model, Hsiao's Model, Fernandez Model, Bell Lapadula's Model, Biba's Model & Dion's Model	
Unit-4 – Database Security Models	9 Hour
Sea View Model, Jajodia Model, Sandhu's Model, The Orion Model, Jajodia Model, Kogan's Model, Sorion Model, A Model for Frame based systems & A Model for the Protection of Active Database	
Unit-5 - Security software Design	9 Hour
A Methodological Approach to Security Software Design, Secure DBMS Design Security Packages, Database Security Design, Retiss System, ASES System discovery, Bussolati AND Martella's Model & Case Study.	

Learning Resources	1. Database Security and Auditing, Hassan A. Afyouni, India Edition, CENGAGE Learning, 2009. 2. Database Security, Castano, Second edition, Pearson Education. 3. Michael Gertz and Sushil Jajodia (Editors), Handbook of Database Security: Applications and Trends, ISBN-10: 0387485325. Springer, 2007.	4. Bhavani Thuraisingham, Database and Applications Security: Integrating Information, Security and Data Management, CRC Press, Taylor & Francis Group, 2005. 5. Database security by Alfred Basta, Melissa zgola, CENGAGE learning. 6. Handbook of Database Security: Applications and Trends. (2008). Germany: Springer US.
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Elaiyaraja K, Eagle Software India Pvt Ltd.	1. Dr. Noor Mahammad, IIITDM	1. Dr. A. Suresh, SRMIST

Course Code	21CSE486T	Course Name	OPERATION SYSTEM SECURITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Outline the fundamentals of efficient security operations in a center	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Illustrate the basics of Infrastructure and Organizational Structures															
CLR-3:	Emphasize the most valuable resource person in an organization															
CLR-4:	Explain the working of Daily Operations, Training and Metrics.															
CLR-5:	Acquire knowledge on the concepts of Intelligence and Outsourcing															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the basic concepts of operation system security on centers	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Identify infrastructural requirements, structures, and operational procedures	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Classify the operational security functions and management procedures.	-	-	3	-	3	-	-	-	-	-	-	-	-	-	3
CO-4:	Identify and acquire knowledge on daily operations and trainings.	2	-	-	-	3	-	-	-	-	-	-	-	-	-	3
CO-5:	Understanding the concept of system metrics, thresholds, outsourcing and deliverables	2	-	3	-	3	-	-	-	-	-	-	-	-	-	-

Unit-1 - Operating System Security	9 Hour
Defining an operations Center, Purpose of the Operation Center, Emergency Operations Center, Mission Operations Center, Threat Operations Center, Network Operations Center, Let Us Build a SOC, Logs, Events, Alerts, False Positive, True Positive, False Negative , True Negative, Incidents , Problems, Define your Requirements, Identify your Customers: Internal versus External Customers, Human Resources, Legal, Audit, Engineering /R&D, IT, External Customers, Customer Objectives, Service level Agreements, Build and Document your Use cases.	
Unit-2 - Infrastructure Security	9 Hour
Organisational Infrastructure – Operations Infrastructure, Support Infrastructure , Organisational Security Infrastructure, Perimeter Defences, Network Defences, Host Defences, Application Defences Data Defences, Policies and Procedures, Security Architecture , Siem/Log Management, Operation Center Infrastructure Ticketing Systems, Building the Ticket System, Subject, Parsed Values from Events, Time Ticket Created, User Group Queue, Source(SIEM, Email, Phone), Category, Status, Reason Codes, Acknowledgement/Ticket Feedback, Workflow and Automation, Portal Interference, Mobile Devices, Support Infrastructure, Physical, Private SOC Network, Video Projectors, Labs. Different Reporting Lines, Legal, CISO, CIO, Compliance, SOC Organisation, Engineering, Security Architecture, Security Monitoring and Analysis, responsibility, Authority, Fulfilling needs.	
Unit-3 - Mostvaluable resource	9 Hour
Operational Security, Culture, Personality, Core skill sets, Analysis, Security Analyst- Job Description Security Engineering, Security Operation Engineer- Job Description, Security Architect, Security Architect-Job Description, SOC Team Lead, SOC Team Lead – Job Description, SOC Management, SOC Manager- Job Description , SOC Games, Special Projects, Do not Forget your People.	

Unit-4 - Operations	9 Hour
Problem and change Event Communications- Master stage Logs, Shift turnovers, Daily Operations Calls, Critical Bridges, IR, Detection, Confirmation, Analysis, Containment, Recovery, Review, Communication Plan, Regular Workshops, Checklists, Shift Schedules, Types of Shift Schedules, Other Shift Options, Follow the Sun, Shift Rotation, Dealing with Absenteeism. Internal Functional Training, Internal Skill set Training, Playbooks and Runbooks, Job Task Qualification Training, Tools and Product Training, Formal Training and Certifications, Schools and Universities, vendor Training, OJT, Training Plans, SOC shift Operations, Leaders, Customer Notifications, SOC Phones, Progression and Visibility, Training Exercises.	
Unit-5 - Outsourcing	9 Hour
Heads Up Display, Supervisor Metrics, Vulnerabilities, Vulnerability Prioritizing, Base CVSS2 Threshold, Temporal CVSS2 Threshold, Asset Prioritizing as a Part of Metrics, Historical Monitoring of Patches. Know Thyself, Known IP Space, Know Thy Enemy, Blacklists, Block Listing Projects, Other Types of Lists, Organisational and Industry Partners, Proactive Activity Monitoring. Types of MSSPs, - Strategic Partners, Pure Play Providers, Boutique Providers. Advantages of MSSP Outsourcing- Cost, Organisational, Enhanced Capabilities, SLA, Documentation, Disadvantages to MSSP Outsourcing, and Large Numbers of Customers. Lack of Dedicated Resources, Data Storage Issues, Costs, Quality of Work and Staffing, How the Services will be Delivered, people, Size Verses Experience, Service Execution, Tools, Similar Versus Larger MSSP, Security, DR, Exit Strategy, MSSP Selection, Providing the Service, Testing Your MSSP.	

Learning Resources	<ol style="list-style-type: none"> David Nathans Designing and Building a Security Operations Center, Elsevier Science - Syngress. Gregory Jarpey and Scott McCoy, Security Operations Center Guidebook A Practical Guide for a Successful SOC · Elsevier Science- 2017. Joseph Muniz, Gary McIntyre, Nadhem AlFardan, Security Operations Center, Building, Operating, and Maintaining Your SOC · Pearson Education- 2015. 	<ol style="list-style-type: none"> Robert H. Deatherage, Jr., Security Operations an Introduction to Planning and Conducting Private Security Details for High-Risk Areas · Taylor & Francis - 2021 Robert McCrie, Security Operations Management · Elsevier Science - 2011
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr S, Venkata Prasad, Tata Consultancy Services, Chennai	1. Dr. G. Srinivasan, IIITDM, Chennai	1. Dr.S.Murugaanandam, SRMIST.

Course Code	21CSE487T	Course Name	CYBER WARFARE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes				
CLR-1:	Describe the relationships between cyber warfare, information assurance, information operations, and network-centric warfare	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-2:	Develop and maintain an effective cybersecurity workforce prepared to support various cyber warfare activities																													
CLR-3:	Apply international cybersecurity policy and doctrine to develop frameworks for effective deterrence and management of operational risk																													
CLR-4:	Define technical and operational requirements for command & control, situational awareness, and decision support systems for operational cybersecurity organizations																													
CLR-5:	Describe trends in the development of cyber warfare capabilities from an international perspective																													
Course Outcomes (CO):		At the end of this course, learners will be able to:												-	-	2	-	-	-	-	2	-	-	-	-	-	-	-	-	-
CO-1:	Understand the cyber war and its importance, battlefield of cyber war.	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-			
CO-2:	Analyze the organized crimes in cyberspace and the role of cyber in Military Doctrines	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
CO-3:	Manage the development of cyber capabilities to meet weaponization standards	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	3			
CO-4:	Identify and apply decision frameworks for ethical and legal concepts in the context of cyber warfare	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3			
CO-5:	Develop and maintain an effective cybersecurity workforce prepared to support various cyber warfare activities with the legal status	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			

Unit-1 - Cyber Warfare, Threatscape and Cyberspace Battlefield	9 Hour
What is Cyber Warfare? – What is Cyber Warfare? Have We Seen a Cyber War? Why Cyber Warfare Is Important? Introduction to Cyber Warfare Threatscape: definition of cyberwar, motivation, attackers, threats, Attack Methodology with the Tools and Techniques Used to Execute Them, Defense in Depth—How Organizations Defend Today (Defensive Mountain Range), What the Threat Is After (What We Should Focus on Defending). The Cyberspace Battlefield - Boundaries in Cyber Warfare, Where Cyber Fits in the War-Fighting Domains, Review of the Threat Actors, Fielding Systems at the Speed of Need.	
Unit-2 - Cyber Doctrine, Warrior and Accessing the problem	9 Hour
Cyber Doctrine - Current U.S. Doctrine, Sample Doctrine/Strategy from Around the World, Key Military Principles That Must Be Adapted to Cyber Warfare, Guidance and Directives, Operations and Exercises. Cyber Warriors - What Does a Cyber Warrior Look Like? Differences from Traditional Forces, Present Cyber Warfare Forces, Staffing for Cyber War. Assessing the Problem - The Complex Domain of Cyberspace, Cyber Warfare in the 20th and 21st Centuries, China, Israel, Russia, The Second Russian-Chechen War (1997–2001), The Estonian cyber-attacks (2007), The Russia-Georgia War (2008), Iran, North Korea, Cyber Espionage, Titan Rain, Cyber Crime, Future Threats, Increasing Awareness, Critical Infrastructure, The Conficker Worm: The Cyber Equivalent of an Extinction Event? Africa: The Future Home of the World's Largest Botnet? The Way Forward.	

Unit-3 - Weapons – Logical, Physical and Psychological	9 Hour
Logical Weapons - Reconnaissance Tools, DNS, Scanning Tools, Access and Escalation Tools, Exfiltration Tools, Sustainment Tools, Assault Tools, Obfuscation Tools. Physical Weapons - How the Logical and Physical Realms Are Connected? Infrastructure Concerns, Supply Chain Concerns, Tools for Physical Attack and Defense. Psychological Weapons - Social Engineering Explained, How the Military Approaches SE, How the Military Defends Against SE.	
Unit-4 - Computer Network Exploitation, Defense and Non-State Actors	9 Hour
Computer Network Exploitation - Intelligence and Counter-Intelligence, Reconnaissance, Surveillance. Computer Network Attack - Waging War in the Cyber Era, The Attack Process. Computer Network Defense - What We Protect, Security Awareness and Training, Defending Against Cyber Attacks. Non-State Actors in Computer Network Operations - Individual Actors, Corporations, Cyber Terrorism, Organized Cyber Crime, Autonomous Actors - The Rise of the Nonstate Hacker.	
Unit-5 - Legal System Impacts and status of Cyber Warfare, Challenges and Future of Cyber War	9 Hour
Legal System Impacts - Legal Systems, Key U.S. Laws, Privacy Impacts, Digital Forensics. Ethics - Ethics in Cyber Warfare, Bellum Iustum (Just War Theory). The Legal Status of Cyber Warfare - Cyberspace Challenges - Cybersecurity Issues Defined, Interrelationship of Cybersecurity Challenges, Way Ahead. The Future of Cyber War - Emerging Trends, Trends Driving Where We Will Go	

Learning Resources	1. Cyber Warfare, 2nd Edition, by Jason Andress, Steve Winterfeld, Released October 2013, Publisher(s): Syngress, ISBN: 9780124166332.	4. Information Operations - Doctrine and Practice: A Reference Handbook, Christopher Paul, Praeger Security International, 2008, ISBN: 0275995917,
	2. Inside Cyber Warfare, 2nd Edition, Jeffrey Carr, Released December 2011, Publisher(s): O'Reilly Media, Inc. ISBN: 9781449310042	5. Law, Policy, and Technology: Cyberterrorism, Information Warfare and Internet Immobilization, Pauline C. Reich, and Eduardo Gelbstein, IGI Global, 2012, ISBN: 1615208313
	3. The Basics of Cyber Warfare: Understanding the Fundamentals of Cyber Warfare in Theory and Practice, Steve Winterfeld and Jason Andress, Elsevier, 2012, ISBN: 978012404737.	6. Information Warfare and Security, Dorothy Denning, Addison Wesley Professional, 1998, ISBN: 0201433036

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. Arun, Senior Software Engineer, Quick Heal		1. Vigneshwaran P, SRMIST

Course Code	21CSE488T	Course Name	HACKER MIND: PROFILING THE IT CRIMINAL	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Compare and contrast the differences between digital evidence and traditional evidence	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Critically evaluate standards and good practices for digital evidence and digital crimes															
CLR-3:	Describe and critique digital crime process models															
CLR-4:	Discuss data and identify data sources															
CLR-5:	Discuss the ways in which digital evidence is authenticated															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understanding the Concept of Cyber Criminology	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Identify the challenges faced nationally and internationally at combating cybercrime, and the steps being taken by organizations and law enforcement to address these challenges	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
CO-3:	Identifying the Contemporary Forms of Crimes	-	-	2	-	-	-	2	-	-	-	-	-	-	-	3
CO-4:	Know psychology of cyber criminals.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Take what they have learned in class and apply it to cybercrime-related current events.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Principles and Concepts of Cyber Criminology	9 Hour
Crime, Tort, Misdemeanour, Cyber Space, Cyber Crime, Cyber Criminology, Information Security, Penetration Testing, Incident Response, GRC, etc.- Conventional crimes vs. Cyber Crimes.	
Unit-2 - Contemporary Forms of Crimes	9 Hour
White Collar Crimes, Economic Offences, Organized Crimes, Terrorism, Crime and Media and other contemporary forms of crimes.	
Unit-3 - Psychology of Cyber Criminals	9 Hour
Types of Cyber Criminals – Modus Operandi of Cyber Criminals – Profiling of Cyber Criminals - Tools and Techniques adopted by Cyber Criminals – Psychological theories relating to cyber criminals.	
Unit-4 - Cyber Crime	9 Hour
Sociological and Criminological Perspectives – Causes of Cyber Crimes - Criminological Theories and Cyber Crime – Routine Activity Theory, Social Learning Theory, Differential Association Theory, Differential Opportunity Theory, Media and Crime and latest theories and other related theories.	
Unit-5 - Crime Prevention	9 Hour
Crime and sense of security - Social control and crime prevention - Community and crime prevention - Contemporary crime prevention strategies Tutorial The Role of Criminal Justice Administration and Cyber Crimes a. Police – Organizational structure of Police in India – Different wings in the States and Districts and their functions - Police & Law Enforcement – F.I.R. – cognizable and non-cognizable offences, bail able and non-bail able offences – arrest , search, seizure – Interrogation of suspects and witnesses – charge sheet – Cybercrime cells – structure & investigation of cybercrime cases . b. Judiciary - Different types of courts – Cyber Appellate Court / Tribunals / Powers – Proceedings in the court before trial, after trial, plea of guilty, sentencing. c. The Role of N.G.O.s in the Prevention of Cyber Crimes d. The Role of Victims of Cyber Crimes in the Criminal Justice Administration	

Learning Resources	1. Clifford, Ralph. 2021. <i>Cybercrime: The Investigation, Prosecution and Defense of a Computer-Related Crime</i> . Second Edition. Carolina Academic Press.	3. McQuade, Samuel. 2006. <i>Understanding and Managing Cybercrime</i> . Pearson.
	2. Holt, Thomas. 2019. <i>Crime On-Line: Correlates, Causes and Context</i> . Second Edition. Carolina Academic Press.	4. Yar, Majid. 2013. <i>Cybercrime and Society</i> . Second Edition. Sage Publications.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Venkata Prasad S, TATA consultancy services, svenkataprasad@yahoo.com	1. Dr. Abhishek Srivastava, asrivastava@iiti.ac.in, CSE, IIT, Indore.	1. Dr.M B Mukesh Krishnan, SRMIST
	2. Dr. A. Amuthan, amuthan@pec.edu, Pondicherry Engineering College, Pondicherry.	

Course Code	21CSE489T	Course Name	MOBILE AND WIRELESS SECURITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Outline the fundamentals Mobile and Wireless Networks	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Illustrate the importance of security and explain about Mobile Security															
CLR-3:	Introduce and explain about Wifi, Bluetooth security in Wireless Networks															
CLR-4:	Explain WiMAX and LTE Security in Wireless Networks															
CLR-5:	Implement about the Security of Downloadable Applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understanding the modern concept and foundation of Mobile security	2	-	3	-	3	-	-	-	-	-	-	-	-	-	-
CO-2:	Identify and classify various next generation networks	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Analyze various sources of vulnerabilities from Mobile.	2	-	3	-	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Analyze various sources of vulnerabilities from Wireless Networks	-	-	3	-	3	-	-	-	-	-	-	-	-	-	3
CO-5:	Create network security attacks and its countermeasures	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Mobile and Wireless Networks	9 Hour
Mobile Cellular Networks – (Generation Networks), 802.11 Standards –802.11,802.15, 802.16, 802.20, 802.21, IEEE wireless networks, Mobile Internet networks, Attacks and defence strategies on Cellular networks, Security Issues in Mobile Communication: Mobile Communication History, Security – Wired Vs Wireless, Security Issues in Wireless and Mobile Communications, Security Requirements in Wireless and Mobile Communications, Security for Mobile Applications, Advantages and Disadvantages of Application – level Security	
Unit-2 - Mobile Security	9 Hour
Basics on security, Secure communication protocols, Importance of Authentication and Authorization, Challenges of Cybersecurity, Incident Response Process, Security risks in Mobile, Security in the GSM, GPRS security, 3G security, Android Architecture, and Security Model for Android, Fundamentals of Android Development, Android Rooting, Intercepting Android Traffic, Attacks on Android, and Security Model for iOS, Case Studies on Mobile Security	
Unit-3 - Wireless Security	9 Hour
Wi-Fi Security: Introduction, Attacks on wireless networks: Active, passive attacks, DoS attacks, TCP, Trojan and Dictionary Attacks, Security in the IEEE 802.11 standard, Security in 802.1x, Security in 802.11i, Authentication in wireless networks, Layer 3 security mechanisms. Bluetooth Security: Introduction, Bluetooth technical specification, Bluetooth security	
Unit-4 - WiMAX and LTE Security	9 Hour
Introduction, WiMAX architecture and OFDM, Security risks involved in 802.16-2004, Security risks involved in 802.16e Security in GSM, UMTS, GPRS, VoIP security, LTE security	
Unit-5 - Security of Downloadable Applications	9 Hour
Introduction, Security policy, The implementation of a security policy, Execution environments for active contents, Validation of active contents, Detection of attacks	

Learning Resources	<ol style="list-style-type: none"> 1. Hakima Chaouchi, Maryline Laurent-Maknaviciu Wireless and Mobile Network Security, Wiley-ISTE, 2013. 2. M. Au, R. Choo and G. Kessler, Mobile security and privacy. Cambridge, MA: Syngress, 2017. 3. J. Joshi, Network Security. New York: Elsevier, 2009. 4. S. AHMADI, MOBILE WIMAX. [Place of publication not identified]: ELSEVIER ACADEMIC Press, 2016. 	<ol style="list-style-type: none"> 5. https://onlinecourses.nptel.ac.in/noc21_cs16/preview 6. https://blog.rsisecurity.com/what-is-the-mobile-security-framework/ 7. https://wimaxforum.org/ 8. https://www.coursera.org/lecture/security-awareness-training/mobile-devices-and-security-EMjmM
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Venkata Prasad S, TATA consultancy services, svenkataprasad@yahoo.com	1. Dr. Abhishek Srivastava, asrivastava@iiti.ac.in , CSE, IIT, Indore.	1. Dr. Mary Subaja Christo, SRMIST
	2. Dr. A. Amuthan, amuthan@pec.edu , Pondicherry Engineering College, Pondicherry.	

Course Code	21CSE490J	Course Name	WINDOWS AND LINUX INTERNALS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basic concepts of windows operation system tools and terminologies	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Exploring the operating system architecture and kernel drivers															
CLR-3:	Classify the operational management services in windows operating system.															
CLR-4:	Acquire knowledge on Linux operating system basics.															
CLR-5:	learn the technical aspects and to apply Linux operating system kernel operations and file systems.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Inspect and apply the basic concepts of windows operation system tools and terminologies	-	-	2	-	-	-	-	2	-	-	-	-	-	-	-
CO-2:	Recognize and clarify the operating system architecture and kernel drivers	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Demonstrate foundation knowledge of the operational management services in windows operating system.	-	-	-	-	-	-	-	2	-	-	-	-	-	-	3
CO-4:	Inspect and apply the basic concepts on Linux operating system basics.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Exploring the Linux operating system kernel operations and file systems.	-	-	-	-	-	-	-	2	-	-	-	-	-	-	3

Unit-1 - Operating System Security	12 Hour
Concepts and Tools, Windows Operating System Versions, Foundation Concepts and Terms, Windows API, Services, Functions, and Routines, Processes, Threads, and Jobs, Virtual Memory, Kernel Mode vs. User Mode, Terminal Services and Multiple Sessions, Objects and , Security ,Registry , Unicode , Digging into Windows Internals , Reliability and Performance Monitor , Kernel Debugging , Windows Software Development Kit ,Windows Driver Kit , Sysinternals Tools.	
Unit-2 - Windows Architecture	12 Hour
System Architecture, Requirements and Design Goals, Scalability, Differences Between Client and Server Versions, Operating System Model, Architecture Overview, Portability , Symmetric Multiprocessing , Checked Build, Key System Components , Environment Subsystems and Subsystem DLLs , Ntdll.dll ,Executive , Kernel. , Hardware Abstraction Layer, Device Drivers,	
Unit-3 - Windows Management	12 Hour
Management Mechanisms , The Registry , Viewing and Changing the Registry , Registry Usage , Registry Data Types , Registry Logical Structure, Transactional Registry (TxR) , Monitoring Registry Activity , Registry Internals , Services , Service Applications ,The Service Control Manager ,www.it-ebooks.info viii Table of Contents Service Startup , Startup Errors ,Accepting the Boot and Last Known Good, Service Failures , Service Shutdown , Shared Service Processes , Service Tags, Service Control Programs, Windows Management Instrumentation , Providers , The Common Information Model and the Managed Object Format Language. , Class Association, WMI Implementation. , WMI Security, Windows Diagnostic Infrastructure. ,WDI Instrumentation, Diagnostic Policy Service ,Diagnostic Functionality	

Unit-4 - Linux Operating System	12 Hour
<i>Bootup, Process and Interrupt Management, Virtual Filesystem (VFS, Linux Page Cache, IPC mechanisms., Booting, Building the Linux Kernel Image, Booting: Overview, Booting: BIOS POST, Booting: bootsector and setup, Using LILO as a bootloader, High level initialization, SMP Bootup on x86, Freeing initialisation data and code, Processing kernel command line, Process and Interrupt Management., Task Structure and Process Table, Creation and termination of tasks and kernel threads., Scheduler, Linux linked list implementation, Wait Queues, Kernel Timers., Bottom Halves, Task Queues., Tasklets, ,, How System Calls Are Implemented on i386 Architecture, Atomic Operations</i>	
Unit-5 - Linux Kernel	12 Hour
<i>Linux Versus Other Unix-Like Kernels, Hardware Dependency, Linux Versions, Basic Operating System Concepts, An Overview of the Unix File system, An Overview of Unix Kernels , Memory Addressing, Memory Addresses , Segmentation in Hardware, Segmentation in Linux , Paging in Hardware , Paging in Linux , Processes, Processes, Lightweight Processes, and Threads , Process Descriptor , Process Switch , Creating Processes , Destroying Processes</i>	

Learning Resources	<ol style="list-style-type: none"> Solomon, David A., Mark E. Russinovich, and Alex Ionescu. Windows internals. Microsoft Press, 2009. Yosifovich, Pavel, David A. Solomon, and Alex Ionescu. Windows Internals, Part 1: System architecture, processes, threads, memory management, and more. Microsoft Press, 2017. Mohanta, Abhijit, and Anoop Saldanha. "Windows Internals." Malware Analysis and Detection Engineering. Apress, Berkeley, CA, 2020. 123-162. Bovet, Daniel P., and Marco Cesati. Understanding the Linux Kernel: from I/O ports to process management. "O'Reilly Media, Inc.", 2005. Mauerer, Wolfgang. Professional Linux kernel architecture. John Wiley & Sons, 2010.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr S, Venkata Prasad, TCS, Chennai	1. Dr. T Veera kumar, ECE, NIT, GOA.	1. Dr S Murugaanandam, SRMIST

Course Code	21CSE491T	Course Name	CYBER CRIMES AND DIGITAL FORENSIC	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	To Study about the Cyber Crime	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	To learn and understand cybercrimes occurrence															
CLR-3:	To study the fundamentals of Computer Forensics															
CLR-4:	To learn, analyze and validate Forensics Data															
CLR-5:	To study the tools and tactics associated with Cyber Forensics															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understanding concepts related to cyber world and cyber law in general	2	-	3	-	3	-	-	-	-	-	-	-	-	-	-
CO-2:	Develop competitive edge on various facets of cyber crimes	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Understand data and identify data sources	2	-	-	-	3	-	-	-	-	-	-	-	-	-	3
CO-4:	Understand and able to classify digital evidence	2	-	3	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Compare and contrast the differences between digital evidence and traditional evidence	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-

Unit-1 - Criminal Law & Prevention	9 Hour
Introduction to Criminal aw, Nature of Jurisprudence, Participants and Steps in the Criminal Justice Process, Theories of Punishment I: Retribution and Prevention, Theories of Punishment II: Rehabilitation and Incapacitation, Sentencing and Punishment, Correlation between law and social change, Legal evolution and social complexity, Symbolic and instrumental uses of law, Problems in the study of impact and effectiveness.	
Unit-2 - Cyber Law & IT Act 2000	9 Hour
Introduction to Cyber Law, Evolution of the Information Technology Act, Genesis and Necessity, Salient features of the Information Technology Act, 2000, Various authorities under Information Technology act, Powers. Penalties & Offences, Amendments, Cyber Space Jurisdiction, Jurisdiction Issues under IT Act, 2000, Traditional Principles of Jurisdiction, Extra Terrestrial Jurisdiction, Case Laws on Cyber Space Jurisdiction.	
Unit-3 - Cyber Forensics Fundamentals	9 Hour
Cyber Forensic Basics, Introduction to Cyber Forensics, Storage Fundamentals, File System Concepts, Data Recovery, Operating System, Software, Basic Terminology, Applications	
Unit-4 - Recovery Policies	9 Hour
Data and Evidence Recovery, Introduction to Deleted File Recovery, Formatted Partition Recovery, Data Recovery Tools, Data Recovery Procedures and Ethics, Preserve and safely handle original media, Document a "Chain of Custody", Complete time line analysis of computer files based on file creation, file modification and file access, Recover Internet Usage Data, Recover Swap Files/Temporary Files/Cache Files, Introduction to Encase Forensic Edition, Forensic Tool Kit (FTK), Use computer forensics software tools to cross validate, findings in computer evidence-related case.	

Unit-5 - Investigation Models	9 Hour
Cyber Forensics Investigation and Decryption methods, Introduction to Cyber, Forensic Investigation, Investigation Tools, e-Discovery, Digital Evidence Collection, Evidence Preservation, Fundamentals of File Systems, Network Forensics Artefacts, Mobile Device Forensics, Digital Forensics writing Reports, E-Mail Investigation, E-Mail Tracking, IP Tracking, E-Mail Recovery, Encryption, Search and Seizure of Computers, Recovering deleted evidences, Password Cracking	

Learning Resources	1. David J. Loundy, <i>Computer Crime, Information Warfare, and Economic Espionage</i> , Carolina Academic Press (2018) (ISBN: 0890891109). 2. Jack Balkin, Et Al. Eds., <i>And Cybercrime: Digital Cops In A Networked World</i> (Nyu Press 2017) (ISBN: 0814799833). 3. Orin S. Kerr, <i>Computer Crime Law: American Casebook Series</i> (2016) (ISBN: 0314144005).	4. Orin S. Kerr, <i>Computer Crime Law: American Casebook Series</i> (2016) (ISBN: 0314144005). 5. Ralph D. Clifford, <i>Cybercrime: The Investigation, Prosecution and Defense Of A Computer-Related Crime</i> (Second Edition 2016) (ISBN: 0890897239). 6. Samuel C. Mcquade, Iii, <i>Understanding and Managing Cybercrime</i> (2016) (ISBN: 020543973x).
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Balan C, Scientist F, CDAC, cbalan@cdac.in	1. Dr. S. Janakiraman, Associate Professor, Pondicherry University, sj.dbt@pondiuni.edu.in	1. Dr. C.N.S.Vinoth Kumar SRMIST
2. Mr.E.Balaji, IT Analyst, Tech Mahindra	2. Dr. R.Shyamala, Associate Professor, Anna University College of Engineering Tindivanam, vasuchaaru@gmail.com	2. Dr.R.Naresh, SRMIST

Course Code	21CSE492T	Course Name	CYBER CRIMES AND CYBER SECURITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	introduce the cyber world and cyber law in general	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	explain about the various facets of cyber crimes															
CLR-3:	enhance the understanding of problems arising out of online transactions and provoke them to find solutions															
CLR-4:	Exhibit knowledge to secure corrupted systems, protect personal data, and secure computer networks in an organization															
CLR-5:	Practice with an expertise in academics to design and implement security solutions															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understanding concepts related to cyber world and cyber law in general	-	2	2	-	-	-	-	2	-	-	-	-	-	-	-
CO-2:	Develop competitive edge on various facets of cyber crimes	-	2	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-3:	Analyze and evaluate the cyber security needs of an organization	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Measure the performance and troubleshoot cyber security systems.	-	2	-	-	-	-	-	2	-	-	-	-	-	-	3
CO-5:	Implement cyber security solutions and use of cyber security, information assurance, and cyber/computer forensics software/tools.	-	-	2	-	-	-	-	2	-	-	-	-	-	-	3

Unit-1 - Criminal Law & Judicial Procedure	9 Hour
Introduction to Criminal Law, History of criminal law, Penology and Treatment of Offender, Judicial process as an instrument of social ordering, Indian Penal Code, Indian Evidence Act, Legislature and Judiciary, Nature, content and justiciability, Directive Principles of State Policy, Inter relationship between Fundamental Rights and DPSP, Definitions under Code of Criminal Procedure -1973	
Unit-2 - Cyber Law & IT Act 2000	9 Hour
Introduction to Cyber Law, Evolution of the Information Technology Act, Genesis and Necessity, Salient features of the Information Technology Act – 2000, Various authorities under Information Technology act, Powers. Penalties & Offences, Amendments, Cyber Space Jurisdiction, Jurisdiction Issues under IT Act, 2000, Traditional Principles of Jurisdiction, Extra Terrestrial Jurisdiction, Case Laws on Cyber Space Jurisdiction	
Unit-3 - Security Risks and Threats	9 Hour
Security Threat Management, Risk Assessment, Forensic Analysis, Security threat correlation, Threat awareness, Vulnerability sources and assessment, Vulnerability assessment tools, Threat identification, Threat Analysis, Threat Modeling, Model for Information Security Planning.	
Unit-4 - Security Policies	9 Hour
Security Elements, Authorization and Authentication, types, policies and techniques, Security certification, Security monitoring and Auditing, Security Requirements Specifications, Security Policies and Procedures, Firewalls, IDS, Log Files, HoneyPots	

Unit-5 - Trusted Security Models		9 Hour
Access control, Trusted Computing and multilevel, Security models, Trusted Systems, Software security issues, Physical and infrastructure security, Human factors, E-Mail Recovery, Encryption, Email, and Internet use policies		
Learning Resources	1. Swiderski, Frank and Syndex, "Threat Modeling", Microsoft Press, 2018.	3. Joseph M Kizza, "Computer Network Security", Springer Verlag, 2019
	2. William Stallings and Lawrie Brown, "Computer Security: Principles and Practice", Prentice Hall, 2018.	4. Thomas Calabres and Tom Calabrese, "Information Security Intelligence: Cryptographic Principles & Application", Thomson Delmar Learning, 2018.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Balan C, Scientist F, CDAC, cbalan@cdac.in	1. Dr. S. Janakiraman, Associate Professor, Pondicherry University, sj.dbt@pondiuni.edu.in	1. Dr. C.N.S.Vinoth Kumar, SRMIST
2. Mr.E.Balaji, IT Analyst, Tech Mahindra	2. Dr. R.Shyamala, Associate Professor, Anna University College of Engineering Tindivanam, vasuchaaru@gmail.com	2. Dr.P.Madhavan SRMIST

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 11G

**(Syllabi for Computer Science and Engineering w/s in
Information Technology Programme Courses)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC314P	Course Name	BIG DATA ESSENTIALS	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
Identify the basics of big data and hadoop		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:																
Demonstrate the tools and techniques in big data																
CLR-3:																
Inspect the query language based on big data application																
CLR-4:																
Interpret classification and clustering in big data application																
CLR-5:																
Experiment the Big data Visualization tools																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:		2	-	-	3	-	-	-	-	-	-	-	-	-	-	2
Acquire knowledge on the basics of big data																
CO-2:		-	-	-	3	3	-	-	-	-	-	-	-	-	-	3
Examine the tools and techniques using Hadoop, HDFS, and Map Reduce																
CO-3:		2	-	-	3	-	-	-	-	-	-	-	-	-	-	3
Build any database for the application in big data																
CO-4:		-	-	-	3	-	-	-	-	-	-	-	-	-	-	3
Apply different classification and clustering algorithms using data sets in an application																
CO-5:		2	-	-	3	3	-	-	-	-	-	-	-	-	-	3
Analyze the Visualization techniques in big data																

Unit-1 - Introduction	9 Hour
Introduction to Big Data, Impact of Big Data, Parallel Processing, and Data Parallelism, Tools of Big Data, Introduction to the Hadoop Ecosystem, Introduction to MapReduce, The Hadoop Ecosystem/Common components: Introducing HDFS, Hive, HBase, and Spark, other modules, Installing Hadoop	
Unit-2 – Hadoop Distributed File System	9 Hour
Features of HDFS, HDFS Commands, Retrieving file data from HDFS using Python Snakebite, Deleting files in HDFS using Python Snakebite, Map Reduce and Spark RDD Big Data, Working with HDFS, Working with HBase, Difference between HDFS and HBase, Hadoop Word Count using Map Reduce, Matrix Multiplication using Map Reduce	
Unit-3 – Pig Programming	9 Hour
Introduction to Pig, Parallel processing using Pig, Pig Latin-Input and output, Hive: Introduction, data types and file formats, QL-data definition, data manipulation, QL views, indexes, Hive queries with partitioning.	
Unit-4 - Spark Framework	9 Hour
GPU Computing, CUDA Programming model, Multiplication in CUDA, CUDA Memory model, Shared memory matrix multiplication Writing Spark application, Spark programming in R, Scala, Python, Java, Streaming application, Classification and Clustering in Big data, K-Means clustering, Decision Tree Classification, Naive Bayes Classification.	
Unit-5 – Big Data Visualization	9 Hour
Introduction to big data visualization, Tree Maps, Maps, Gauge, Sunburst, Different visualization tools, Creating Visualization in Tableau, Different visualization methods in Tableau	

Learning Resources	7. Sima Acharya, Subhashini Chellappan," BIG Data and Analytics" Wiley Publication, 2020.	9. Thomas Erl, "Big Data Fundamentals-Concepts, Drivers and Techniques", Pearson publication, 2016.
	8. Michael Minelli,Michele Chambers, AmbigaDhiraj, "BigData, BigAnalytics - Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley Publication, 2018.	10. Kyle Banker, PiterBakkum, Shaun Verch," MongoDB in Action" Dream tech Press publication 2016. 11. Achari, Shiva "Hadoop Essentials" Birmingham, UK: Packt Publishing. 2015. 12. Tom White, "HADOOP: The Definitive Guide", O Reilly 2012.

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20%)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	-	15%	-	-
Level 2	Understand	25%	-	-	20%	-	20%	-	-
Level 3	Apply	30%	-	-	25%	-	25%	-	-
Level 4	Analyze	30%	-	-	25%	-	25%	-	-
Level 5	Evaluate	-	-	-	10%	-	10%	-	-
Level 6	Create	-	-	-	5%	-	5%	-	-
	Total	100 %		100%		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
2. Kumanan P, Project Manager, CTS, Chennai	2. Dr.V.Vijayarajan, Associate Professor/HOD, Vellore Institute of Technology, Vellore	2. Mrs.V.Vijayalakshmi, SRMIST

Course Code	21CSC317J	Course Name	INFORMATION RETRIEVAL TECHNIQUES	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basics and importance of Information Retrieval	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Analyze a problem based on fitting an appropriate modeling and retrieval evaluation to its solution															
CLR-3:	Apply machine learning techniques for classification and clustering of Information															
CLR-4:	Implementation of various search engine system operations															
CLR-5:	Apply knowledge of Retrieving information on Text models and various recommender systems															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Define the basic methods of Information Retrieval and their importance	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Interpret the Modeling methods and Evaluation of Information Retrieval	3	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Infer appropriate methods for indexing, classification, and clustering	-	3	-	3	-	-	-	-	-	-	-	-	-	2	-
CO-4:	Clarify the various search engine system operations	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Demonstrate recommender systems and language models	-	2	3	-	-	-	-	-	-	-	-	-	-	2	3

Unit-1 - Introduction	12 Hour
Information Retrieval: Definition, Objectives, Functional Overview, Relationship to DBMS– Early Developments – Areas and Applications of Information Retrieval- Issues with IR – The IR Search Architecture - Data Retrieval and Visualization- Information versus Data Retrieval	
Unit-2 - Modeling and Performance Evaluation	12 Hour
IR Models – Boolean Model - Term Weighting – Vector Space Model – Probabilistic Model – Language Models – Neural Network Model – Text Processing and Retrieval Models – Retrieval Metrics – Query Processing and Refinement Techniques - Query Optimization - Precision -Recall - F-Measure	
Unit-3 - Indexing and Data Mining Techniques	12 Hour
Indexing: Introduction - Dictionaries - Inverted Files - Encoding - Static and Dynamic Inverted Indices - Scalable Indexing - Index Compression - Classification: K- Nearest Neighbor - Naïve Bayes - Support Vector Machines- Clustering: Partitioning method - K- Means Clustering - Hierarchical Clustering	
Unit-4 - Search Engines	12 Hour
The Web – History of Web - Searching the Web - Structure of the Web - Search Engine Architectures — Search Engine Ranking – Link-based Ranking – Simple Ranking Functions – Static and Dynamic Ranking - Search Engine Optimization - Google Search Engine - Web Crawler	
Unit-5 - Text Retrieval Model and Recommendations System	12Hour
Natural Language Processing in IR - Basic Document Retrieval - Stemming - n-gram models - Document Scoring - Document as a Vector - Token Recognition- Document Scoring -Document as a Vector - Advance Topics: Recommendation Systems - Sentimental Analysis - Recommender Systems Functions	

Practice:	
Practice 1: Case Study on Data Retrieval Techniques Practice 2: Case Study on Various Data Visualization tools Practice 3: Extraction of Raw Data Practice 4: Implementation of Term Weighting Practice 5: Implementation of Text Processing Model Practice 6: Implementation of Neural Network Model Practice 7: Implementation of Scalable Indexing Practice 8: Implementation of Classification Technique on a dataset	Practice 9: Implementation of the Clustering technique on a dataset Practice 10: Case Study on Implementation of Various search engines Practice 11: Implementation of Page Ranking Algorithm on a search engine Practice 12: Implementation of Web Crawler Practice 13: Implementation of Basic Document Retrieval Practice 14: Case Study on various Recommendation Systems Practice 15: Implementation of Sentimental Analysis

Learning Resources	<div>1. Ricardo Baeza-Yates and Berthier Ribeiro-Neto, —Modern Information Retrieval: The Concepts and Technology behind Search, Second Edition, ACM Press Books, 2011.</div> <div>2. Stefan Buettcher, Charles L. A. Clarke and Gordon V. Cormack, —Information Retrieval: Implementing and Evaluating Search Engines, The MIT Press, 2016</div> <div>3. Jaime Spooner - Modern Information Retrieval, Excelic Press, 2019.</div> <div>4. Yates - Modern Information Retrieval, Pearson India, 1st Edition, 2016.</div> <div>5. Kowalski Gerald Et Al - Information Retrieval Architecture and Algorithms, Springer India, 1st Edition, 2013.</div>	<div>6. Ricardo Baeza, Yates - Modern Information Retrieval: The Concepts and Technology Behind Search, Addison-Wesley Professional; 2nd edition, 2011</div> <div>7. Ricci, F, Rokach, L. Shapira, B.Kantor, —Recommender Systems Handbook, First Edition, 2011.</div> <div>8. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schtze, Introduction to Information Retrieval, Cambridge University Press. 2008.</div> <div>9. C. Manning, P. Raghavan, and H. Schütze, —Introduction to Information Retrieval, Cambridge University Press, 2008.</div>

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	10%	25%	-
Level 2	Understand	30%	-	-	25%	30%	-
Level 3	Apply	30%	-	-	30%	25%	-
Level 4	Analyze	25%	-	-	25%	20%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. K. Arul, Project Manager, ANCIT Consulting, Bangalore	1. Dr. D. Karthika Renuka, Professor, PSG College of Technology	1. Dr. V.M. Gayathri, SRMIST
2. Mr. Gopinath Balu, Saama Technologies	2. Dr. A. Balasundaram, Assistant Professor (Gr-III), VIT Chennai	2. Dr. P. Supraja, SRMIST

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSE267T	Course Name	STATISTICS FOR MACHINE LEARNING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Grasp the basics of statistics for machine learning	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the concepts of machine learning models and supervised learning															
CLR-3:	Familiarize the unsupervised learning techniques															
CLR-4:	Gain knowledge in tree-based machine learning models															
CLR-5:	Utilize the reinforcement learning and recommendation Engines															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Acquire the knowledge on Statistics Machine Learning Terminologies.	3	-	-		-	-	-	-	-	-	-	-	3	-	-
CO-2:	Perceive the concepts about the Machine Learning Models and Supervised Learning Technique	3	2	-		-	-	-	-	-	-	-	-	3	-	-
CO-3:	Implement the Unsupervised Learning Techniques	2	3	-	2	-	-	-	-	-	-	-	-	-	2	-
CO-4:	Apply the knowledge in tree-based machine learning models	3	3	-	2	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Analyze the concepts of Reinforcement Learning and Recommendation Engines	3	3	-	3	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to Statistical Terminology	9 Hour
Statistical terminology for model building and validation- Major difference between statistical modeling and machine learning- Machine learning terminology - Steps in Machine learning development and deployment- Statistical fundamentals and terminology for model building and validation.	
Unit-2 - Machine Learning Models and Supervised Learning	9 Hour
Regression in machine learning models-Types of Regression-Linear Regression-Simple Linear Regression-Multiple Linear Regression-Ridge and Lasso Regression-Logistic Regression, Supervised Learning - K-Nearest Neighbor- Naive Bayes-Support Vector Machine (SVM)	
Unit-3 - Unsupervised Learning	9 Hour
K-means Clustering, Principal Component Analysis (PCA), Singular Value decomposition (SVD), Deep auto encoders, Deep auto encoders applied on handwritten digits using Keras	
Unit-4 - Tree based Machine learning Models	9 Hour
Ecision Tree Classifier-Random Forest Classifier-Bagging Classifier-AdaBoost Classifier-Gradient Boost Classifier.	
Unit-5 - Reinforcement Learning and Recommendations	9 Hour
Introduction to Reinforcement Learning-Characteristics of Reinforcement Learning-Reinforcement Learning Basics-Category1.Value Based- Category 2. Policy Based- Category 3. Actor centric- Category 4. Model Free - Category 5-Model Based-Fundamental categories in sequential decision making -Content based filtering-Collaborative Filtering- Applications of reinforcement learning with integration of machine learning.	

Learning Resources	1. Pratap Dangeti, "Statistics for Machine Learning", 1st edition, Packt Publishing, 2017	4. Peter Bruce, Andrew Bruce, "Practical Statistics for Data Scientists", 2nd edition, O'Reilly, 2017
	2. Richard Golden, "Statistical Machine Learning a Unified Framework", 1st edition, CRC press, 2020	5. Gareth James, Daniela Witten, "An Introduction to Statistical Learning", 2nd edition, Springer, 2014
	3. Himanshu Singh, "Statistics to Machine learning", 1st edition, BPB publications, 2021	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Amish Anand @wipro.com	1. Dr. Ameer, National Institute of Technology, Calicut	1. Dr. J. Godwin Ponsam, SRMIST
	2. Dr. Varaprasad Rao, Sree Dattha Institute of Engineering & Science	2. Dr. R. Radhika, SRMIST

Course Code	21CSE310J	Course Name	QUANTUM COMPUTATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1: Gain knowledge about quantum computing and quantum mechanics		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2: Analyse the Quantum Circuits																
CLR-3: Utilize Open source Qiskit for quantum programming																
CLR-4: Learn about Grover and Deutsch Jozsa quantum algorithms																
CLR-5: Utilize the quantum concept and explore its applications																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1: Identify the need of quantum computing and quantum mechanics		1	3	-		-	-	-	-			-	-	2	-	-
CO-2: Explore the Quantum gates and Quantum Circuits		2	3	1	-	-	-	-	-			-	-	2	-	-
CO-3: Develop the quantum programs for circuit optimization.		2	3	-	3	-	-	-	-	-	-	-	-	2	-	-
CO-4: Incorporate the Quantum algorithms Deutsch Jozsa and Grover		2	3	-	3	-	-	-	-	-	-	-	-	2	-	-
CO-5: Demonstrate the different Quantum simulators and real time applications		1	3	-	3	-	-	-	-	-	-	-	-	2	-	-

Unit-1 – Introduction to Quantum Computation	12 Hour
Need for Quantum Computing and fundamental concepts- Vector spaces, Probability- Complex numbers and mathematical preliminaries- Postulates of quantum mechanics- Bra-ket notations- Measurements- Composite systems- Bells theorem- Entanglement- Pure and Mixed states- Bloch sphere.	
Unit-2 – Quantum Gates and Circuits	12 Hour
Fubini study metric- Geometry of quantum states- Tutorial style problem solving session- Complexity classes- Turing machine- Turing machine concepts- Quantum gates- Quantum circuits- Quantum circuits design	
Unit-3 – Quantum Circuit Optimization	12 Hour
Quantitative measures of circuit- Analysis of quality of Circuits- Circuit optimization- Tutorial style problem solving sessions- Introduction to quantum algorithms- Deutsch Jozsa algorithm- Oracles and Phase kick back- Deutsch Jozsa Algorithm-details	
Unit-4 – Quantum Grover algorithm	12 Hour
Introduction to Grover algorithm- Detailed walk through on Grovers algorithm- Quantum Amplitude Estimation- Tutorial-problems analysis- Problem solving session- Programming concepts in Qiskit- Analysis of Qiskit- Exploring Qiskit- Programming in quantum- Analysis of exercises created by NPTEL- Usage of IBM composer.	
Unit-5 – Quantum Applications	12 Hour
Introduction to quantum applications- Research challenges of quantum- Introduction to QC Models- Physical Realization of Models- Tech landscape- VQE- Tutorial-problems- Problem solving session- Discussion of different use cases- Use case in logistics- Use case in ML and image processing- Use case in finance and quantum cryptography.	

Lab Experiments	
Lab 1: Python basics Lab 2: Navigation on Circuit composer and Qiskit in Quantum Lab Lab 3: Project preparation phase 1 (Analysis of problem statement related to quantum computing) Lab 4: Quantum hardware and Simulators Lab 5: implement single and multiple qubit gates Lab 6: Project preparation phase 2 (Design of the project based on problem statement) Lab 7: Quantum circuits Lab 8: Visualization tools (State vector and Q-Sphere)	Lab 9: Project preparation phase 3 (Implementation of quantum problem statement in cloud environment) Lab 10: Quantum teleportation in Qiskit Lab 11: Implementation of Grover's algorithm Lab 12: Project preparation phase 4 (Testing of the software implemented) Lab 13: project presentation and demo (use case developed) Lab 14: Project thesis preparation Lab 15: Project report submission (Thesis of use case developed)

Learning Resources	1. Quantum Computation and Quantum Information. M. A. Nielsen and I. L. Chuang, Cambridge University Press 2. Presskil Lecture notes: Available online: http://www.theory.caltech.edu/~preskill/ph229/ 3. Michael A. Nielsen and Isaac L. Chuang, "Quantum Computation and Information, Cambridge, 2002 4. Mikio Nakahara and Tetsuo Ohmi, "Quantum Computing", CRC Press, 2008 5. N. David Mermin, "Quantum Computer Science", Cambridge, 2007 6. https://qiskit.org/	7. An Introduction to Quantum Computing. P. Kaye, R. Laflamme, and M. Mosca, Oxford University Press, New York 8. Quantum Computer Science. N. David Mermin: Cambridge University Press 9. Quantum Cryptography. D. Unruh: Available online: https://courses.cs.ut.ee/all/MTAT.07.024/2017_fall/uploads/ 10. NIST Post Quantum Cryptography, Available online: https://csrc.nist.gov/projects/post-quantum-cryptography/round-2-submissions 11. Quantum Algorithms for Cryptographically Significant Boolean Functions - An IBMQ Experience. SAPV Tharmashastha, D. Bera, A. Maitra and S. Maitra, Springer 2020.
--------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	-	15%	-
Level 2	Understand	20%	-	-	-	20%	-
Level 3	Apply	45%	-	-	40%	45%	-
Level 4	Analyze	20%	-	-	30%	20%	-
Level 5	Evaluate	-	-	-	30%	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Prabha Narayan, QKRISHI		1. Dr. Gayathri.M , SRMIST

Course Code	21CSE373T	Course Name	STREAMING ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basic building blocks of stream processing	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Relate streaming data in real time															
CLR-3:	Explore the data ingestion options into stream processing engines															
CLR-4:	Extend stream processing results to end users															
CLR-5:	Explore NOSQL storage options to store real time data															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Illustrate the concepts and terminologies in stream processing	2	3	-	2	2	-	-	-	-	-	-	-	2	-	-
CO-2:	Interpret stream processing applications using Apache Spark Streaming	2	2	-	2	2	-	-	-	-	-	-	-	-	3	-
CO-3:	Summarize real-time streaming data pipelines and applications that adapt to the data streams using Kafka	2	2	-	2	2	-	-	-	-	-	-	-	-	3	-
CO-4:	Interpret stream processing applications using Apache Storm Streaming	2	2	-	2	2	-	-	-	-	-	-	-	-	3	-
CO-5:	Inquire real time data using NoSQL databases & MongoDB	2	2	-	2	2	-	-	-	-	-	-	-	-	-	3

Unit-1 - Fundamentals of Stream Processing	9 Hour
Introducing Stream Processing, Stream Processing, Examples of Stream Processing, Scaling Up Data Processing, Distributed Stream Processing, Stream-Processing Model, Sources and Sinks, Immutable Streams Defined from One Another, Transformations and Aggregations, Window Aggregations, Stateless and Stateful Processing, Stateful Streams, An Example: Local Stateful Computation in Scala, Stateless or Stateful Streaming, Streaming Architectures, Components of a Data Platform, Architectural Models, The Use of a Batch-Processing Component in a Streaming Application, Referential Streaming Architectures, Streaming Versus Batch Algorithms	
Unit-2 - Apache Spark & Structured Streaming	9 Hour
Apache Spark as a Stream-Processing Engine, Spark's Distributed Processing Model, Spark's Resilience Model, Introducing Structured Streaming, The Structured Streaming Programming Model	
Unit-3 - Kafka-A Realtime Data and Stream Processing	9 Hour
Getting Started with Kafka, Kafka, Publish Subscribe messaging model, Kafka Architecture, Messages and Batches, Schemas, Topics and Partitions, Producers and consumers, Brokers and Clusters, Multiple Clusters, Data Ecosystem, Kafka Producers: Writing messages to Kafka, Kafka Consumers - Reading data from Kafka, Stream Processing- Stream Processing Design Patterns-Kafka Streams by Examples- Kafka Streams: Architecture Overview	
Unit-4 - Apache Storm	9 Hour
Apache Storm – Introduction, Real-Time Processing and Storm Introduction, Storm Deployment, Topology Development, and Topology Options, Storm Parallelism and Data Partitioning, Integration of Storm, and Kafka	
Unit-5 - NoSQL Databases in Cloud and MongoDB	9 Hour
NoSQL Data Bases, AWS Cloud Dynamo Database: Amazon DynamoDB features, Serverless, Introduction to MongoDB, MongoDB Data Model, MongoDB Architecture - Core Processes, MongoDB Tools, Standalone Deployment, Replication, Sharding, MongoDB Use Cases- Performance Monitoring, and Social Networking.	

Learning Resources	1. Garillot F and Mass. G., <i>Stream Processing with Apache Spark</i> , 1st ed., O'Reilly Media, Inc., 2019. 2. Narkhede N, Shapira. G, and Palino T., <i>Kafka: The Definitive Guide - Real-Time Data and Stream Processing at Scale</i> , 1st ed., O'Reilly Media, Inc., 2017 3. Ankit Jain, <i>Mastering Apache Storm</i> , 1st ed., Packt Publishing, 2017	4. https://docs.mongodb.com/manual/changeStreams/ 5. Shakuntala Gupta Edward Navin Sabharwal, "Practical MongoDB Architecting, Developing, and Administering MongoDB" Apress, 2016 6. https://aws.amazon.com/dynamodb/features/?pg=dynamodbt&sec=hs
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Gangeyan Ranganathan, Project Delivery Specialist II, Deloitte Consulting LLP, Sacramento, California	1. Dr Surendiran B, Associate Professor, National Institute of Technology, Puducherry	1. Dr. B Yamini, SRMIST
2. Mr. Shri Raghu Raaman, Solidity Developer, Pixelvault Inc., Toronto, Canada	2. Dr. Selvakumar K., B.E., M.E., Ph. D, Assistant Professor Grade-II, Department of Computer Applications, National Institute of Technology Trichy, Tiruchirappalli-620015, Tamil Nadu, India	2. Dr. G Suseela, SRMIST

Course Code	21CSE475T	Course Name	APPLIED GRAPH THEORY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basics of graph theory	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Gain Knowledge on trees and circuits															
CLR-3:	Outline planar and dual graphs															
CLR-4:	Illustrate about matching and coloring problems															
CLR-5:	Learn the applications of graph theory															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Comprehend the knowledge of graph basics	2	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Acquire the ability to solve the trees and circuit problems	-	-	3	3	-	-	-	-	-	-	-	-	-	3	-
CO-3:	Design the Dual Graphs and detect the planarity	-	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO-4:	Apply the knowledge of matching and coloring to solve complex problems	2	3	3	-	-	-	-	-	-	-	-	-	2	-	-
CO-5:	Make use of the graph theory in real time applications	2	-	-	3	-	-	-	-	-	-	-	-	-	3	-

Unit-1 - Introduction to Graphs	9 Hour
Graphs-Definition of graphs and digraphs- Types of graphs- Directed graphs - Graph Isomorphism - Incidence and Adjacency Matrices- Subgraphs- Vertex degrees and counting -Large bipartite subgraphs - The handshake lemma - Havel-Hakimi Theorem- - Independent Sets and Cliques -Path, Walk, Connections and Circuits- Cycles-Euler graphs- Hamiltonian Path and Circuit- Travelling Salesman Problem	
Unit-2 - Trees and Circuits	9 Hour
Introduction to trees - Properties of trees - Pendant Vertices, Distance and Centre vertices- Rooted and Binary Trees- On counting trees- Spanning Trees: Finding spanning trees of a graph- Prim's Spanning Tree Algorithm, Kruskal's Spanning Tree Algorithm - Cut Sets: Properties of cut sets- Connectivity and Separability – Network Flows: 1-Isomorphism, 2-Isomorphism	
Unit-3 - Planar and Dual Graphs	9 Hour
Combinatorial and Geometric Graphs- Planar Graphs- Representations of a planar graphs -Kuratowski's Two Graphs - Detection of Planarity- Geometric Dual- Combinatorial Dual – Thickness and Crossings, Euler's Formula, Five – Color Theorem and the five color Conjecture, Non-Hamiltonian Planar Graphs, Planarity Algorithm	
Unit-4 - Matchings and Colorings	9 Hour
Matchings and Coverings in Bipartite Graphs - Chromatic number - Lower bounds from clique number and maximum independent set - Upper bounds from greedy coloring - Szekeres-Wilf and Brooks' Theorem - k-critical graphs - Cartesian product of graphs - Interval graphs - k-Chromatic graphs - Mycielski's construction - Turán's Theorem - Edge coloring - Line graphs - Vizing's Theorem	
Unit-5 - Applications of Graph Theory	9 Hour
Transport Networks – Extensions of Max-Flow and Min-Cut Problems - Minimal Cost Flows – The Multicommodity Flow- Further Applications – More on Flow Problems – Activity Networks in Project Planning – Analysis of an Activity Network – Graphs in Computer Programming - Graphs in Game Theory	

Learning Resources	1. Narsingh Deo - Graph Theory with Applications to Engineering, Dover Publications McGraw Hill Education –2016 2. Robin J. Wilson - Introduction to Graph Theory, Pearson Education, Fourth Edition, 2004 3. J.A. Bondy and U.S.R. Murthy – Graph Theory with Applications, Elsevier Science Publishing, Fifth Edition, 2008	4. R. Gould – Graph Theory, Dover Publications, Reprint, 2012 5. Reinhard Diestel - Graph Theory, Springer Publisher, Fifth edition, 2017
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Krishna Kumar, Technical Lead, Wipro	1. Dr.K.M. Dhanya, Associate Professor, Government Engineering College, Palakkad	1. Dr.V.R. Balasaraswathi, SRMIST
2. Mr. Lakshmikanthan Pudunagar Subbiah, Wintel CC team	2. Dr.T. Suguna, Assistant Professor, Government College of Technology, Coimbatore	2. Dr. Meenakshi K, SRMIST

Course Code	21CSE476T	Course Name	LOGICAL DEDUCTION AND NON-VERBAL REASONING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Explore the basic concepts of logics	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Identify the insights of logics in terms of Computer based Applications															
CLR-3:	Evaluate and understand predicate logic															
CLR-4:	Relate abstract and logical thinking skills to Computational Approach															
CLR-5:	Identify and analyze case studies that uses the ideology of non-verbal reasoning															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Appraise the importance and role of logics in computer science	3	3	-	-	-	-	-	-	-	-	-	2	-	2	-
CO-2:	Analyze the syntax and semantics of propositional logic and its applications	3	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Apply the concept of predicate logic to computational Science	3	2	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-4:	Ability to understand the logical and abstract thinking concepts of Non-Verbal Reasoning	-	2	-	3	-	-	-	-	-	-	-	-	-	2	-
CO-5:	Utilize the Non-Verbal Reasoning knowledge gained to Computational Applications	-	2	-	3	-	-	-	-	-	-	-	-	-	2	-

Unit-1 - Logics in Computer Science	9 Hour
Introduction: What is Logic – History of logic – Overview of logic in computer science, Sets, Relations and Functions, operations on Binary Relations, Ordering Relations, Partial order and Trees, Infinite Sets, Set theory -Basics for formulating Data Structures, Databases	
Unit-2 - Propositional Logic and Applications	9 Hour
Introduction to Propositional Logic: Syntax, well-formed Formulas, Semantics, Interpretations, truth tables, satisfaction – Satisfiability, entailment, validity – CNF / DNF, Binary Decision Diagrams- Model Counting, Mathematical Induction, Deduction, Applications - Query Search Engines, Query Search Databases	
Unit-3 - Predicate Logic	9 Hour
Introduction to Predicate Logic-Syntax and Semantics, well-formed Formulas, Quantifiers, Decision Problems, Equivalences, Translation of Predicates to Natural Language, Applications-Natural Language, Databases	
Unit-4 - Non-Verbal Reasoning: Introduction to Logical and Abstract Concepts	9 Hour
Image Series, Shapes-Animation and computer graphics, Rule Deduction- Rule based Algorithms, Pattern, and Incomplete Patterns - Pattern Recognition Algorithms and Applications	
Unit-5 - Non-Verbal Reasoning: Case Studies	9 Hour
Grouping of Identical Figures- Clustering Algorithms and Application, Cube, and dice - Naive Approach Vs Computational Approach, Figure Formation and Analysis-Knowledge Representation and reasoning	

Learning Resources	1. Michael Huth and Mark Ryan, Logic in Computer Science Modelling and Reasoning about Systems, 2nd Edition, 2004.	4. Uwe Schoning, Logic for Computer Scientists, http://tinman.cs.gsu.edu/~raj/8710/f16/UweSchoning/UweSchoningBook.pdf , 1989
	2. Steve Reeves and Mike Clarke, Logic for Computer Science, Department of Computer Science Queen Mary, and Westfield College University of London U.K. Department of Computer Science University of Waikato New Zealand https://www.cs.waikato.ac.nz/~steve/LCS.pdf , 2003 Edition.	5. Acob Eisenstein, Natural Language Processing, https://cseweb.ucsd.edu/~nnakashole/teaching/eisenstein-nov18.pdf , 2018.
	3. Mauricio Ayala-Rincon, Applied Logic for Computer Scientists, https://users.aalto.fi/~rintanj1/notes-logic.pdf , 2017.	6. RS Aggarwal, A Modern Approach to Verbal and Non-Verbal Reasoning, 16th Edition, 2018.
		7. John Vince, Essential Computer Animation Fast How to Understand the Techniques and Potential of Computer Animation 2000 Edition, Springer.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. John Paul, Senior IT Analyst, Bank of America	1. Dr. Devan, Associate Professor, Department of CSE, Easwari Autonomous College	1. Dr. A. Helen Victoria, SRMIST
2. Mr. Lakshmi Narayanan, Telecom Engineer	2. Dr. L. C. Manikandan, Professor, Department of CSE, Valia oonambakulathamma College of Engineering and Technology, Parippally, Thiruvananthapuram, Kerala	2. Dr. M. Anand, SRMIST

Course Code	21CSE477T	Course Name	CLOUD NATIVE ARCHITECTURE FOR MODERN PLATFORMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:														
CLR-1:	Understand architectural principles behind a modern application platform.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Understand the best high-level structures for different kinds of applications, including web, database, thick-client, and web applications															
CLR-3:	Understand the core principles of software design.															
CLR-4:	Understand how Spring and ReactJS frameworks eliminate tedious configuration and repetitive coding tasks, making it easy to build enterprise-ready, production-quality software. Components of modern platforms.															
CLR-5:	Understand micro services, reactive development, and other modern application designs.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Demonstrate events, perform state updates, and manage conditional content; Apply styles dynamically and conditionally to create a modern UI.	2	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Implement components and stereotypes to satisfy given business requirements that could include both synchronous and asynchronous web applications.	-	-	3	2	-	-	-	-	-	-	-	-	-	3	-
CO-3:	Design and implement a scalable polyglot persistence layer including regular star schema and document store.	-	-	3	-	2	-	-	-	-	-	-	-	-	2	-
CO-4:	Design independent, composable, loosely coupled services that integrate well with device independent frontend UI components of modern platforms.	-	-	3	-	2	-	-	-	-	-	-	-	-	2	-
CO-5:	Build non-functional characteristics such as scalability, performance engineering and security aspects into the solution.	-	-	3	3	-	-	-	-	-	-	-	-	-	2	-

Unit-1 - Modern Application Platforms	9 Hour
Introduction to modern application platforms, Introduction concept: distributed systems, Agility: user stories and acceptance test cases, Modelling: Requirements, Technology: Web, Web Stock and REST, Technology: Synchronous Controllers and asynchronous Web flux mapping- Workshop using user stories, spring boot framework, synchronous controllers, and Asynchronous Web Flux sockets. Ploygot Persistence, Introduction Concept: Distributed Database, Technology: NoSQL and NewSQL Data modellig. Agility: Product Backlog, Modelling: Data, Technology: Mapping to Repositories, Workshop using Document Database and RDBMS. CA Project Instructions briefing, Service Fundamentals Introduction Concept: Cloud Computing Introduction, Agility: Pair Programming, Modelling: user Interface Technology Service design and API end points, Technology: Mapping Entities to Repositories, Workshop using service components, data access components and API endpoints.	
Unit-2 - Full Stack Components	9 Hour
Full Stack Components: Introduction Concept: Distributed Service communication, Agility: Test Driven Development, Modelling: Technical Backlog, Technology: Reactive Client-side Technologies, Technology: Build tools and Test automation, Technology: End to End Application Layering, Workshop using Synchronous components and client side. CA Project Mile stone MVP Submission, Cloud Native Reference Architecture, Introduction Concept: Cloud managed services (distributed), Modeling: Architectural Prototype, Technology: Reference Architecture, Technology: Cloud Native Design, Technology: Container Kuberetes part 1.	

Unit-3 - Micro Services	9 Hour
Micro services Architecture: Introduction Concept: Domain Drive Design, Modelling: Bounded Context, Workshop using end to end layering of components and cloud hosting, and Technology: Element of micro services and implementation mechanism, Technology: Container - Kubernetes part 2, Technology: Inter-micro services communication, Workshop for moving from monolithic to microservices components. CA Project milestone Archetype Submission, Serverless Architecture, Introduction Concept: Function as a service, Modelling: Functions, Technology: Elements of functions and workflow implementation mechanism	
Unit-4 - Functions and Containers	9 Hour
Technology: Functions Vs Containers (Kubernetes vs Kubeless), Technology: Inter-functional communication, Workshop using serverless functions, Event Driven Architecture, Introduction Concept : Work Queue Systems, Technology : Producer, Consumer and Messages, Technology: Event Brokers versus message Brokers, Technology: Event-Driven Processing, Workshop using Event driven messages (both producers and consumer) and processing the same Design for Scalability, Introduction Concept: Application scaling, Concept: Data Scaling, Caching and Replication, Concept: Distributed systems communication Technology: Container orchestrated scaling and replication.	
Unit-5 - Container Hosting	9 Hour
Workshop for container hosting, CA project milestone First Iteration Submission, Metrics, Monitoring and Performance Engineering, Introduction Concept: Quality metrics for non-functional Requirements, Concept: Distributed tracing for profiling an monitoring concept: Performance Engineering, Technology: Contain orchestrated scaling and replication, Workshop for performance engineering, Security Architecture for Modern Platforms, Introduction Concept: Distributed Service Security, Modelling: Threat models and SWOT Analysis, Technology: Identity and access management, Technology: Data asset classification and Protection, Technology: Container security, Workshop for Security Implementation Platform Reliability Engineering, Introduction concept: Distributed service reliability, Technology: Service Level Indicators, Workshop for reliability Implementation.	

Learning Resources	<ol style="list-style-type: none"> 1. Clean Architecture: A Craftsman's Guide to Software Structure and Design by Robert C. Martin; published by: Pearson; publication date: September 2017. 2. Johnson, Rod, et al. "The spring framework–reference documentation." interface 21 (2004): 27. 3. Walls, Craig. Spring in action. Simon and Schuster, 2022. 4. White, Joshua, and Willie Wheeler. Spring in practice. Simon and Schuster, 2013. 5. Boduch, Adam, and Roy Derks. React and React Native: A complete hands-on guide to modern web and mobile development with React. js. Packt Publishing Ltd, 2020.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Srinivasan Varadharajan, Senior Principal Software Engineer, Manhattan Associates, Atlanta, United States.	1. Dr. Surya Priya Asaithambi, Principal Lecturer and Consultant, Software Systems Practice, National University of Singapore.	1. Dr M. Thenmozhi, SRMIST
2. Mr. Shiva Praveen, American Express, USA.	2. Dr. B. Vinayaga Sundaram, Associate Professor, Madras Institute of Technology, Chennai.	2. Dr. S. Metilda Florence, SRMIST

Course Code	21CSE479T	Course Name	FAULT TOLERANT SYSTEMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1: Familiarize the measures of Fault tolerance and Dependable Systems		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2: Understand the various techniques used for hardware fault tolerance.																
CLR-3: Determine the various forms of redundancy for enhancing system reliability																
CLR-4: Understand the various techniques for software fault tolerance																
CLR-5: Exploring fault tolerance in real time systems																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1: Identify the faults which may cause the system to fail		2	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2: Apply various techniques for overcoming hardware failure and identify the best suited technique for the identified fault		2	-	-	3	-	-	-	-	-	-	-	-	3	-	-
CO-3: Choose various redundancy forms to enhance reliability of the system identified with fault		2	-	-	3	-	-	-	-	-	-	-	-	3	-	-
CO-4: Analyze the methodology best suited for identified software fault.		2	-	-	3	-	-	-	-	-	-	-	-	3	-	-
CO-5: Illustrate the fault tolerance in real time systems.		2	3	-	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to Fault-Tolerance	9 Hour
Error, Faults and Failures; Fault Classification, Basic Measures of Fault Tolerance: Traditional and Network; Reliability and Availability; Dependable system, techniques for achieving dependability, dependability measure	
Unit-2 - Hardware Fault Tolerance	9 Hour
Failure Rate, Reliability, and Mean Time to Failure, Canonical and Resilient Structures, Reliability Evaluation Techniques, Fault-Tolerance Processor-Level Techniques, Byzantine Failures.	
Unit-3 - Information Redundancy	9 Hour
Coding, Resilient Disk Systems, Data Replication, Algorithm-Based Fault Tolerance	
Unit-4 - Software Fault Tolerance	9 Hour
Acceptance Tests, Single-Version Fault Tolerance, N-Version Programming, Recovery Block Approach, Preconditions, Postconditions, and Assertions, Exception-Handling, Software Reliability Models, Fault-Tolerance Remote Procedure Calls	
Unit-5 - Checkpointing	9 Hour
Checkpoint Level, Optimal Checkpointing, Checkpointing in Distributed and Shared-Memory Systems, Checkpointing in Real-Time Systems, Case studies: IBM G5, IBM Sysplex, Itanium	

Learning Resources	1. Israel Koren and C. Mani Krishna; <i>Fault-Tolerant Systems</i> ; Morgan-Kaufman Publishers, 2007	4. Martin L. Shooman; <i>Reliability of Computer Systems and Networks: Fault Tolerance, Analysis, and Design</i> ; John Wiley & Sons Inc., 2002
	2. Dubrova, Elena. <i>Fault-tolerant design</i> . New York: Springer, 2013	5. P. Jalote, "Fault Tolerance in Distributed Systems", Prentice-Hall Inc. 1994
	3. Michael R. Lyu; <i>Handbook of Software Reliability Engineering</i> ; IEEE Computer Society Press (and McGraw-Hill), 1996	6. D. K. Pradhan, "Fault-Tolerant Computing, Theory and Techniques", Prentice-Hall, 1998

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Joseph Aloysius, Consultant, TCS.	1. Dr. Latha, Prof & head, dept of CSE, St. Peters Engg college, chennai	1. Dr.V. Elizabeth Jesi, , SRMIST
		2. Ms. G. Saranya, , SRMIST

Course Code	21CSE480T	Course Name	IMAGE AND VIDEO PROCESSING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basics of Digital Image Processing concepts.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Apply simple image enhancement techniques in spatial and frequency domain															
CLR-3:	Analyze the concepts of Image compression and segmentation techniques															
CLR-4:	Gain some basic knowledge on Digital video processing.															
CLR-5:	Utilize the video processing and streaming techniques for real-time programming applications.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe the basics of Digital Image Processing concepts.	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-2:	Identify appropriate image enhancement, smoothing and sharpening filters techniques for real time applications	-	2	-	3	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Implement image compression techniques for real time applications	-	2	-	3	-	-	-	-	-	-	-	-	-	3	-
CO-4:	Acquire the fundamental concepts and terminologies in video processing.	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-5:	Demonstrate Video streaming Techniques for real time applications	-	-	2	3	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Fundamentals of Image Processing and Image Transforms	9 Hour
Basic steps of Image Processing System Sampling and Quantization of an image, Basic relationship between pixels. Image Segmentation: Segmentation concepts, Point, Line and Edge Detection, Thresholding, Region based segmentation	
Unit-2 - Image Enhancement	9 Hour
Spatial domain methods: Histogram processing, Fundamentals of Spatial filtering, smoothing spatial filters, Sharpening spatial filters. Frequency domain methods: Basics of filtering in frequency domain, Image smoothing, Image sharpening, Selective filtering.	
Unit-3 - Image Compression and Segmentation	9 Hour
Image compression fundamentals –Basic compression methods- Lossy & Lossless, Transform and Truncation coding, Huffman coding, Predictive coding, JPEG Standards. Image segmentation techniques.	
Unit-4 - Fundamentals of Video Processing	9 Hour
Analog Video, Digital Video. Time-Varying Image Formation models: Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Video signals, Filtering operations	
Unit-5 - Streaming video over the Internet	9 Hour
Architecture for Video Streaming Systems, Video Compression, Application Layer Qos Control For Streaming Video, Continuous Media Distribution Services, Streaming Servers, Media Synchronization, Protocols For Streaming Video.	

Learning Resources	1. Gonzalez and Woods, "Digital Image Processing using MATLAB", 2nd Edition, McGraw Hill Education, 2016	4. A Murat Tekalp, "Digital Video Processing", PERSON, 2010
	2. Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Third Edition, Pearson Education, 2014.	5. Bovik, "Handbook of Image & Video Processing", Academic Press, 2010
	3. S. Sridhar, "Digital Image Processing", Oxford University Press, 2020.	6. Yao Wang, Jörn Ostermann and Ya Qin Zhang, "Video Processing and Communications", Prentice Hall Publishers, 2002.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Albert Rex, HP, Chennai	1. Dr. Ameer, National Institute of Technology, Calicut	1. Dr. K. Nimala, SRMIST
2. Mr. Amish Anand, Wipro Technologies	2. Dr. Varaprasad Rao, Sree Dattha Institute of Engineering & Science	2. Dr. G. Geetha, SRMIST

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 11H

**(Syllabi for Computer Science and Engineering w/s in
Internet of Things Programme Courses)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC313J	Course Name	CLOUD COMPUTING FOR IoT	Course Category	C	PROFESSIONAL CORE										L	T	P	C		
																2	0	2	3		
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil														
Course Offering Department		School of Computing			Data Book / Codes / Standards			Nil													
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes			
CLR-1:	Restate the Applications, Platform and Cloud services.					Engineering Knowledge	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2:	Label the different levels of cloud platforms and various laws.						Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning				
CLR-3:	State Cloud applications and new opportunities																				
CLR-4:	Recognize the security levels and privacy of several layers of IoT																				
CLR-5:	Evaluate the Authentication and Security of IoT.																				
Course Outcomes (CO):		At the end of this course, learners will be able to:																			
CO-1:	Memorize the essentials of Applications, Platform and Cloud services.					-	2	-	-	3	-	-	-	-	-	-	-	-	3	3	
CO-2:	Categorize different levels of cloud platforms and IoT systems.					-	2	-	-	3	-	-	-	-	-	-	-	-	3	3	
CO-3:	Demonstrate new opportunities and cloud applications					-	2	-	-	3	-	-	-	-	-	-	-	-	3	3	
CO-4:	Analyze the different security levels and privacy of several layers of IoT					-	2	-	-	3	-	-	-	-	-	-	-	-	3	3	
CO-5:	Assess their knowledge of the Authentication and Security of IoT.					-	3	-	-	3	-	-	-	-	-	-	-	-	3	3	
Unit-1 - Introduction to Cloud Computing																12 Hour					
Introduction to Cloud Computing, Characteristics of Cloud Computing, Software Virtualization, Containerizing applications, Virtual Machine Provisioning & Manageability, Cloud Deployment models, Introduction to IoT Platform, Cloud IoT Architecture, IoT Cloud Services, and Identity & Device Management.																					
Unit-2 - Cloud Modules and its Services																12 Hour					
Introduction to Core IoT Modules, IoT cloud platforms like Open Shift & Kaa, Monitoring cloud services, Benefits & limitations, Deploy application over cloud, IoT Modules-A connected ecosystem, IoT Vs Machine-to-Machine (M2M) Vs SCADA, Metcalfe's law and Beckstrom's laws.																					
Unit-3 - Cloud Policies and Mechanism																12 Hour					
Policies and Mechanisms for Resource Management, Stability of a Two-Level Resource Allocation Architecture, A Utility-Based Model for Cloud-Based Web Services, Resource Bundling: Combinatorial Auctions for Cloud Resources, Scheduling Algorithms for Computing Clouds, Resource Management and Dynamic Application Scaling, Architectural Styles for Cloud Applications, Existing Cloud Applications and Opportunities for New Applications.																					
Unit-4 - Security and Privacy of IoT																12 Hour					
Security and Impact of the Internet of Things (IoT) on Mobile Networks, Networking Function Security, IoT Networking Protocols, Secure IoT Lower Layers, Secure IoT Hig Layers, Secure Communication Links in IoTs. Back-end Security. Secure IoT Databases. Security Products-Existing Test bed on Security and Privacy of IoTs																					

Unit-5 - Protocols of IoT	12 Hour
Authentication in IoT, Computational Security for the IoT, Privacy-Preserving Time Series Data Aggregation, Secure Path Generation Scheme for Real-Time Green Internet of Things, Security Protocols for IoT Access Networks, Framework for Privacy and Trust in IoT, Policy-Based Approach for Informed Consent in Internet of Things, Network Robustness of Internet of Things and IoT security lifecycle.	

Lab Experiments	
1. Configure a VM instance in your local machine in cloud by creating a cloud account 2. Allocate CPU, Memory size and storage space as per a specified requirement of Cloud 3. Configure a Nested Virtual Machine (VM under another VM) in cloud and local machine 4. Implementation of cloud scheduling algorithms using CloudSim 5. Analyze cloud scheduling algorithms using OPNET 6. Performance of Cloud scheduling algorithms using Cloud analyst tool 7. Measure Cloud load balancing algorithms using Cloud Sim 8. Investigate Cloud load balancing algorithms using OPNET	9. Experiment Cloud load balancing algorithms using Cloud analyst tool 10. Evaluate IoT based home automation system 11. Exploit IoT based water level control system 12. Design a Factory automation using IoT 13. Assess Secure data communications between two IoT devices 14. Examine IoT based assistive device for aged persons Create an IoT based power automation system

Learning Resources	1. Rajkumar Buyya, "Cloud Computing Principles and Paradigms", Wiley & Sons publisher, 2010. 2. David E.Y Sarna, "Implementing and Developing Cloud Computing Applications", CRC Press, 2018. 3. Marco Schwartz, "Internet of Things with the Arduino Yun", Packt Publishing, 2014.	4. Whitehouse O, "Security of things: An implementers' guide to cyber-security for internet of things devices and beyond", 1st edition, NCC Group, 2014. 5. DaCosta, Francis, and Byron Henderson, "Rethinking the Internet of Things: a scalable approach to connecting everything", 1st edition, Springer Nature, 2013.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	20%	30%	-
Level 4	Analyze	30%	-	-	35%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. G. Pradeep, Intel @ FICE, Bangalore	1. Dr. Sudeepa Mishra, Indian Institute of Technology, Ropar, Punjab.	1. Dr. A. Suresh, SRMIST
2. Mr. Rajachozhan, Zoho Corp, Chennai	2. Dr. Subramanian Ganesan, Professor, Oakland University, USA.	2. Dr. V. Anbarasu. SRMIST

Course Code	21CSC315J	Course Name	FOG COMPUTING	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	0	2	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Relate the basic concepts and the need of fog computing	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Articulate the research challenges and opportunities in the Fog computing															
CLR-3:	Predict the basic knowledge in Integrating Fog, IoT & cloud															
CLR-4:	Grasp the infrastructure, middleware architectures and data management for Fog computing															
CLR-5:	Classify the knowledge of Fog in various applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Contrast fog computing and edge computing	-	-	3	2	2	-	-	-	-	-	-	-	-	2	3
CO-2:	Classify and address the research challenges in Fog Edge computing platform	-	-	3	3	2	-	-	-	-	-	-	-	-	2	3
CO-3:	Summarize the knowledge in integrating IoT, Cloud and Fog	-	-	3	-	2	-	-	-	-	-	-	-	-	2	3
CO-4:	Execute various data management techniques and design of middleware for Fog computing	-	-	3	-	2	-	-	-	-	-	-	-	-	2	3
CO-5:	Experiment the knowledge of Fog in the design of various application	-	-	3	2	2	-	-	-	-	-	-	-	-	2	3

Unit-1 - Introduction	12 Hour
Fog Computing Basics, Fog and Edge Computing Completing the Cloud, Hierarchy of Fog and Edge Computing, Business models, Opportunities and Challenges, Fog Computing Communication Technologies.	
Unit-2 - Addressing the Challenges in FEC	12 Hour
The Networking Challenges, The Management Challenges, Miscellaneous Challenges.	
Unit-3 - Foundation	12 Hour
Management and Orchestration of Network Slices in 5G, Fog, Edge, and Clouds: Background, Network Slicing in 5G, Network Slicing in Software-Defined Clouds, Network Slicing Management in Edge and Fog, Future Research Directions.	
Unit-4 - Middleware and Data Management	12 Hour
Introduction, Need for Fog and Edge Computing Middleware, Design Goals, State-of-the-Art Middleware Infrastructures, System Model, Proposed Architecture, Case Study Example. Data Management in Fog Computing, Future Research and Directions.	
Unit-5 - Application and Issues	12 Hour
Fog Computing Realization for Big Data Analytics, Data Analytics in the Fog, Prototypes and Evaluation. Case Study 1: Fog Computing in E-Health Monitoring. Case Study 2: Intelligent Traffic Lights Management (ITLM) System.	

Lab Experiments Lab 1: iFog Simulator installation and configuration setup. Lab 2: Implementation of Fog Nodes with different configuration set up. Lab 3: Demonstration on various fog simulators. Lab 4: Implementation of application models using iFog. Lab 5: Simulation of application models using iFog Master Worker application models. Lab 6: Simulation of application models using iFog Master Sequential Unidirectional application model. Lab 7: Design of sensor nodes and simulate with different tuple emission rates. Lab 8: Design of mobile edge node using iFog.	Lab 9: Connection of lower-level fog device with Gateway. Lab 10: Simulation of clustering in fog nodes Lab 11: A Case Study – Scheduling in Fog Computing Lab 12: A Case Study - Computational Offloading in Fog Computing Lab 13: A Case Study - Security and Privacy in Fog Computing Lab 14: A Case Study - Cloud-fog Collaborations Lab 15: A Case Study – Green Fog Computing
--	---

Learning Resources	1. Rajkumar Buyya and Satish Narayana Srirama, "Fog and Edge Computing Principles and Paradigms", Wiley Series on Parallel and Distributed Computing, 2019. 2. Assad Abbas, Samee U. Khan, and Albert Y. Zomaya, "Fog Computing: Theory and Practice", Wiley Series on Parallel and Distributed Computing, 2020.	3. Amir Vahid Dastjerdi and Rajkumar Buyya, "Fog Computing: Helping the Internet of Things Realize its Potential", University of Melbourne, 2016. 4. Sudip Misra, Subhadeep Sarkar and Subarna Chatterjee, "Sensors, Cloud, and Fog: The Enabling Technologies for the Internet of Things", CRC Press, 2019.
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	20%	30%	-
Level 4	Analyze	30%	-	-	35%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Vignesh, TCS, Bangalore	1. Dr. Arulprakash, Professor, IIT Madras	1. Dr. V Anbarasu, SRMIST
2. Mr. Rajachozhan, Zoho Corp, Chennai	2. Dr. Raju Abraham, NIOT, Chennai	2. Dr. A. Suresh. SRMIST

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSE264T	Course Name	INTRODUCTION TO IOT: SENSORS, ACTUATORS AND MICROCONTROLLERS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Recognize the basic concepts of IoT and applications	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Recollect the fundamentals of sensors and actuators, their characteristics, and various classification of sensors and actuators															
CLR-3:	Identify about various classification of sensors and actuators															
CLR-4:	Articulate the basics of Interfacing devices and microcontrollers															
CLR-5:	Utilize on IoT based applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Recollect the fundamental concepts in IoT.	-	-	3	2	-	-	-	-	-	-	-	-	2	2	-
CO-2:	Determine the performance characteristics of sensors and actuators.	-	-	3	2	-	-	-	-	-	-	-	-	2	2	-
CO-3:	Classify the different sensors and actuators used in IoT.	-	-	3	2	-	-	-	-	-	-	-	-	2	2	-
CO-4:	Categorize the Interfacing methods, circuits and controllers used in IoT applications.	-	-	3	2	-	-	-	-	-	-	-	-	2	2	-
CO-5:	Solve IoT based Applications.	-	-	3	2	-	-	-	-	-	-	-	-	2	2	-

Unit-1 - Introduction to IoT	9 Hour
Introduction – Physical Design of IoT - Logical Design of IoT – IoT Enabling Technologies – IoT Levels & Deployment Templates – Domain Specific IoTs – Home Automation – Cities - - Environment – Energy – Retail – Logistics – Agriculture – Industry – Health & Lifestyle.	
Unit-2 - Sensors and Actuators	9 Hour
Definitions - Classification of Sensors and Actuators – Gathering Requirements for Interfacing – Performance Characteristics of Sensors and Actuators: Input and Output Characteristics – Temperature Sensors and Thermal Actuators – Optical Sensors and Actuators – Electric and Magnetic Sensors and Actuators.	
Unit-3 - Classification of Sensors and Actuators	9 Hour
Mechanical Sensors and Actuators – Acoustic Sensors and Actuators – Chemical Sensor and Actuators – Radiation Sensors and Actuators – MEMS and Smart Sensors: Production of MEMS – MEMS Sensors and Actuators – Smart Sensors and Actuators – Sensor Networks.	
Unit-4 - Microcontrollers	9 Hour
Interfacing Methods and Circuits – Amplifiers, Digital Circuits, Bridge Circuits, Data Transmission, Excitation Methods, and Circuits – Interfacing to Microprocessors: General Purpose Controller, General requirements for interfacing sensors and actuators - ESP8266, Node MCU, TI-CC3200, Access point and station point mode, HTTP, MQTT, transmission and receiving, Intel-Gallileo boards.	
Unit-5 - IoT Applications	9 Hour
Application Domains of IoT – IoT based Smart Home Framework – IoT and Health care – IoT and Smart Mobility – Car Parking System – Major Instances of Crop Growth and IoT - IoT Architecture of Smart Agriculture – Smart Grid – IoT-based Smart Cities – IoT and Smart Education	

Learning Resources	<ol style="list-style-type: none"> 1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things, A Hands -on Approach", 1st Edition, Vpt Publisher, 2014. 2. Nathan Ida, "Sensors, Actuators, and their Interfaces: A multidisciplinary Introduction", Institution of Engineering and Technology Publishing, 2020. 3. Jacob Fraden, "Handbook of Modern Sensors: Physics, Designs, and Applications", Springer International Publishing, 2015. 4. Agus Kurniawan, "Smart Internet of Things Projects", Packt publishing, 2016. 5. Peter Waher, "Learning Internet of Things", Packt publishing, 2015. 6. Muhammad Azhar Iqbal, Sajjad Hussain, Huanlai Xing and Muhammad Ali Imran, "Enabling the Internet of Things: Fundamentals, Design and Applications", Wiley Publications, 2021.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	35%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Rajachozhan, Zoho Corp, Chennai	1. Dr. B. Surendiran, NIT, Puducherry	1. Ms. P. Mahalakshmi, SRMIST
2. Mr. Adarsh B, IoT Domain Expert, Happiest Mind Technologies, Hyderabad.	2. Dr. Nagendra Kumar S, Associate Professor, University of Hyderabad, Telangana	2. Dr. A. Suresh. SRMIST

Course Code	21CSE265T	Course Name	INTRODUCTION TO EMBEDDED PROGRAMMING AND EMBEDDED OS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Identify the basics of Embedded Programming and GNU C Programming Tool Chain in Linux	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Solve program using Embedded C and Micro Python for Embedded programming															
CLR-3:	Articulate basic open-source software, packages, and simulation tools															
CLR-4:	Recognize Embedded programming on open-source boards															
CLR-5:	Define Embedded Operating systems and its importance in Embedded product design															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Classify and demonstrate expertise on C programming tool chain	-	-	3	2	-	-	-	-	-	-	-	-	3	3	-
CO-2:	Perceive to write python codes for Embedded applications	-	-	3	2	-	-	-	-	-	-	-	-	3	3	-
CO-3:	Demonstrate the knowledge acquired can choose and apply appropriate Operating systems for the context of requirement	-	-	3	2	-	-	-	-	-	-	-	-	3	3	-
CO-4:	Convert in programming with logical acumen the open-source boards for any problem in Embedded industries	-	-	3	2	-	-	-	-	-	-	-	-	3	3	-
CO-5:	Extend the required programming skills that enhances their chances of employability in Embedded and IoT Industries	-	-	3	2	-	-	-	-	-	-	-	-	3	3	-

Unit-1 - Introduction to Embedded Programming and GNU C Programming tool chain	9 Hour
Introduce Object oriented programming with C: Basic skeleton, Header libraries for projects, ports, preprocess, basic sample codes; Steps of compilation; Handling time constraints: create delays (Hardware and Software) - timeout mechanism: loops and hardware - Introduction to GCC - Debugging with GDB - The Make utility - GNU Configure and Build System - GNU Binary utilities - Profiling - using gprof - Introduction to GNU C Library	
Unit-2 - Introduction to Python programming on open-source board for Embedded Systems	9 Hour
Introduction to basic Python programming: Variables, Basic operators, reading input from user, Basic datatypes, Conditional and control statement -Introduce basic open-source hardware: Arduino (or any recent version including NodeMCU), Raspberry Pi, PyBoard; Introduce basic port programming with Raspberry Pi/Arduino/NodeMCU for Embedded application;	
Unit-3 - Introduction to Micro Python for Embedded Systems	9 Hour
Introduction to Micro Python programming: High level comparison on Python standard libraries and micro-libraries, MicroPython-specific libraries, Port-specific libraries; Micro python on Microcontrollers; Micro Python programming with PyBoard and Node MCU	
Unit-4 - Introduction to Simulation tools for Embedded development	9 Hour
Introduction to Matlab; Embedded Programming with Matlab: Building Arduino/Raspberry Pi/ESP8266(NodeMCU) with Matlab, Introduce and demo using Embedded MATLAB Mex; Introduction to Proteus: Basic programming with Proteus and Raspberry Pi (or any open-source hardware)	

Unit-5 - Introduction to Embedded Operating Systems	9 Hour
<i>Embedded Operating systems: Introduction, Types, Characteristics, Advantages and Disadvantages; Introduction to Real time operating systems (RTOS), Task Scheduling, Survey of RTOS</i>	

Learning Resources	<ol style="list-style-type: none"> 1. Michael J Pont, "Embedded C", Pearson Education, 2007. 2. Barr, "Programming Embedded Systems: With C and GNU Development Tools", Second Edition, O'Reilly Publishers, 2006 3. Nicholas H. Tollervey, "Programming with Micro Python: Embedded Programming with Microcontrollers and Python", O'Reilly Publishers, 2017 4. https://www.labcenter.com/raspberry_pi/ 5. K.C. Wang, "Embedded and Real-Time Operating Systems", Springer International Publishing, 2017.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	35%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Thirukkumaran Raman, Head – R&D, IIoT COE, Chools Group, Bangalore	1. Dr. Manju Khari, Jawaharlal Nehru University, New Delhi	1. Dr. Kayalvizhi Jayavel, SRMIST
2. Mr. Rajachozhan, Zoho Corp, Chennai	2. Dr. T. M. Thasleema, Professor, Department of CSE, Central University of Kerala.	2. Dr. R. Kayalvizhi, SRMIST

Course Code	21CSE266T	Course Name	INTERNET OF THINGS ARCHITECTURE AND PROTOCOLS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Identify M2M & IoT analytics along with IoT and its applications	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Solve IoT Technical design constraints and its interaction with remote control															
CLR-3:	Recognize knowledge of different layers in IP based and Web communication protocols															
CLR-4:	Label the Transport Layer protocols in depth and Cloud based services															
CLR-5:	State the real-world problems in IoT															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Outline the essentials of IoT and its applications.	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-
CO-2:	Summarize IoT Architecture Reference model and its control.	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-
CO-3:	Examine the IP based protocols and Authentication Protocols for IoT	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-
CO-4:	Handle different layered protocols in IoT and cloud-based services.	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-
CO-5:	Experiment real world problems in IoT with Arduino and Raspberry Pi	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-

Unit-1 - Architecture and Framework of IoT	9 Hour
IoT- An Architectural Overview, Applications of IoT, IoT Conceptual framework, Design Principles, Standards and Considerations, M2M fundamentals, IoT Technologies, M2M and IoT analytics, Challenges of IOT and Sources of IoT.	
Unit-2 - Standardization of IoT	9 Hour
IoT/M2M System layers, Design Standardization, The IoT Architectural Reference Model as Enabler, IoT in Practice, IoT in Logistics and Health, Functional and communication models, Real-World Design Constraints, Technical Design constraints and Interaction and remote control.	
Unit-3 - Authentication and Communication	9 Hour
Web communication protocols for connected devices, Message communication protocols for connected devices, web connectivity for connected-devices network using gateway Internet connectivity principles, IP addressing in IoT, Proxy authentication, Media Access control, Application Layer Protocols and Zigbee smart energy.	
Unit-4 - Cloud based Services in IoT	9 Hour
Transport layer: SCTP-TLS, DCCP, Data acquiring and storage, Organizing the data, Knowledge Acquiring, Managing and Storing processes, Cloud computing paradigm for data collection, IoT cloud-based services and Data enrichment.	
Unit-5 - IoT Devices in Real Time Scenario	9 Hour
Security in IoT Protocols, Radio frequency identification technology, Wireless Sensor Networks, Introduction to Arduino, Arduino IDE, Node MCU, Introduction to Raspberry Pi, 6LoWPAN and RPL	

Learning Resources	1. Pethuru Raj and Anupama C. Raman "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017	4. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, and Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISO Press, 2017.
	2. Arshdeep Bahga and Vijay Madisetti "Internet of Things: A Hands-on Approach", Universities Press, 2015.	5. Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stefan Avesand, Stamatis Kamouskos and David Boyle, "From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence", 1st Edition, Academic Press, 2014.
3. Qusay F. Hassan, "Internet of Things A to Z: Technologies and Applications", John Wiley & Sons, 2018.		

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	35%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers			
Experts from Industry		Experts from Higher Technical Institutions	Internal Experts
1. Mr. G. Pradeep, Intel @ FICE, Bangalore		1. Dr. Sudeepta Mishra, Indian Institute of Technology, Ropar, Punjab	1. Dr. A. Suresh, SRMIST
2. Mr. Adarsh B, Happiest Minds Technologies, Hyderabad		2. Dr. P. Rajesh, Professor, Central University of Kerala.	2. Dr. C. Malathy, SRMIST

Course Code	21CSE365T	Course Name	MACHINE LEARNING FOR IoT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	Restate the basic theory underlying machine learning.												
CLR-2:	Recognize the general concepts of Internet of Things and recognize various devices, sensors, and applications												
CLR-3:	Grasp machine learning algorithms to solve problems of moderate complexity.												
CLR-4:	Articulate to design, build, and integrate IoT platforms, incorporating different types of sensors, actuators, and machine learning methods												
CLR-5:	Define the current requirements of applied machine learning with IoT and the issues raised by current research												
Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	Summarize the basic theory underlying machine learning.												
CO-2:	Solve general concepts of Internet of Things and recognize various devices, sensors, and applications												
CO-3:	Analyze machine learning algorithms to solve problems of moderate complexity.												
CO-4:	Estimate to build and integrate IoT platforms, incorporating different types of sensors, actuators, and machine learning methods.												
CO-5:	Differentiate the framework for current requirements of applied machine learning with IoT and the issues raised by current research												

Program Outcomes (PO)												Program Specific outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3

Unit-1 - Machine learning and its Models	9 Hour
Introduction to Machine Learning: Definition of learning systems, Goals and applications of machine learning, Aspects of developing a learning system: training data, concept representation, Role of machine intelligence in IoT, Machine Learning Models: Bayesian classifiers, Nearest-neighbor classifiers, Linear and Polynomial classifiers, Random forests, Decision trees, Support vector machines, Dimensionality reduction methods, K-mean clustering, Artificial neural networks, Deep neural networks	
Unit-2 - IoT- Data analytics	9 Hour
Internet of Things: Data Analytics, IoT analytics challenges, IoT data acquisition, Data Exploration and Pre-processing, IoT technologies, Architecture and Networking protocols, IoT Communication Technologies, Devices and Gateways	
Unit-3 - Sensor & Actuators	9 Hour
Overview of Sensors working, Analog and Digital Sensors, Interfacing of Temperature, Humidity, Motion, Light and Gas Sensor with Arduino, Interfacing of Actuators with Arduino, Interfacing of Relay Switch and Servo Motor with Arduino	
Unit-4 - Computing Framework	9 Hour
Fog computing, Edge computing, Cloud computing, Characteristics of Cloud Computing, Driving factors towards cloud, Architecture, Role of Networks in Cloud computing, protocols used, Role of Web services, Service Models: IaaS, PaaS, SaaS, NaaS, Cloud Clients, Deployment Models: Public Clouds, Community Clouds, Hybrid Cloud, Private Cloud, Issues in Cloud Computing, Applications, Distributed computing.	

Unit-5 - Machine learning applications with IoT **9 Hour**

Applications of Machine learning in smart cities: Use cases - Smart energy, Smart mobility, Smart citizens, Urban planning, Smart city data characteristics, and applied machine learning algorithms to Internet of Things use cases.

Learning Resources	<ol style="list-style-type: none"> 1. Vijay Madisetti and Arshdeep Bahga, "Internet of Things: A Hands-on Approach", University Press, 2014. 2. C.M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006. J. Watt, R. Borhani, and A. K. Katsaggelos "Machine Learning Refined: Foundations, Algorithms and Applications", 1st Edition, Cambridge University Press, 2016. 3. Andrew Minter "Analytics for the Internet of Things (IoT) Intelligent Analytics for your Intelligent Devices", Packet Publishing, 2017. 4. Madhumathy P, M Vinoth Kumar and R. Umamaheswari "Machine Learning and IoT for Intelligent Systems and Smart Applications," CRC Press, 2021. 5. D. Barber, "Bayesian Reasoning and Machine Learning", Cambridge University Press, 2012. 6. Michael Stanley and Jongmin Lee "Sensor Analysis for the Internet of Things", Morgan & Claypool Publishers, 2018. 7. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill, 2017. 8. Cuno Pfister, "Getting Started with the Internet of Things", O'Reilly Media, 2011.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	35%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Vignesh, TCS, Bangalore	1. Dr. E. Ilavarasan, Puducherry Technological University, Puducherry.	1. Dr. M. Shobana, SRMIST
2. Mr. Adarsh B, Happiest Minds Technologies, Hyderabad	2. Dr. T. M. Thasleema, Professor, Department of CSE, Central University of Kerala.	2. Dr. A. Suresh. SRMIST

Course Code	21CSE366T	Course Name	INTRODUCTION TO CLOUD APPLICATION DEVELOPMENT FOR IoT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Compare the concepts of cloud computing	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Perceive the basic knowledge on developing cloud applications.															
CLR-3:	Define the concepts of Internet of Things															
CLR-4:	State the knowledge on integrating cloud in IoT platform															
CLR-5:	Outline the smart computing of developed IoT applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Memorize the cloud computing services and their models	-	-	3	2	-	-	-	-	-	-	-	-	-	3	3
CO-2:	Distinguish the different applications in the cloud environment.	-	-	3	2	-	-	-	-	-	-	-	-	-	3	3
CO-3:	Examine the architecture of IoT and identify the challenges	-	-	3	2	-	-	-	-	-	-	-	-	-	3	3
CO-4:	Implement the concept of IoT cloud convergence in Azure cloud environment	-	-	3	2	-	-	-	-	-	-	-	-	-	3	3
CO-5:	Demonstrate the cloud-based IoT applications in various domains	-	-	3	2	-	-	-	-	-	-	-	-	-	3	3

Unit-1 - Introduction to Cloud Computing	9 Hour
Introduction – Characteristics of Cloud Computing – Cloud Models – Service Models, Deployment Models - Cloud Service Examples – IaaS – PaaS – SaaS - Cloud-based Services and Applications - Cloud Concepts and Technologies.	
Unit-2 - Developing for Cloud	9 Hour
Cloud services and Platforms - Cloud Application Design - Design considerations for cloud applications - Reference Architectures for Cloud Applications - Cloud Application Design Methodologies - Data Storage Approaches – Cloud Application Development in Python	
Unit-3 - Introduction to IoT	9 Hour
Overview of IoT – IoT Architecture – Smart Computing – IoT Design: Issues and Challenges – Internet of Things Application Development – Application Development Phases – Wireless Technologies for IoT – Protocol Stack – Electronic Platforms – Developing IoT Applications	
Unit-4 - IoT Cloud Convergence	9 Hour
Introduction-Opportunities and Challenges – Architecture for Convergence – Data Offloading and Computation: An IoT Perspective – Dynamic Resource Provisioning – Security aspects in IoT Cloud Convergence - Test Beds and Technologies – Developing IoT Applications in Azure.	
Unit-5 - Smart Computing over IoT - Cloud	9 Hour
Introduction-Big Data Analytics and Cognitive Computing – Deep Learning Approaches – Algorithms, Methods, and Techniques, Case Studies, Enterprise Use Cases for Digital Transformation: Oil and gas industry transformation – License management system – Smart Campus	

Learning Resources	1. Arshdeep Bahga and Vijay Madisetti, "Cloud Computing: A Hands-On Approach", University Press, 2016.	3. Rekha Kodali, Dr. Gopala Krishna Behara, Sankara Narayanan Govindarajulu "Developing Cloud Native Applications in Azure using, NET Core," BPB Publications, 2020.
	2. Parikshit N. Mahalle, Nancy Ambritta P., Gitanjali Rahul Shinde, and Arvind Vinayak Deshpande, "The Convergence of Internet of Things and Cloud for Smart Computing", Newgen Publishing UK, 2022.	4. Monika Mangla, Suneeta Satpathy, Bhagirathi Nayak and Sachi Nandan Mohanty, "Integration of Cloud Computing with Internet of Things", Willey Publications, 2021.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	35%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Thirukkumaran Raman, IIOT COE, Chools Group, Bangalore	1. Dr. P. Anandhakumar, Anna University, MIT Campus, Chennai	1. Dr. S. Thenmalar, SRMIST
2. Mr. Adarsh B, Happiest Minds Technologies, Hyderabad	2. Dr. E. Ilavarasan, Puducherry Technological University, Puducherry.	2. Dr. A. Suresh. SRMIST

Course Code	21CSE367T	Course Name	IoT FORENSICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Sense the software vulnerabilities and security solutions to reduce the risk of exploitation in the IoT Devices.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	State the performance and troubleshoot cyber security systems.															
CLR-3:	Classify and execute risk management processes, risk treatment methods, and key risk and performance indicators															
CLR-4:	Articulate knowledge to secure corrupted systems, protect personal data, and secure computer networks in an organization.															
CLR-5:	Perceive with an expertise in academics to design and implement security solutions.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Identify the cyber security needs of an organization.	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-
CO-2:	Recite key terms and concepts in Cryptography, Governance and Compliance.	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-
CO-3:	Practice cyber security solutions and use of cyber security, information assurance, and cyber/computer forensics software/tools.	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-
CO-4:	Understand IoT security architecture and investigate cybercrime issues.	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-
CO-5:	Analyze the importance of IoT security in future and in agile development.	-	3	3	-	-	-	-	-	-	-	-	-	2	2	-

Unit-1 - Overview of Digital Forensics	9 Hour
Introduction to Digital Forensics, branches of digital forensics, digital evidence, Types of Evidence, Chain of custody, types of Cyber Crime, types of cyber criminals, crime scene management, evidence collection techniques - Switched Off System, Live System, Live response and triage-based acquisition techniques, order of volatility.	
Unit-2 - Evidence Collection	9 Hour
Analysis of evidence, concept of imaging and cloning, file formats of forensic images, concept of write blocker, Hardware and Software Write blocker, Hash Function, fuzzy hash and hash collision, data recovery, tools for image creation and analysis.	
Unit-3 - File Artifacts	9 Hour
MFT analysis, recycle bin forensics, i30 analysis, other NTFS artifacts - data, UsnJrnl, amcache, shimcache, shellbags, Ink files, jump lists, USB, and Bring Your Own Device (BYOD) Forensic Examinations, Incident response procedure, browser forensics, printer artifacts, yellow dot concept in printer forensics.	
Unit-4 - IoT Device Architecture	9 Hour
Introduction to Internet of Things, IoT Architecture, Characteristics of IoT, IoT Security Challenges and Factors of Threat, Effects of IoT Security Breach, Role of Digital Forensics in Cybercrime Investigation for IoT, IoT in Digital Forensic, Digital Forensics Investigation Framework for IoT Devices, Road Map for Issues in IoT Forensics, IoT Security Steps, How to Access IoT Security.	

Unit-5 - IoT Security	9 Hour
Introduction to IoT Sensors: Security in Network Forensics, Cybersecurity Versus IoT Security and Cyber-Physical Systems , The IoT of the Future and the Need to Secure , The Future—Cognitive Systems and the IoT , Security Engineering for IoT Development , Building Security Into Design and Development , Security in Agile Developments , Focusing on the IoT Device in Operation , Cryptographic Fundamentals for IoT Security Engineering , Types and Uses of Cryptographic Primitives in the IoT , Encryption and Decryption , Symmetric Encryption , Asymmetric Encryption , Digital Signatures.	

Learning Resources	<ol style="list-style-type: none"> 1. Darren R. Hayes, "A Practical Guide to Computer Forensics Investigations", Pearson Publisher, 2014. 2. Eoghan Casey, "Digital Evidence and Computer Crime: Forensic Science, Computers and Book", 3rd Edition, Academic press, 2011. Eoghan Casey, "Handbook of Digital Forensics and Investigation", Academic press, 2009. 3. Michael Hale Ligh, Andrew Case, Jamie Levy, A. Aron Walters "The Art of Memory Forensics: Detecting Malware and Threats in Windows, Linux, and Mac Memory", 1st Edition, John Wiley&Sons, 2014. 4. Amelia Phillips, Bill Nelson, and Christopher Steuart, "Guide to Computer Forensics and Investigations", Fifth Edition, Cengage Learning, 2015. 5. Rohatgi, Shipra, and Sakshi Shrivastava, "A Generic Digital Scientific Examination System for Internet of Things", 6. Digital Forensics and Internet of Things: Impact and Challenges, pp: 87-110, Wiley, 2022. 7. Karthika. D, "IoT Sensors: Security in Network Forensics," Digital Forensics and Internet of Things: Impact and 8. Challenges, pp: 111-129, Wiley, 2022.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	35%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Anand Gurupatham, Renault Nissan, Chennai	1. Dr. Arulprakash, Professor, IIT Madras	1. Dr. C.N.S. Vinoth Kumar, SRMIST
2. Dr. Saravanan, Mahindra & Mahindra, Chennai	2. Dr. Raju Abraham, NIOT, Chennai	2. Dr. P. Madhavan. SRMIST

Course Code	21CSE368J	Course Name	NETWORK PROGRAMMING FOR IoT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing		Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:
CLR-1:	Articulate strong Practical skill on Raspberry Pi	
CLR-2:	Identify the Python programming Environment for Raspberry Pi	
CLR-3:	Perceive the basics of Cloud for IOT	
CLR-4:	Implement Raspberry with the networks	
CLR-5:	Engage small projects using IOT devices	
Course Outcomes (CO):		At the end of this course, learners will be able to:
CO-1:	Hands on Hardware interfacing with Raspberry Pi	
CO-2:	Configuration of Python on Raspberry Pi	
CO-3:	Practice AWS for IoT	
CO-4:	Implement the Networking of Raspberry Pi	
CO-5:	Analyze and Demonstrate Real – time IoT systems with Python and Java	

Unit-1 - Raspberry Pi	12 Hour
Introduction to Raspberry Pi: Getting Started with Raspberry Pi: Basic functionality of Raspberry Pi, setting up the board, booting Raspberry Pi 3, Downloading an Operating System, format an SD card and booting the OS, Interfacing Hardware with the Raspberry Pi, Raspberry Pi Remote Access, Bash Command line.	
Unit-2 - Python for IOT	12 Hour
Python: Basics of Python programming language: Programming on the Raspberry Pi. Python on Raspberry Pi, Python Programming Environment - Micro Python: Features, Limitations, Experimenting with Python on PC, Installing Python 3 on Windows 10, Running the Python Console, Running Python Programs with the Interpreter.	
Unit-3 - Cloud Storage for IOT	12 Hour
Introduction - Communication API - WAMP: AutoBahn for IoT - Xively Cloud for IoT - Python Web Application Framework: Django - Amazon Web Services for IoT - Case Studies: Weather Monitoring system.	
Unit-4 - Powering Pi	12 Hour
Installing Raspbian – formatting SD Cards – Connecting Raspberry Pi – Networking your Raspberry Pi, via Wireless Network – Creating Simple Raspberry Pi Application	
Unit-5 - Case Study Projects	12 Hour
NetBeans – Introduction. Downloading and Configuring NetBeans. Revisiting Hello Raspberry Pi - Binary Timer – IOT Hat – Building Motion Activated Alarm System with Python	

Lab Experiments	
1.	Installation and Booting of Raspberry Pi
2.	Interfacing Raspberry Pi with the Operating System
3.	Sensing the available networks
4.	Basics commands in Raspberry Pi
5.	Python Programming on Raspberry Pi
6.	Expressions, Functions, Strings
7.	Sense the Finger using Raspberry Pi
8.	Temperature Notification using Raspberry Pi
9.	MySQL Database Installation in Raspberry Pi
10.	SQL Queries by Fetching Data from Database in Raspberry Pi
11.	Switch Light on and Off Based on the Input of User Using Raspberry Pi
12.	Connecting Raspberry Pi through Wireless Networks
13.	Downloading and configuring NetBeans
14.	Weather Monitoring System
15.	Mini - Project

Learning Resources	Learning Resources	
	1. Simon Monk, "Programming the Raspberry Pi: Getting Started with Python", McGraw Hill Professional, 2012	3. Stephen Chin and James L Weaver, "Raspberry Pi with Java: Programming the Internet of Things (IoT)", McGraw-Hill, 2015
	2. Charles Bell, "Micro Python for the Internet of Things, A Beginner's Guide to Programming with Python on Microcontrollers", Apress, 2017.	4. Jason Van Schooneveld, "Build Physical Projects with Python on the Raspberry Pi", 2020. https://realpython.com/python-raspberry-pi/

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	20%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	15%	-	-
Level 6	Create	-	-	-	05%	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Anand Gurupatham, Renault Nissan, Chennai	1. Dr. Arulprakash, Professor, IIT Madras	1. Dr. S. Thanga Revathi, SRMIST
2. Dr. Saravanan, Mahindra & Mahindra, Chennai	2. Dr. Raju Abraham, NIOT, Chennai	2. Dr. Mary Subaja Christo, SRMIST

Course Code	21CSE369J	Course Name	INTRODUCTION TO SECURITY OF INTERNET OF THINGS AND CYBER-PHYSICAL SYSTEMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Restate the basics of security challenges for IoT and Cyber Physical Systems	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Recognize about the IoT Economy and the Need for IoT Security															
CLR-3:	State the Secured IoT Systems Architectures															
CLR-4:	Define the secured connectivity in IoT Systems															
CLR-5:	Articulate towards Privacy and Access Control for IoT Security															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Outline the security challenges in IoT and CPS Platforms	-	-	3	2	-	-	-	-	-	-	-	-	-	3	3
CO-2:	Report the importance of IoT security in IoT Economy	-	-	3	2	-	-	-	-	-	-	-	-	-	3	3
CO-3:	Examine the Various Architectures in the IoT Systems	-	-	3	2	-	-	-	-	-	-	-	-	-	3	3
CO-4:	Classify the communication protocols and analyze their security concerns in Industrial IoT	-	-	3	2	-	-	-	-	-	-	-	-	-	3	3
CO-5:	Investigate the privacy and Access control in IoT Systems	-	-	3	2	-	-	-	-	-	-	-	-	-	3	3

Unit-1 - Security Challenges in IoT and Cyber Physical Systems	12 Hour
IoT Architectures, Properties and Security Requirements – Constrained Application Protocol – Datagram Transport Layer Security – Cyber Physical Systems (CPS) and Communications – CPS Models and Security Aspects – CPS Security Threats	
Unit-2 - IoT Economy and Need for IoT Security	12 Hour
IoT System – IoT Components and Need for Security – Analyzing the Mirai Attack – Defending IoT Castle – Attacking IoT Castle and Breach Consequences – Understanding the IoT Economy and Cybercriminal Economy – Cryptocurrency and where Cybercriminal go to hide	
Unit-3 - Architecting Secured IoT Systems	12 Hour
IoT System Architecture – IoT: Low-Cost System – IoT Architecture Layers – Fundamental Cloud Architecture and Security Architecture in IoT Systems – Security Architecture Process – Security Concerns of Industrial IoT	
Unit-4 - Secure Connections	12 Hour
Connectivity in IoT – IoT Communication Protocol Classifications – Network Security for IoT – Security Analysis for Protocols – AI and IoT Unite – Safe Driving App meets Smart Fridge	
Unit-5 - Privacy and Access Control	12Hour
Information Privacy – Personal Information and Personal Knowledge – Privacy Controls – Privacy Legislations –Challenges of IoT Security Usability – Principles for Designing Usable IoT Security Controls	

Lab Experiments	
1.	Wireshark filters and PCAP inspection
2.	Nmap scan of an IoT device and exploitation with Metasploit
3.	Burp Suite interception on IoT web portal for exposed secrets
4.	Using Postman to send password data to an IoT API
5.	Exploiting an IoT portal for consumer-grade devices
6.	Injecting commands into vulnerable IoT web services
7.	Obtaining and analyzing Specification Sheets
8.	Sniffing serial and SPI
9.	Recovering firmware from PCAP
10.	Recovering filesystems with binwalk
11.	Pillaging the filesystem
12.	WiFi PSK cracking
13.	BLE device interaction
14.	Zigbee traffic capture
15.	Conducting a replay transmission attack on IoT

Learning Resources	Learning Resources	
	1. Song Guo, Deze Zeng, "Cyber-Physical Systems: Architecture, Security and Application," Springer, First Edition, 2019	4. Roshani Raut, Sandeep Kautish, Zdzislaw Polkowski, Anil Kumar, Chuan-Ming Liu, "Green Internet of Things and Machine Learning,"
	2. David M Wheeler Damilare D Fagbemi and JC Wheeler, "The IoT Architect's Guide to Attainable Security and Privacy," CRC Press Taylor & Francis Group, First Edition, 2020.	5. Scrivener Publishing, Wiley, 2022.
		6. Anand Tamboli, "Build Your Own IoT Platform Develop a Flexible and Scalable Internet of Things Platform", Second Edition, Apress, 2022.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	20%	30%	-
Level 4	Analyze	30%	-	-	35%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. R. Lenin Babu, Conversight.Ai, USA,	1. Dr. K. Selvakumar, Professor, Annamalai University,	1. Dr. C. Rajesh Babu, SRMIST
2. Mr. U. Aravind Kumar, JPA Solutions, Bangalore,	2. Dr. K. G. Srinivasa, Professor, NITTR Chandigarh,	2. Dr. B. Balakiruthiga, SRMIST

Course Code	21CSE370J	Course Name	DATA VISUALIZATION FOR IoT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Relate the various types of data, apply, and evaluate the principles of data visualization	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Convert skills to visualization Techniques to a problem	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Retrieve structured approach to create effective visualization																	
CLR-4:	Extend valuable insight from the massive dataset using visualization																	
CLR-5:	Label interactive visualization for better insight using visualization tools																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	List the different data types, visualization types to bring out the insight and create, interpret plots	-	3	-	2	-	-	-	-	-	-	-	-	2	2	-		
CO-2:	Interpret the visualization towards the problem based on the dataset to bring out valuable insight.	-	3	-	2	-	-	-	-	-	-	-	-	2	2	-		
CO-3:	Demonstrate the analysis of a large dataset using various visualization techniques and tools.	-	3	-	-	2	-	-	-	-	-	-	-	2	2	-		
CO-4:	Solve the streaming visualization Techniques for large scale data	-	3	-	2	-	-	-	-	-	-	-	-	2	2	-		
CO-5:	Categorize various visualizations for geospatial and to Design visualization dashboard.	-	-	3	2	-	-	-	-	-	-	-	-	2	2	-		

Unit-1 - Introduction to Data Visualization and its Techniques	12Hour
Overview of data visualization -Data Abstraction - Task Abstraction - Analysis: Four Levels for Validation. Visualization Techniques- Scalarand Point techniques– Colormaps– Contouring–Height Plots-Vector visualization techniques–Vector properties–Vector Glyphs–Vector Color Coding–Matrix visualization techniques.	
Unit-2 - Visual Analysis and Types	12 Hour
VisualVariables-NetworksandTrees-MapColorandOtherChannels-ManipulateView-Heat Map. Time- Series data visualization – Text data visualization – Multivariate data visualization and case studies.	
Unit-3 - Visualization Tools & Techniques	12 Hour
Introduction to various data visualization tools: R –basics, Data-preprocessing, Statistical analysis, Plotly and ggplot library, Tableau, D3.js, Gephi.	
Unit-4 - Visualization of Streaming Data	12Hour
Best practices of Data Streaming, processing streaming data for visualization, presenting streaming data, streaming visualization techniques, streaming analysis.	
Unit-5 - Geo-Spatial Visualization and Dashboard Creations	12 Hour
Chloropleth map, Hexagonal Binning, Dotmap, Cluster map, cartogram map, Dashboard creation using visualization tools for the IOT related use case applications.	

Lab Experiments	
<ol style="list-style-type: none"> 1. A Study on R-programming tool 2. A study on the Data Visualization Techniques 3. Experiments on Acquiring and plotting data using R. 4. Perform Correlation regression and analysis of variance on a dataset and visualize the results 5. Explore Statistical Analysis- Multivariate Analysis 6. Explore on the various libraries used for Text processing and perform Text visualization 7. Perform PCA on a dataset and visualize the results 8. A study on Tableau and Gephi. Tools 9. Preparing and training data based on K-means clustering analysis using R 10. Using R programming deploy Histogram and Heat-map on a Streaming dataset and provide proper inference 11. Experiment on Time-series analysis for stock market dataset 12. Experiment on Visualization of massive dataset generated from IOT related applications 13. Experiment on Visualization on Streaming dataset such as Stock market dataset, weather forecasting 14. Perform effective visualization using Choropleth map, Dotmap, and Cluster map 15. Perform Dashboard creation for an IOT application using visualization tools 	

Learning Resources	Learning Resources	
	1. Tamara Munzer, "Visualization Analysis and Design", CRC Press, 2014.	4. Christian Toninski, Heidrun Schumann, "Interactive Visual Data Analysis", CRC press publication, 2020.
	2. Aragues Anthony, "Visualizing Streaming Data: Interactive Analysis Beyond Static Limits", O'Reilly Media, Inc., 2018.	5. Alexandru C. Telea, "Data Visualization: Principles and Practice", AK Peters, 2014.
	3. Dr. Chun-hauh Chen, W.K.Hardle, A. Unwin, "Hand book of Data Visualization", Springer publication, 2016.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	30%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Albert Rex, @HP Company, Chennai	1. Dr. Ameer, National Institute of Technology, Calicut	1. Dr. K. Nimala, SRMIST
2. Mr. Rajachozhan, Zoho Corp, Chennai	2. Dr. Raju Abraham, NIOT, Chennai	2. Mr. V. Nallarasan SRMIST

Course Code	21CSE371J	Course Name	IoT TECHNIQUES, TOOLS, AND ITS APPLICATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Restate the phases in developing a flexible and scalable IoT Platform	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Label the software defined approach to IoT															
CLR-3:	Conclude the IoT Eco Systems and Services															
CLR-4:	Grasp the role of Blockchain in IoT															
CLR-5:	Articulate towards Green IoT Applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Discuss and define IoT Eco-System	-	-	2	-	3	-	-	-	-	-	-	-	-	3	3
CO-2:	Examine the IoT services and challenges	-	-	2	-	3	-	-	-	-	-	-	-	-	3	3
CO-3:	Exploit Blockchain and standards in IoT	-	-	2	-	3	-	-	-	-	-	-	-	-	3	3
CO-4:	Demonstrate Software Defined Internet of Everything in smart city	-	-	2	-	3	-	-	-	-	-	-	-	-	3	3
CO-5:	Summarize Green IoT Applications	-	-	2	-	3	-	-	-	-	-	-	-	-	3	3

Unit-1 - IoT Eco-Systems	12 Hour
IoT Reference Framework – OSI Model for IoT – IoT Requirements for Networking Protocols – IoT Protocol Stack: Link Layer and Internet Layer, IoT Protocol Stack: Application Protocols Layer, IoT Protocol Stack: Application Services Layer.	
Unit-2 - IoT Services and Challenges	12 Hour
IoT Services Platform and Manager – Manager Discovery and Communications Manager – Element, Firmware, Topology and Group Manager – IoT Security Challenges and Requirements – IoT Domain Architecture, Attacks and Countermeasures – IoT Verticals	
Unit-3 - Blockchain and Standards in IoT	12 Hour
Blockchain – Evolution and Anatomy of Blockchain – Features of Blockchain – Blockchain Applications in IoT – Blockchain Security in IoT – Industry Organizations and Standards Landscape	
Unit-4 - Software Defined Internet of Everything	12 Hour
Internet of Everything- Smart city Integrated Perspective – Traditional Network Architecture – SDN Network Architecture – Application Scenario Analysis – Architecture and Deployment Models of SDN Protocols - Network Policies for Internet of Everything	
Unit-5 - Green IoT	12 Hour
Green IoT and ML for Smart Computing – Machine Learning based Smart Applications- Lifecycle of Green IoT – Applications, Challenges and Opportunities for Green IoT – Machine Learning Enabled Techniques for Energy Consumption of IoT Devices – Energy Efficient Routing Infrastructure for Green Computing	

Lab Experiments	
<ol style="list-style-type: none"> 1. A Study on R-programming tool 2. A study on the Data Visualization Techniques 3. Experiments on Acquiring and plotting data using R. 4. Perform Correlation regression and analysis of variance on a dataset and visualize the results 5. Explore Statistical Analysis- Multivariate Analysis 6. Explore on the various libraries used for Text processing and perform Text visualization 7. Perform PCA on a dataset and visualize the results 8. A study on Tableau and Gephi. Tools 9. Preparing and training data based on K-means clustering analysis using R 10. Using R programming deploy Histogram and Heat-map on a Streaming dataset and provide proper inference 11. Experiment on Time-series analysis for stock market dataset 12. Experiment on Visualization of massive dataset generated from IOT related applications 13. Experiment on Visualization on Streaming dataset such as Stock market dataset, weather forecasting 14. Perform effective visualization using Choropleth map, Dotmap, and Cluster map 15. Perform Dashboard creation for an IOT application using visualization tools 	

Learning Resources	1. Ammar Rayes and Samer Salam, "Internet of Things from Hype to Reality", Third Edition, Springer, 2022	3. Roshani Raut, Sandeep Kautish, Zdzislaw Polkowski, Anil Kumar and Chuan-Ming Liu, "Green Internet of Things and Machine Learning", Scrivener Publishing, Wiley, 2022
	2. Gagangeet Singh Aujla, Sahil Garg Kuljeet Kaur and Biplab Sikdar, "Software Defined Internet of Everything", First Edition. Springer. 2022.	4. Anand Tamboli, "Build Your Own IoT Platform Develop a Flexible and Scalable Internet of Things Platform", Second Edition. Apress. 2022.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	30%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr R Lenin Babu, Conversight.Ai, USA,	1. Dr. K. Selvakumar, Professor, Annamalai University,	1. Dr. C. Rajesh Babu , SRMIST
2. Mr. U. Aravind Kumar, JPA Solutions, Bangalore,	2. Dr. K. G. Srinivasa, Professor, NITTR Chandigarh,	2. Dr. B. Balakiruthiga, SRMIST

Course Code	21CSE467T	Course Name	ADVANCED DATABASE SYSTEMS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Restate the Fundamentals of Internet of Things and its technologies and Distributed processing techniques for IoT	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Label the uses of Machine Learning in IoT, DL framework and cloud platforms for IoT.															
CLR-3:	State the deep learning applications for IoT, Image Recognition. Speech/ Voice Recognition															
CLR-4:	Articulate indoor localization and state detection techniques with available classifier.															
CLR-5:	Grasp deep learning techniques in real time examples.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Classify the basic theory underlying in Internet of Things.	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-
CO-2:	Describe the Deep learning techniques in IoT and its limitations	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-
CO-3:	Solve deep learning algorithms and problems of moderate complexity.	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-
CO-4:	Analyze Indoor Localization and IoT based human psychological and psychological state detection using Deep Learning Techniques.	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-
CO-5:	Investigate security attacks in IoT and detections, with real time examples.	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-

Unit-1 - Introduction	9 Hour
Internet of Things - Data Analytics, IoT analytics challenges, IoT data acquisition, Data Exploration and Pre-processing, IoT technologies, Architecture and Networking protocols, IoT Communication – Data Access and Distributed processing for IoT.	
Unit-2 - IoT Ecosystems, Deep Learning Techniques, and Frameworks	9 Hour
The End-to-End Life Cycle of the IoT - IoT application domains- The key characteristics and requirements of IoT data – Realtime Examples - Deep Learning Architectures for IoT - A soft introduction to ML - ML tasks - Delving into DL - Artificial neural networks - Neural network architectures - DL frameworks and cloud platforms for IoT – Limitations of IoT devices, edge/fog computing, and cloud perspective.	
Unit-3 - Deep Learning Application for IoT	9 Hour
Image Recognition in IoT - IoT applications and image recognition - Transfer learning for image recognition in IoT - CNNs for image recognition in IoT applications - Audio/Speech/Voice Recognition in IoT - Speech/voice recognition for IoT - DL for sound/audio recognition in IoT - CNNs and transfer learning for speech recognition in IoT applications	
Unit-4 - Indoor Localization and State Detection	9 Hour
Indoor Localization in IoT - An overview of indoor localization - Techniques for indoor localization - DL-based indoor localization for IoT - K-nearest neighbor (k-NN) classifier - AE classifier - Physiological and Psychological State Detection in IoT - IoT-based human physiological and psychological state detection - Deep learning for human activity and emotion detection in IoT - LSTM, CNNs, and transfer learning for HAR/FER in IoT applications - Data collection - Data exploration - Data preprocessing - Model training - Model evaluation.	

Unit-5 - IoT Security	9 Hour
Security attacks in IoT and detections - Anomaly detection and IoT security - DL for IoT security incident detection - DNN, autoencoder, and LSTM in IoT security incidents detection - Advanced Aspects and Analytics in IoT - Predictive Maintenance for IoT - DL for predicting RLU – Realtime Examples - Deep Learning in Healthcare IoT - CNN and LSTM in healthcare applications – Deep Learning for Smart Cities IoT- Deep Learning for Industrial IoT	

Learning Resources	1. Mohammad Abdur Razzaque and Md. Rezaul Karim, "Hands on Deep Learning for IoT", First Edition, Packet Publishing Ltd, 2019. 2. Amita Kapoor, "Hands on Deep Learning for IoT", First Edition, Packet Publishing Ltd, 2019.	3. Vijay Madisetti, Arshdeep Bahga, "Internet of Things: A Hands-on Approach", University Press, 2014 4. Andrew Minter, "Analytics for the Internet of Things (IoT) Intelligent Analytics for Your Intelligent Devices", Packt Publishing, 2017 5. Cuno Pfister, "Getting Started with the Internet of Things", O'Reilly Media, 2011.
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	35%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. R. Lenin Babu, Conversight. AI, USA.	1. Dr. K. G. Srinivasa, Professor, NITTR Chandigarh,	1. Dr. Meenakshi K, SRMIST
2. Mr. Vignesh, TCS, Bangalore	2. Dr. E. Ilavarasan, Puducherry Technological University, Puducherry.	2. Dr. M. Shobana, SRMIST

Course Code	21CSE468T	Course Name	EDGE COMPUTING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Compare the concepts and technologies of IoT and Edge	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	State IoT and M2M communication	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Outline the protocols and standards of IoT and Edge															
CLR-4:	Label the edge computing Architecture and its components															
CLR-5:	Recognize the integration of Edge and Cloud Computing for IoT															

Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Distinguish the concepts and technologies of IoT and Edge	-	-	3	2	-	-	-	-	-	-	-	-	3	3	-
CO-2:	Summarize the IoT and M2M Communication	-	-	3	2	-	-	-	-	-	-	-	-	3	3	-
CO-3:	Hands on practice on Arduino and RaspberryPi	-	-	3	2	-	-	-	-	-	-	-	-	3	3	-
CO-4:	Investigate the different cloud and edge analytics	-	-	3	2	-	-	-	-	-	-	-	-	3	3	-
CO-5:	Demonstrate the Edge computing integration with Cloud and IoT in an industrial application.	-	-	3	2	-	-	-	-	-	-	-	-	3	3	-

Unit-1 - IoT and Edge Computing	9 Hour
Introduction to IoT – IoT Applications – Challenges in IoT – Introduction to Edge Computing – Need for Edge Computing – Challenges in Edge Computing	
Unit-2 - Edge Architecture and Protocols	9 Hour
IoT Architecture – IoT versus Machine-to-Machine communication – IoT and Edge architecture - IoT and Edge Protocols – MQTT, COAP, AMQP, Low Power Lossy Network Routing, HTTP– Communication methods – Bluetooth, Zigbee, 6LowPAN, LoRaWAN, 5G, WiFi.	
Unit-3 - Modelling and Simulation	9 Hour
ESP32, Arduino, RaspberryPi: Introduction, RaspberryPi Board: Hardware Layout and Pinouts, Operating Systems on RaspberryPi, Edge to Cloud Protocols, MQTT, MQTT publish- subscribe, MQTT architecture details, MQTT state transitions, MQTT packet structure, MQTT data types, MQTT communication formats –Introduction to fog Computing – Relationship between Edge and Fog with Cloud Computing - Fog/Edge Simulator: iFogSim, Edge CloudSim, Cloud4Net	
Unit-4 - Big Data Analytics in Edge Computing	9 Hour
Big Data – Data Types in Big Data – Characteristics of big data – Benefits – Applications – Big Data Layered Architecture – Big Data Implementation: Hortonworks, Cloudera, MAP R – Edge Analytics – Benefits of Edge analytics – Difference between cloud analytics and edge analytics	
Unit-5 - Case Study / Industrial Applications	9 Hour
Edge for Continuous Motion Recognition – Edge for Recognition of Sound from audio – Edge analytics in Irrigation System – IoT-Edge for Smart Energy Management – Edge analytics in Remote Monitoring and Maintenance for an industry – Edge analysis in Healthcare System – Smart Building.	

Learning Resources	<ol style="list-style-type: none"> 1. K. Anitha Kumari, G. Sudha Sadasivam, D. Dharani, and M. Niranjnamurthy "Edge Computing: Fundamentals, Advances and Applications", (Advances in Industry 4.0 and Machine Learning), 1st Edition, CRC Press, 2021. 2. Rajkumar Buyya and Satish Narayana Srirama, "Fog and Edge Computing: Principles and Paradigms", Wiley, 2019. 3. Ripon Patgiri, Sivaji, and M.D. Borah "Edge Analytics," Springer, https://link.springer.com/book/10.1007/978-981-19-0019-8, 2022. 4. http://rucon.ec.tuwien.ac.at/files/Aral,%20De%20Maio%20-%202020%20-%20Simulators%20and%20Emulators%20for%20Edge%20Computing.pdf 5. https://arxiv.org/ftp/arxiv/papers/1910/1910.03026.pdf
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	35%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. U. Aravind Kumar, JPA Solutions, Bangalore.	1. Dr. M. D. Selvaraj, Indian Institute of Information Technology, Chennai	1. Mrs. V. Vijayalakshmi, SRMIST
2. Mr. U. Aravind Kumar, JPA Solutions, Bangalore,	2. Dr. K. G. Srinivasa, Professor, NITTR Chandigarh,	2. Dr. A. Suresh. SRMIST

Course Code	21CSE469T	Course Name	ENERGY MANAGEMENT FOR IoT DEVICES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Restate the rudiments of energy conservation and IoT	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	State the knowledge on various energy conservation schemes in IoT															
CLR-3:	Utilize the conventional and optimization algorithms for conserving energy in IoT devices															
CLR-4:	Find the various techniques of green IoT and impact of conventional techniques of IoT															
CLR-5:	Articulate the knowledge on existing energy efficient architecture for energy conservation and harvesting															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Interpret the knowledge on IoT and energy conservation approaches in IoT	-	3	-	2	-	-	-	-	-	-	-	-	2	3	-
CO-2:	Choose appropriate energy conservation component for real world problems	-	3	-	2	-	-	-	-	-	-	-	-	2	3	-
CO-3:	Experiment the appropriate energy conservation algorithms for improving the lifetime of IoT devices	-	3	-	2	-	-	-	-	-	-	-	-	2	3	-
CO-4:	Analyze various green IoT techniques and able to design green IoT for real world problems	-	3	-	2	-	-	-	-	-	-	-	-	2	3	-
CO-5:	Develop and demonstrate energy efficient architecture for real world problems	-	3	-	2	-	-	-	-	-	-	-	-	2	3	-

Unit-1 - Introduction	9 Hour
Introduction to IoT, Architecture of IoT, Components of IoT, Applications of IoT, Challenges in IOT, Energy Management in IoT, Energy harvesting, Block diagram of energy harvesting, Various ambient energies, Energy harvesting schemes, Harvesting modules, Rectenna Model, Sensing antenna, DC-DC Converter, Wireless energy harvesting, Near Field Communication, Inductive coupling, Paradigmatic view of energy efficient IoT, Pragmatic energy efficient IoT system architecture.	
Unit-2 - Energy Conservation Schemes	9 Hour
Energy conservation schemes, Sleep/wakeup scheme, Data driven scheme, Mobility based scheme, Load balancing, Working of load balancing, Hardware based load balancing, Software Based Load Balancing, Compare hardware and software based load balancing techniques, Load balancing algorithms, Static Algorithms, Dynamic Algorithms, Issues of energy conservation in IoT, Basic model of smart home system, Energy Conservation in Smart Home and IoT, Automation and Sensors in Smart Home, Case study: energy conservation component for smart home	
Unit-3 - Algorithms for Conserving Energy	9 Hour
Static energy efficient algorithms, Exact allocation algorithm, Best Fit Heuristic Algorithm, Dynamic energy efficient algorithms, Hardware Level Solution, Dynamic Voltage Frequency Scaling (DVFS), Software Level Solution, First Fit Decreasing algorithm (FFD), Modified Best Fit Decreasing algorithm (MBFD), Genetic Algorithm (GA), Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO), Simulated Annealing (SA), Cat Swarm Optimization(CSO), Hybrid Genetic Algorithm and Cat Swarm Optimization (HGACSO), Hybrid Genetic Algorithm, Particle Swarm Optimization and Simulated annealing(HGAPSOSA), Comparison of dynamic energy efficient algorithm, Compare and contrast static and dynamic energy efficient algorithms.	

Unit-4 - Green IoT	9 Hour
Green IoT an Overview, Smart Homes, Smart Cities, Energy Efficient smart health care, Importance of Green IOT, Taxonomy of green IoT techniques, Various Approaches to Achieve Green IoT, software based green IoT techniques, Hardware based green IoT techniques, Policy based techniques, Awareness based Approach - Toward Green IoT, Energy Awareness, IoT Based Smart Metering, Communication Technology Creating Awareness About Green Information, Promoting Recycling, Habitual Based Techniques, Comparative analysis of different green IoT approaches, Case study: impact of smart phones on the environment in present and future trends.	

Unit-5 - Selected Applications of Energy Systems	9 Hour
Designing energy efficient IoT based Intelligent Transport System, Intelligent Transport System, Motivations for IoT in Transportation, Communication Technology and Related Power Issues, Information Extraction and Underlying Power Issues, Energy Efficiency Challenges and Corresponding Solutions, Further Challenges and Opportunities, Capacity Estimation of Electric Vehicle Aggregator for Ancillary Services, Development of Electric Vehicles, Motivation for Vehicle to Everything (V2X) and V2G Technology, Electric Vehicles and Solar Power Plants in Smart Grid Environment, Potential of EV to Grid Connection, Capacity Estimation of Aggregator, Battery Management System, Grid Connection and Performance Testing of V2G.	

Learning Resources	1. Mamta Mittal, Sudeep Tanwar, Basant Agarwal, Lalit Mohan Goyal, "Energy Conservation for IoT Devices Concepts, Paradigms and Solutions" Springer Singapore, 2019. 2. Madhur.B, "IoT projects with Bluetooth Low Energy - Harness the power of connected things" Packt Publishing, 2017.	3. Rushan Arshad, Saman Zahoor, Munam Ali Shah, Abdul Wahid and Hongnian Yu, "Green IoT: An Investigation on Energy Saving Practices for 2020 and beyond," Special Section on Future Networks: Architectures protocols and applications, IEEE Publisher, 2017.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	35%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ms. Aparna, TCS, Kolkata.	1. Dr. Arulprakash, Professor, IIT Madras	1. Dr. V Anbarasu, SRMIST
2. Mr. U. Aravind Kumar, JPA Solutions, Bangalore,	2. Dr. K. G. Srinivasa, Professor, NITTR Chandigarh,	2. Dr. A. Suresh. SRMIST

Course Code	21CSE470T	Course Name	APPLIED SOFTWARE TECHNIQUES IN IoT ENGINEERING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Distinguish the phases of data gathering and management of IoT Platform	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Solve the software integration of communication protocol HTTP, MQTT															
CLR-3:	State the CoAP and integrating the Edge computing and Interoperability															
CLR-4:	Label the role of cloud service provider and taming the IoT															
CLR-5:	Articulate towards IoT Applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Outline the phases of data gathering and state data management concepts of IoT Platform	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-
CO-2:	Summarize Software Integration of communication protocol used in IoT	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-
CO-3:	Appraise the CoAP to integrate the edge devices and interoperability	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-
CO-4:	Implement a scenario using emerging cloud computing technologies	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-
CO-5:	Inspect the IoT Applications and its performances	-	-	2	3	-	-	-	-	-	-	-	-	2	3	-

Unit-1 - Sensing Technologies	9 Hour
Getting Started – Definition – Setting up, Initial Edge Tier Applications – Design Concepts, Data Simulation – Simulating Sensors and Actuators and its application, Data Emulation – Emulating sensors and actuators, Data Management – Data Translation and Management concepts	
Unit-2 - Communication Technologies	9 Hour
Introducing the MQTT protocol – Preparing – Publishing – Checking encrypted communication – Adding MQTT support to the actuator - Testing MQTT - Security considerations - MQTT Integration – Java client. Introducing the HTTP protocol - Creating an HTTP server - Adding dynamic synchronous resources - Adding dynamic asynchronous resources	
Unit-3 - Interoperability	9 Hour
CoAP – Adding CoAP to the devices - CoAP Server Implementation - CoAP Client Integration – Concepts, Edge Integration – adding TLS – add security. Benefits of interoperability – Achieving interoperability using CoAP – Adding LWM2M – Testing LWM2M device	
Unit-4 - Emerging Cloud Computing Technologies	9 Hour
Integrating with various cloud services – Programming – integrating with an IoT CSP – Taming the IoT. XMPP – Adding XMPP – Connecting to broker – Data available – Publishing – Adding chat interface – Testing.	
Unit-5 - Product Life Cycle & Use cases	9 Hour
Defining ownership of data – understanding provisioning – Adding – Managing – tokens for identification – Testing. Use case: Home Environment monitoring and temperature adjustment, Garden monitoring and water adjustment, pond quality monitoring.	

Learning Resources	1. Andy King A., "Programming the Internet of Things: An Introduction to building integrated device-to-cloud IoT solutions", O'Reilly Media, Inc.", 2021.	3. Anand Tamboli, "Build your own IoT platform: develop a fully flexible and scalable internet of things platform", 2nd edition, AK press, 2019.
	2. Peter Waher, "Mastering Internet of Things: Design and create your own IoT applications using Raspberry Pi 3", Packet Publishing Ltd., 2018.	4. Ahmed Bakir, "Program the Internet of Things with Swift for IOS - Learn How to Program Apps for the Internet of Things," AK press, 2018.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	35%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Mohan Raj, Renault Nissan Technology & business Centre Private Limited, Chennai,	1. Dr. P.T.V.B. Bhuvaneswari, Professor, MIT Campus, Anna University.	1. Dr. Kayalvizhi R, SRMIST
2. Mr. S. Santosh Kumar, Associate Consultant, CGI, Bangalore,	2. Dr. S. Sudha, Associate Professor, Anna University, Chennai,	2. Dr. S. Ushasukhanya, SRMIST

Course Code	21CSE471T	Course Name	FUNDAMENTALS OF CYBER SECURITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Restate the basic terminology, concepts, and standards of cyber security	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	State the understanding on software application security															
CLR-3:	Label the Concepts for secure information systems															
CLR-4:	Outline the Information Security Policies, Standards, and Cyber Law															
CLR-5:	Sense the modern theory on Security in Emerging Technology															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe the information, principles, standards of cyber security	-	-	3	2	-	-	-	-	-	-	-	-	-	3	2
CO-2:	Practice the data security considerations in real time applications	-	-	3	2	-	-	-	-	-	-	-	-	-	3	2
CO-3:	Illustrate security concerns in developing Secure Information Systems	-	-	3	2	-	-	-	-	-	-	-	-	-	3	2
CO-4:	Analyze Information Security Policies, Standards, and Cyber Law	-	-	3	2	-	-	-	-	-	-	-	-	-	3	2
CO-5:	Investigate the Security used in emerging technologies	-	-	3	2	-	-	-	-	-	-	-	-	-	3	2

Unit-1 - Introduction to Information Systems	9 Hour
Introduction to Information Systems, Types of Information Systems, Development of Information Systems, Changing the Nature of Information Systems Introduction to information security, Need for Information Security, Threats to Information Systems, Information Assurance, Cybersecurity and Security Risk Analysis	
Unit-2 - Cybersecurity Application Security:	9 Hour
Application Security, Data Security Considerations: Backups, Archival, Security Technology, Intrusion Detection, Denial-of-Service (DOS) Attack, Security Threats, Security Threats to E-Commerce, Electronic Payment Systems, Digital Signature, Cryptography	
Unit-3 - Developing Secure Information Systems	9 Hour
Secure Information System Development, Application Development Security, Information Security Governance and Risk Management, Security Architecture and Design, Security Issues in Hardware, Data Storage, and Downloadable Devices, Physical Security of its Assets, Back-Up Security Measures	
Unit-4 - Information Security Policies, Standards, and Cyber Law:	9 Hour
Security Policies, Policy Review Process, Information Security Standards, Cyber Laws in India, Intellectual Property Law, Semiconductor Law, Software Licenses	
Unit-5 - Security in Emerging Technology:	9 Hour
Security of Big Data Analytics, Security of Cloud Computing, Security of Internet of Things (IoT), Security of Smart Grid, Security of Scada Control Systems, Security of Wireless Sensor Networks (WSNs)	

Learning Resources	1. C. P. Gupta and K. K. Goyal, "Cyber security: A Self-Teaching Introduction", 1st Edition, Mercury Learning, and Information Press, 2020.	3. Charles J. Brooks, Christopher Grow, Philip Craig and Donald Short, "Cybersecurity Essentials," First Edition, John Wiley & Sons publishers, 2018.
	2. Charles P. Pfleeger, Shari Lawrence Pfleeger, and Jonathan Margulies, "Security in Computing", Fifth Edition, Prentice Hall, 2015.	4. William Stallings, "Cryptography and Network Security Principles and Practices," Seventh edition, Pearson, 2017 5. Man, Ho Au, Raymond Choo, "Mobile Security and Privacy," Syngress Publications, 2016.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	35%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. G. Pradeep, Intel @ FICE, Bangalore.	1. Dr. Sudeepta Mishra, Indian Institute of Technology, Ropar, Punjab	1. Dr. N. Prasath SRMIST
2. Mr. P.J Sanakaranarayanan, Security Analyst, Philips, Bangalore.	2. Mr. Karthikeyan.C.M.T, Government College of Engineering, Bargur	2. Mr. J. Prabakaran, SRMIST

Course Code	21CSE472J	Course Name	FULL STACK DEVELOPMENT FOR IoT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Restate the IoT components for full stack development	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Identify the techniques for designing the prototype application	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	Perceive the hardware and software for developing full stack																											
CLR-4:	Define the protocol communication from underlying network layer to User interface																											
CLR-5:	Solve real time application prototypes																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	List the components of IoT framework and open-source platforms	-	-	3	-	2	-	-	-	-	-	-	-	-	3	3												
CO-2:	Summarize the hardware design for the IoT prototype	-	-	3	-	2	-	-	-	-	-	-	-	-	3	3												
CO-3:	Illustrate the software concepts into designed hardware components	-	-	2	-	2	-	-	-	-	-	-	-	-	3	3												
CO-4:	Analyze the required protocol communication for data transmission	-	-	3	-	2	-	-	-	-	-	-	-	-	3	3												
CO-5:	Construct a prototype with dashboard for real time problem statements and measure its performance.	-	-	3	-	2	-	-	-	-	-	-	-	-	3	3												

Unit-1 - IoT Application Development Overview	12 Hour
Components of IoT framework- Creative Coding Platforms - Open-Source Platforms - Mobile phones and similar devices - Arm Devices - Basic Electronics (circuit theory, measurements, parts identification) Sensors and Software: Why full stack development? Interfacing to the Real World	
Unit-2 - Prototype Hardware Development	12 Hour
Transducers, Classification, Roles of sensors in IOT, Various types of sensors, designing with sensors and boards, special requirements for IOT sensors, Role of actuators, types of actuators-Different IoT protocols features and uses, Physical device – Arduino Interfaces, GPIO Basics, Programming, APIs / Packages	
Unit-3 - Prototype Embedding	12 Hour
Preparing the development environment (Arduino IDE), Exploring the Arduino language (C/C++) syntax, Coding, compiling, and uploading to the microcontroller, Working with Arduino Communication Modules: Bluetooth Modules, WIFI Modules, Interfacing Arduino and Blynk via USB like LED Blinking, temperature monitoring applications	
Unit-4 - Integrating WIFI/protocol Module	12Hour
ESP8266 WIFI Serial Module: Overview, Setting Up the Hardware, Interfacing with Arduino, Creating an IoT Temperature and Humidity Sensor SystemESP32, Arduino, RaspberryPi: Introduction, RaspberryPi Board: Hardware Layout and Pinouts, Edge to Cloud Protocols, like MQTT	
Unit-5 - Application development and Development	12 Hour
Checking Data communication with IoT cloud/edge computing, Creation and interface of Dashboard, Analytics, Addition of intelligence to the prototype, working on improving performance metrics	

Lab Experiments	
<ol style="list-style-type: none"> Exploring the concepts IoT and edge with basic any two applications like Switching ON/OFF Light, monitoring temperature in a room Illustrate the IoT and M2M communication Integration of protocols and standards of IoT and Edge Development of IoT-Edge computing application like smart dustbin, smart water monitoring, smart door Extend the application from the integration of Edge to cloud Illustrate the protocols between IoT and cloud Integration of security mechanisms in the developed applications MySQL Database Installation in Raspberry Pi 	<ol style="list-style-type: none"> Study of RaspberryPi and Beagle board Detect the Vibration of an Object Using Arduino Develop an application for Smart agriculture with full stack techniques Develop an application for Smart city with full stack techniques Develop an application for Industry 4.0 with full stack techniques Develop an application for Traffic control/parking with full stack techniques Develop an application for Object/Human detection with full stack techniques

Learning Resources	<ol style="list-style-type: none"> Bernardo Ronquillo Japón, "Learn IoT Programming Using Node-RED: Begin to Code Full Stack IoT Apps and Edge Devices with Raspberry Pi, NodeJS, and Grafana", PBP Publishers, 2022 Anand Tamboli, "Build Your Own IoT Platform Develop a Flexible and Scalable Internet of Things Platform", Second Edition, Apress, 2022. 	<ol style="list-style-type: none"> D. Dharani, G. Sudha Sadasivam, K. Anitha Kumari and M. Niranjnamurthy, "Edge Computing: Fundamentals, Advances and Applications (Advances in Industry 4.0 and Machine Learning)", First Edition, CRC Press, 2021 David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, and Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	10%	15%	-
Level 2	Understand	25%	-	-	25%	25%	-
Level 3	Apply	30%	-	-	20%	30%	-
Level 4	Analyze	30%	-	-	35%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
<ol style="list-style-type: none"> Mr. Goutham, Head, Innovation and Technology, Prothubs.IO, Head Mr. Dinesh Krishna- Senior System Design Engineer, IoT, Robotics & AI, Auxo Technology Labs 	<ol style="list-style-type: none"> Dr. K. Suganya Devi, National Institute of Technology, Silchar, Assam Dr. Ameer, National Institute of Technology, Calicut 	<ol style="list-style-type: none"> Dr. Vaishnavi Moorthy, SRMIST Mrs. Ushasukhanya S, SRMIST

Course Code	21CSE473T	Course Name	DEEP LEARNING FOR IoT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:								Program Outcomes (PO)												Program Specific outcomes						
CLR-1:	Restate the Fundamentals of Internet of Things and its technologies and Distributed processing techniques for IoT	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Label the use of Machine Learning in IoT, DL framework and cloud platforms for IoT.																											
CLR-3:	Solve the deep learning applications for IoT Image Recognition. Speech/ Voice Recognition																											
CLR-4:	Identify the indoor localization and state detection techniques with available classifier.																											
CLR-5:	Perceive deep learning techniques in real time examples.																											
Course Outcomes (CO):		At the end of this course, learners will be able to:								-	3	-	-	3	-	-	-	-	-	-	-	-	-	-	-	3	3	
CO-1:	Describe the basic theory underlying in Internet of Things.	-	3	-	-	3	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	3	3	
CO-2:	Summarize Deep learning techniques in IoT and its limitations	-	3	-	-	3	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	3	3	
CO-3:	Apply deep learning algorithms to solve problems of moderate complexity.	-	3	-	-	3	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	3	3	
CO-4:	Analyze Indoor Localization and IoT based human psychological and psychological state detection using Deep Learning Techniques.	-	3	-	-	3	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	3	3	
CO-5:	Scrutinize security attacks in IoT and detections, with real time examples.	-	3	-	-	3	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	3	3	

Unit-1- Introduction	9 Hour
Internet of Things - Data Analytics, IoT analytics challenges, IoT data acquisition, Data Exploration and Pre-processing, IoT technologies, Architecture and Networking protocols, IoT Communication – Data Access and Distributed processing for IoT.	
Unit-2- IoT Ecosystems, Deep Learning Techniques, and Frameworks	9 Hour
The End-to-End Life Cycle of the IoT - IoT application domains- The key characteristics and requirements of IoT data – Realtime Examples - Deep Learning Architectures for IoT -A soft introduction to ML - ML tasks - Delving into DL - Artificial neural networks - Neural network architectures - DL frameworks and cloud platforms for IoT – Limitations of IoT devices, edge/fog computing, and cloud perspective.	
Unit-3- Deep Learning Application for IoT	9 Hour
Image Recognition in IoT - IoT applications and image recognition - Transfer learning for image recognition in IoT - CNNs for image recognition in IoT applications - Audio/Speech/Voice Recognition in IoT - Speech/voice recognition for IoT - DL for sound/audio recognition in IoT - CNNs and transfer learning for speech recognition in IoT applications.	
Unit-4- Indoor Localization and State Detection	9 Hour
Indoor Localization in IoT - An overview of indoor localization - Techniques for indoor localization - DL-based indoor localization for IoT - K-nearest neighbour (k-NN) classifier - AE classifier - Physiological and Psychological State Detection in IoT - IoT-based human physiological and psychological state detection - Deep learning for human activity and emotion detection in IoT - LSTM, CNNs, and transfer learning for HAR/FER in IoT applications - Data collection - Data exploration - Data pre-processing - Model training - Model evaluation.	

Unit-5 - IoT Security	9 Hour
Security attacks in IoT and detections - Anomaly detection and IoT security - DL for IoT security incident detection - DNN, autoencoder, and LSTM in IoT security incidents detection - Advanced Aspects and Analytics in IoT - Predictive Maintenance for IoT - DL for predicting RLU – Realtime Examples - Deep Learning in Healthcare IoT - CNN and LSTM in healthcare applications – Deep Learning for Smart Cities IoT- Deep Learning for Industrial IoT	

Learning Resources	1. Mohammad Abdur Razzaque and Md. Rezaul Karim, "Hands on Deep Learning for IoT", First Edition, Packt Publishing Ltd, 2019. 2. Amita Kapoor, "Hands on Deep Learning for IoT", First Edition, Packt Publishing Ltd, 2019.	3. Vijay Madiseti and Arshdeep Bahga, "Internet of Things: A Hands-on Approach", University Press, 2014 4. Andrew Minter "Analytics for the Internet of Things (IoT) Intelligent Analytics for Your Intelligent Devices", Packt Publishing, 2017. 5. Cuno Pfister, "Getting Started with the Internet of Things," O'Reilly Media, 2011.
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	35%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. R. Lenin Babu, Conversight.Ai, USA.	1. Dr. K. Selvakumar, Professor, Annamalai University,	1. Dr. N. Krishnaraj, SRMIST
2. Mr. U. Aravind Kumar, JPA Solutions, Bangalore,	2. Dr. K. G. Srinivasa, Professor, NITTR Chandigarh,	2. Dr. P. Vigneshwaran, SRMIST

Course Code	21CSE474T	Course Name	IoT PRIVACY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Distinguish the fundamentals, various attacks, trust models and importance of security aspects in IoT	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	State the basics of cryptographic algorithms required for IoT security															
CLR-3:	Solve the techniques, protocols, and some ideas on security towards gaming model															
CLR-4:	Articulate the relevance of Blockchain, its techniques towards IoT															
CLR-5:	Perceive the essential components of IoT and its privacy challenges															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe the best practices learnt to identify the attacks and mitigate the same.	-	-	3	-	-	-	-	2	-	-	-	-	-	3	2
CO-2:	Identify the role of cryptographic algorithms to achieve required IoT security.	-	-	3	-	-	-	-	2	-	-	-	-	-	3	2
CO-3:	Analyze the security techniques and protocols during the design of IoT products and gaming designs.	-	-	3	-	-	-	-	2	-	-	-	-	-	3	2
CO-4:	Classify about the skills learnt on ciphers and blockchains when appropriate	-	-	3	-	-	-	-	2	-	-	-	-	-	3	2
CO-5:	Investigate the appropriate IoT devices for a real time case study	-	-	3	-	-	-	-	2	-	-	-	-	-	3	2

Unit-1 - Fundamentals of IoT security and its trust models	9 Hour
Security requirements in IoT architecture, security in enabling technologies, security concerns in IoT applications, security architecture in the IoT, security requirements in IoT, insufficient authentication/authorization, insecure access control, threats to access control, privacy and availability, attacks specific to IoT. Vulnerabilities, attack, counter measures, and fault trees, the secure IoT system implementation lifecycle, Data trustworthiness in IoT, Human IoT trust relationship, Trust and reputation system, trust negotiation, IoT privacy preservation issues	
Unit-2 - Cryptographic fundamentals for IoT	9 Hour
Cryptographic basics and its key role in IoT, mathematical foundations, Encryption and decryption, public-key cryptography, elliptic curve arithmetic, elliptic curve cryptography, message integrity, authentication algorithms, hash functions, Digital signature algorithms – Markle Trees signature algorithms, crypto currencies, bitcoin P2P network, security credential management system (SCMS).	
Unit-3 - Privacy preservation for IoT	9 Hour
Prevent unauthorized access to sensor data, M2M security, FRID security, cyber physical object security, Hardware security, Front-end system privacy protection, management, secure IoT databases, Networking function security, IoT networking protocols, Secure IoT lower layers, secure IoT higher layers, Secure communication, links in IoTs, Back-end security, secure resource, Game theory foundation, Mixed-strategy, Nash equilibrium, repeated games, Bayesian games, coalitional games.	
Unit-4 - Block chain in IoT security	9 Hour
Introduction to Blockchain, Modelling faults and adversaries, Byzantine generals' problem, Consensus algorithms and their scalability problems, digital signatures, verifiable random functions, Zero-knowledge systems blockchain, the challenges and solutions, proof of work, proof of stake, alternatives to Bitcoin consensus, bitcoin scripting language and their us Ethereum and smart contracts, Smart contract languages and verification challenges, comparing Bitcoin scripting Vs. Ethereum smart contracts, Hyper ledger fabric, mechanisms in permissioned blockchain, pseudo-anonymity Vs. anonymity, Zcash and Zk-SNARKS for anonymity preservation, attacks on blockchains, Sybil attacks, selfish mining, 51% attacks.	

Unit-5 - IoT devices and its privacy	9 Hour
Introduction of IoT devices, Difference among IoT devices, computers and embedded devices, Sensors and actuators in IoT, Accelerometer, photo resistor, buttons, motor, LED, vibrator, analog signal Vs. digital signal, Networking in IoT, Real-time communication, Bandwidth efficiency, data analytics in IoT- simple data analyzing methods, IoT architecture, component and technology, Case study- discussion on specific IoT applications and their design considerations, cyber security overview in IoT, general cyber security concepts in IoT security threads in IoT, data privacy in IoT, device/user authentication in IoT, data trustworthiness problem in IoT.	

Learning Resources	<ol style="list-style-type: none"> 1. B. Russel and D. VanDuren, "Practical Internet of Things Security", Packt Publishing, 2016. 2. FeiHU, "Security and Privacy in Internet of Things (IoT): Models Algorithms and Implementations", CRC Press, 2016. 3. Narayanan, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Princeton University Press, 2016. 4. Antonopoulos, "Mastering Bitcoin: Unlocking Digital Cryptocurrencies", O'Reilly, 2014. 5. T.Alpcan and T.Basar, "Network Security: A Decision and Game-theoretic Approach", Cambridge University Press, 2011. 6. Helena Rodrigues, Kristof Van Laerhoven and Rui José, "Security and the IoT ecosystem", Springer International Publishing, 2019. 7. Baldini, Gianmarco, "Internet of Things: IoT Governance, Privacy and Security Issues", European Research Cluster, 2015 8. Ollie Whitehouse, "Security of Things: An Implementers' Guide to Cyber-Security for Internet of Things Devices and Beyond", NCC Group, 2014. 9. Josh Thompson, "Blockchain: The Blockchain for Beginnings, Guild to Blockchain Technology and Blockchain Programming", CreateSpace Independent Publishing Platform, 2017.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	35%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. R. Lenin Babu, Conversight. Ai, USA.	1. Dr. Ansumanmahapatra, National Institute of Technology, Puducherry	1. Mrs. G. Sujatha, , SRMIST
2. Mr. U. Aravind Kumar, JPA Solutions, Bangalore.	2. Dr. K. G. Srinivasa, Professor, NITTR Chandigarh,	2. Dr. T.Y.J. Naga Malleshwari SRMIST

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume - 11I

**(Syllabi for Computer Science and Engineering w/s in
Blockchain Technology Programme Courses)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC305T	Course Name	BLOCKCHAIN USING CRYPTOGRAPHY	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basic services and concepts related to Blockchain Networks	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Define the role of cryptography in Blockchain network															
CLR-3:	Highlighting the services and techniques Ethereum and Cryptocurrency concept in Blockchain															
CLR-4:	Presenting the functions of Cryptocurrency in Blockchain Networks															
CLR-5:	Acquire knowledge in Networking concept and its part using Blockchain concepts															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	comprehend the knowledge of communication in Blockchain	3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-2:	Identify and design the different Cryptographical algorithms using Blockchain	3	2	1	-	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Design the network concepts and implement protocols using Blockchain	-	2	3	-	1	-	-	-	-	-	-	-	-	-	1
CO-4:	Describe the role of Ethereum and Cryptocurrency using Blockchain	2	2	-	-	1	-	-	-	-	-	-	-	-	-	2
CO-5:	Implement the various AI techniques in Blockchain	2	2	1	-	-	-	-	-	-	-	-	-	-	-	1

Unit-1 - Introduction	9 Hour
Distributed Database, Limitations of Distributed Database, Two General Problem- Byzantine General problem and Fault Tolerance- Introduction to Ledgers, Working of financial systems- Introduction about Block Chain technologies- Difference between block chain with database , History of Block Chain-Characteristics of Block Chain - Distributed Ledger and Block Chain - Comparison of Distributed Ledger and Block Chain- Types of Block Chain - Blockchain Network and Nodes - Overview of Blocks - Structure of Block – Examples	
Unit-2 - Blockchain Functionality	9 Hour
Hashing in Blockchain – techniques - Linking Box - Linking Box using SHA - Block Structures - Blockchain Functionality - Creating Blockchain - Digital Structures in Blockchain - Creating Identity – Examples - Signatures in transactions - Asset ownerships in transactions - Blockchain wallet - Crypto Exchange - Differences Between Crypto Wallets vs Exchanges	
Unit-3 - P2P Networking	9 Hour
Peer to Peer Networking - Working of Peer-to-Peer Networking - Measures to ensure the security of P2P networking systems - Introduction to Peer-to-Peer networking - History of Peer-to-Peer networking – Examples - Architecture of Peer-to-Peer networking - Network Discovery - Types of P2P networks in Blockchain - Examples of P2P networks in Blockchain - P2P Crypto Exchanges - P2P Marketplaces vs. OTC Exchanges - Building a sample blockchain using P2P network – Example - Creation of New block - Validation of New Block – Example	
Unit-4 - Introduction of Cryptocurrency	9 Hour
Introduction about Cryptocurrency - History of Cryptocurrency - Distributed Ledger - Bitcoin Protocols - Mining strategy and Rewards – Ethereum - Construction and working of Bitcoin - Construction and working of Ethereum - DAO, Smart contract - GHOST, Vulnerability Attacks, Side Chain, Name coin - Cryptocurrency Regulation: stakeholders-Roots of bitcoin - Legal Aspects - Cryptocurrency Exchange - Black market and Global Economy - Implementing Blockchain as service	

Unit-5 - Real Time Examples **9 Hour**

Implementing Blockchain as service using AI concepts - Enterprise Ethereum Alliance - Ethereum Alliance practical demo - Understanding Ethereum Jargon - Ethereum default Admin Site - Smart contracts in Aselpius - Developing smart contracts - Real Time Examples - Procedure to apply AI concept in Blockchain - Examples.

Learning Resources	1. Gulshan Shrivastava, Dac-Nhuong Le, Kavita Sharma "Cryptocurrencies and Blockchain Technology Applications" Wiley publishers, 2020.	4. Arvind Narayanan, Joesph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder. "Bitcoin and cryptocurrency technologies: A comprehensive Introduction" Princeton University Press, 2016
	2. Koushik Raj, "Foundation of Blockchain : The pathway to Cryptocurrencies and Decentralised blockchain applications ", Kindle Edition, 2019.	5. Cryptography Engineering: Design Principles and Practical Applications, Niels Ferguson, Bruce Schneier, and Tadayoshi Kohno, John Wiley & Sons Inc; 1st edition , 2010
3. Daniel Drescher "Blockchain Basics A non technical Introduction in 25 steps" 2017 A press publishers		

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Imthyaz serif, Director IDEASSION Technology solutions, Chennai	1.Dr. L. Ramanathan, Associate Professor, VIT Vellore	1. Dr. SV.Shri Bharathi, SRMIST

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSE231T	Course Name	FUNDAMENTALS OF BLOCKCHAIN	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:		Understand the fundamentals of blockchain architecture														
CLR-2:		Categorize cryptography techniques and blocks														
CLR-3:		Illustrate the principles consensus algorithms														
CLR-4:		Articulate different attacks														
CLR-5:		Relate hyper ledger and solidity in applications of block chain														
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:		comprehend the knowledge on the fundamentals of block chain														
CO-2:		Interpret the ability to apply models and methods of classical cryptography														
CO-3:		Utilize the principles of consensus mechanisms in real time.														
CO-4:		Categorize the attacks and its impacts.														
CO-5:		Appraise the block chain principles in real time applications														

Unit-1 - Introduction- Blockchain Architecture	9 Hour
Backstory of Bitcoin - Blockchain – Distributed Ledger Technology - Centralized vs. Decentralized Systems- Centralized Systems - Decentralized Systems - Layers of Blockchain - Application Layer - Execution Layer - Semantic Layer - Propagation Layer - Consensus Layer – Importance of Blockchain -Limitations of Centralized Systems	
Unit-2 - Blockchain and Cryptography	9 Hour
Peer to Peer Networking – Types of Blockchain: Public Blockchain - Private Blockchain – Consortium Blockchain - Cryptographic Hash Functions – Cryptographic Nonce – Transactions – Merkle Tree - Symmetric, Asymmetric Key Cryptography - Private Key Storage – Ledgers – Blocks - Chaining Blocks – Blockchain Wallets and its types	
Unit-3 - Consensus Mechanism	9 Hour
Proof of Work Consensus Algorithm - Proof of Stake Consensus Algorithm - Delegated Proof of Stake - Round Robin Consensus Algorithm - Proof of Authority/Proof of Identity Consensus Algorithm - Proof of Elapsed Time Consensus Algorithm – Byzantine Fault Tolerance - Consensus Comparison Matrix, Ledger Conflicts and Resolution.	
Unit-4 - Basic Attacks	9 Hour
Attacks - Sybil attack – DDOS – Eclipse Attack – Selfish Mining Attack – Finney attack – Race attack - Wallet Attacks – Zero knowledge proof – Non-interactive Zero Knowledge Proof – Ring Signature - Homomorphic Encryption	
Unit-5 - Decentralized Applications	9 Hour
Ethereum – Smart contracts - Decentralized Applications – Basics: Hyperledger, Fabric, Corda, Solidity, RemixIDE, Ganache, Metamask, Truffle, NodeJS, and Blockchain Testnet. Blockchain in IoT, Cloud computing, Supply chain management, Healthcare, Automation, Finance. Case Study: Ethereum vs Ethereum classic	

Learning Resources	<ol style="list-style-type: none"> 1. <i>Blockchain Consensus: An Introduction to Classical, Blockchain, and Quantum Consensus Protocols</i>, DOI:10.1007/978-1-4842-8179-6, 1st edition, Publisher: Apress, ISBN: 978-1-4842-8178-9, August 2022. 2. Pethuru Raj, Kavita Saini, Chellammal Surianarayanan, "Blockchain Technology and Applications", CRC Press, 2021. 3. Chandramouli Subramanian, "Blockchain Technology", Universities Press, 2020 	<ol style="list-style-type: none"> 4. Dannen, Chris. <i>Introducing Ethereum and solidity</i>. Vol. 1. Berkeley: Apress, 2017. 5. Imran Bashir, "Mastering Blockchain: Distributed Ledger Technology, decentralization, and smart contracts explained", 2nd Edition, Packt Publishing Ltd, March 2018.
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Kishore Kumar K Senior Technical Consultant (Strategic Accounts) ManageEngine (A Division of Zoho Corporation)	1. Dr. K. Suresh, Associate Professor, Department of Information Technology, Sri Venkateswara College of Engineering Sriperumbuthur	1. Ms. S. Srividhya, SRMIST

Course Code	21CSE232T	Course Name	IoT AND BLOCKCHAIN	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basic services and concepts of IoT and Blockchain	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Illustrate the role of cryptography in Blockchain network															
CLR-3:	Acquire knowledge in Networking concept and its part using Blockchain concepts															
CLR-4:	Exploring security challenges on Blockchain															
CLR-5:	Exploring the tools, platforms, and techniques in Blockchain															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the knowledge of communication in Blockchain	3	2	1	-	-	-	-	-	-	-	-	-	-	-	1
CO-2:	Identify and design different Cryptographical algorithms using Blockchain	3	2	-	-	1	-	-	-	-	-	-	-	-	-	2
CO-3:	Design the network concepts and implement protocols using Blockchain	3	1	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Identify how Industries adopting Baas for security	-	3	2	1	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Design and implement the various tools and techniques in Blockchain	-	-	1	3	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Introduction to IoT & Blockchain	9 Hour
Introduction to Internet of Things (IoT)- Concepts and definitions of IoT-History of IoT –IoT vs Conventional Network-IoT Architecture- Introduction to Blockchain-Generations of Blockchain- Structure of Blockchain- Opportunities and challenges in IoT and Blockchain - IoT simulators: Tinker cad, Cisco Packet Tracer - Blockchain development frame works: Truffle, Hyperledger fabric	
Unit-2 – IoT Security	9 Hour
IoT Layer Challenges – Sensing layer– Challenges in end nodes –Threat based on Network layer- Service layer-based threats-Application Interface layer –Cross layer Challenges-Challenge to implementation of IoT in Blockchain-IoT Device Integration challenges.	
Unit-3 - Consensus Algorithms	9 Hour
Building Blocks of Blockchain-Database-Block-Hash-Minor-Transaction-Smart Contracts-Consensus Mechanisms-PoW-PoS-Characteristics of Blockchain-Types of Blockchain-Permissioned Blockchain-Permissionless Blockchain-Consortium Blockchain, MetaMask plugin to conduct transactions with Ether, cryptocurrency	
Unit-4 - Blockchain as a Service (Baas)	9 Hour
Defining of Blockchain as a Service - IoT Cloud server security challenges– Cloud computing with BaaS-Hybrid Cloud server with BaaS for Remote Monitoring-Case study: Industries adopting BaaS for security.	
Unit-5 - Blockchain Use cases in IoT Sector	9 Hour
Autonomous Decentralized peer to peer telemetry-Blockchain Enabled Security for Smart cities- Blockchain Enabled Smart Home Architecture-Blockchain based self-managed VANETs-Security and privacy of data	

Learning Resources	1. Koushik Raj, "Foundation of Blockchain: The pathway to Cryptocurrencies and Decentralised blockchain applications ", Kindle Edition, 2019. 2. Daniel Drescher "Blockchain Basics A non-technical Introduction in 25 steps" 2017 A press publishers.	3. Nishith Pathathk and Anurag bhandari "IoT, AI, and Blockchain for .NET Building a Next - Generation Applkcaton from the GroundUp" A Press Publisher. 4. Ovidiu Vermesan, PeterFriess,"Internet of Things: Converging Technologiesfor Smart Environments and Integrated Ecosystems "RiverPublishers,2013. 5. Adrian McEwen Hakim Cassimally"DesigningtheInternetofThings", JohnWiley&Sons, 2014.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Jagadeesh.M.M , Senior DevOps Engineer,Ensono Technologies.	1. Dr.Sudhakar, Associate Professor, VIT, ,Andra Pradesh	1. Dr.J.Shobana, SRMIST
	2. Dr.BalasingamUdayabalan, , Associate Professor, East Point College, Bangalore	2. Dr.Ganesh Kumar, SRMIST

Course Code	21CSE233T	Course Name	DISTRIBUTED SYSTEMS AND APPLICATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12			
CLR-1:	recognize the characterization of distributed systems.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Gather knowledge on remote invocation and indirect communication.															
CLR-3:	comprehend the principles distributed objects and components.															
CLR-4:	Know about the security issues and principles of distributed file systems.															
CLR-5:	Analyse the distributed transactions.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Recognize the characteristics of distributed systems.	2	1	-	-	-	-	-	-	-	-	-	-	2	-	2
CO-2:	Describe the concepts of remote invocation and indirect communication.	2	1	-	-	-	-	-	-	-	-	-	-	2	-	3
CO-3:	Explain about operating system support and distributed objects, components.	2	1	2	-	-	-	-	-	-	-	-	-	2	-	2
CO-4:	Recognize the security issues and principles of distributed file systems.	2	2	1	-	-	-	-	-	-	-	-	-	2	-	3
CO-5:	Describe the distributed transactions mechanism and applications of distributed multimedia systems.	2	1	2	-	-	-	-	-	-	-	-	-	2	2	3

Unit-1 - Characterization of Distributed Systems	9 Hour
Examples of distributed systems, Trends in distributed systems, Focus on resource sharing, Challenges - System Models: Physical models, Architectural models, Fundamental models - Interprocess Communication: The API for the Internet protocols, External data representation and marshalling.	
Unit-2 - Remote Invocation and Indirect Communication	9 Hour
Request-reply protocols, Remote procedure call, Remote method invocation - Indirect Communication: Group communication, Publish-subscribe systems, Message queues	
Unit-3 - Operating System Support & Distributed Objects and Components	9 Hour
Operating System Support: The operating system layer, Protection, Processes and threads, Communication and invocation, Operating system architecture, Virtualization at the operating system level - Distributed Objects and Components: Distributed objects, Case study: CORBA, From objects to components.	
Unit-4 - Security and Distributed File Systems	9 Hour
Security: Overview of security techniques, Cryptographic algorithms, Digital signatures, Cryptography pragmatics - Distributed File Systems: File service architecture, Case study: Sun Network File System, Case study: The Andrew File System.	
Unit-5 - Distributed Transactions and Multimedia Systems	9 Hour
Distributed Transactions: Introduction, Flat and nested distributed transactions, Atomic commit protocols, Concurrency control in distributed transactions, Distributed deadlocks, Transaction recovery - Distributed Multimedia Systems: Characteristics of multimedia data, Quality of service management, Resource management, Stream adaptation - Case studies: Tiger, BitTorrent and End System Multicast.	

Learning Resources	1. George Coulouris, Jean Dollimore, Tim Kindberg and Gordon Blair, <i>Distributed Systems - Concepts and Design</i> , Fifth Edition, Addison-Wisely (Pearson Education), 2012.	4. Ajay D. Kshemkalyani, Mukesh Singhal, <i>Distributed Computing - Principles, Algorithms, and Systems</i> , Cambridge University Press, 2011.
	2. Andrew S. Tanenbaum and Maarten van Steen, <i>Distributed Systems: Principles and Paradigms</i> , Second Edition, Pearson Education, 2017.	5. <i>Distributed Systems</i> , IIT Patna (Dr. Rajiv Misra): https://nptel.ac.in/courses/106106168
	3. Kenneth P. Birman, <i>Guide to Reliable Distributed Systems - Building High Assurance Applications and Cloud-Hosted Services</i> , Springer London, 2014.	6. <i>Distributed Computing Systems</i> , IIT Madras (Prof. Ananthanarayana V.S): https://nptel.ac.in/courses/106106107

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. N. Mohanraj, Software Engineer PayPal Inc., Chennai.	1. Dr. M. Vinoth Kumar, Associate Professor, Department of Information Science and Engineering, Dayananda Sagar Academy of Technology & Management, Bengaluru.	1. Dr. M. Prakash, SRMIST

Course Code	21CSE234T	Course Name	PRINCIPLES OF CRYPTOGRAPHY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	recognize the fundamentals of Classical Cryptography.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Articulate Symmetric Cryptography and its methods															
CLR-3:	know the principles Hash Functions and primitives															
CLR-4:	Relate Number Theory concepts for cryptography.															
CLR-5:	Learn Asymmetric Cryptography, Key Management System, Digital Signature Schemes and Public-Key Encryption															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Acquire the knowledge on the fundamentals of cryptography	-	3	-	-	3	-	-	2	-	-	-	-	-	-	2
CO-2:	Describe the models and methods of classical cryptography	3	-	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Utilize the principles of Hash Functions with Crypto system	3	-	2	-	2	-	-	-	-	-	-	-	-	2	-
CO-4:	Apply the knowledge of Number Theory and its applications in cryptography.	-	2	-	-	-	-	-	-	-	-	-	-	-	2	1
CO-5:	Analyse the ability of Key Management System in real time applications	-	3	-	-	2	-	-	-	-	-	-	-	-	2	-

Unit-1 - Introduction	9 Hour
Security Trends-The OSI Security Architecture, Security Attacks, Security Services and Security Mechanisms, A model for Network Security-Classical Encryption Techniques Modern - Cryptography – Historical Ciphers – Cryptanalysis - Formal Definitions - Proofs of Security - The One-Time Pad - Limitations of Perfect Secrecy - Shannon's Theorem.	
Unit-2 - Symmetric Cryptography Algorithm	9 Hour
Symmetric Cryptography Private-Key Encryption- Defining Computationally Secure Encryption, - Constructing Secure Encryption Schemes - Constructing CPA-Secure Encryption Schemes - Modes of Operation - Chosen-Ciphertext Attacks - Message Authentication Codes - Message Integrity - CBC-MAC - Authenticated Encryption.	
Unit-3 - Hash Functions and Symmetric Key Construction	9 Hour
Hash Functions and Application – Definitions - The Merkle–Damgard Transform - Message Authentication Using Hash Functions - Generic Attacks on Hash Functions - The Random-Oracle Model - Hash Functions – Applications Theoretical Constructions of Symmetric-Key - One-Way Functions - From One-Way Functions to Pseudo randomness - Constructing Pseudorandom Generators - Constructing Pseudorandom Functions - Assumptions for Private-Key Cryptography.	
Unit-4 - Number Theory	9 Hour
Introduction to Divisibility theory and canonical decompositions - Division algorithm - Base - b representations Number patterns - Prime and composite numbers GCD - Euclidean algorithm - Fundamental theorem of arithmetic LCM - Diophantine equations and congruences - Linear Diophantine equations - Linear Congruence's - Modular exponentiation - Chinese remainder theorem.	

Unit-5 - Asymmetric Algorithms and Digital Signatures	9 Hour
Asymmetric Cryptography- RSA - Cryptographic Assumptions in Cyclic Groups - Algorithms for Factoring and Computing Discrete Logarithms - Key Management - Public-Key Revolution, Encryption and Hybrid Encryption - RSA Encryption - CDH, DDH-Based Encryption - Digital Signature Schemes - Public-Key Encryption - Trapdoor Permutations - The Paillier Encryption Scheme - Secret Sharing - The Goldwasser – Micali Encryption Scheme - The Rabin Encryption Scheme.	

Learning Resources	1. Introduction to Modern Cryptography (2nd edition) by J. Katz and Y. Lindell. 2. Cryptography Theory and Practice by Douglas Stinson (3rd Edition) by Douglas R Stinson Cryptography: An Introduction by Nigel Smart 3. Koshy, T.. –Elementary Number Theory with ApplicationsII, Elsevier Publications, New Delhi, 2002. 4. Statistical independence in probability, analysis, and number theory By MARK KAC Professor of Mathematics Cornell University
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Kishore Kumar K Senior Technical Consultant (Strategic Accounts) ManageEngine (A Division of Zoho Corporation)	1. Dr. K. Suresh, Associate Professor, Department of Information Technology, Sri Venkateswara College of Engineering Sriperumbudur	1. Ms. S. Srividhya, SRMIST

Course Code	21CSE331T	Course Name	CRYPTOCURRENCIES AND BLOCKCHAIN TECHNOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	comprehend the basic services and concepts related to crypto currencies	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	analyse the role of cryptography in Blockchain network															
CLR-3:	recognize the services and techniques Ethereum and Cryptocurrency concept in Blockchain															
CLR-4:	know the functions of Cryptocurrency in Blockchain Networks															
CLR-5:	Acquire knowledge in Ethereum concept and its part using Blockchain concepts															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the knowledge of cryptocurrency in Blockchain	3	3	1	-	-	-	-	-	-	-	-	-	-	-	2
CO-2:	Identify and design the different Cryptographical algorithms using Blockchain	3	2	1	-	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Design the network concepts and implement protocols using Blockchain	2	2	3	-	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Describe the role of Ethereum and Cryptocurrency using Blockchain	2	2	1	-	-	-	-	-	-	-	-	-	-	-	1
CO-5:	Implement the various AI techniques in Blockchain	2	2	-	-	3	-	-	-	-	-	-	-	-	-	2

Unit-1 - Introduction	9 Hour
Introduction to cryptocurrency - Basics of crypto and cryptocurrencies: - Cryptographic Hash functions - Hash Pointers - Digital Signatures - Digital Signatures – Examples - Public Key as Identities - Mechanics of Bitcoin: Bitcoin Transactions Bitcoin Scripts - Applications of Bitcoin Scripts - Bitcoin Blocks - Bitcoin Network - Limitations and Improvements - Construction of a Cryptocurrency Portfolio - Understanding Crypto Trading -Wallets - Public Key -Private Key	
Unit-2 - Bitcoin Technology	9 Hour
Bitcoin storage - Hot and Cold Storage - Splitting and Sharing Keys - Online wallets and Exchanges - Payment Services - Simplified Payment Verification (SPV) - Transaction Fees - Currency Exchange Markets - Managing secret keys of wallet - Hardware wallet - Paper wallet - Bitcoin Mining - Cryptocurrencies as investment option- Example - Analytical framework for crypto investment option - Fundamental Analysis and Technical analysis - Network Metrics as a price indicator	
Unit-3 - Blockchain Technology	9 Hour
Basics of Blockchain Technology - Introduction to Ledgers, Working of financial systems -Difference between block chain with database , History of Block Chain - Characteristics of Block Chain - Distributed Ledger and Block Chain - Comparison of Distributed Ledger and Block Chain - Types of Block Chain- – Public, Private, Consortium -Blockchain layers – Forks - Double Spending Problem - Byzantine Fault Tolerance protocol - Voting Protocol - Sybil resistance - Permissioned Consensus - Streamlet: A blockchain protocol - Nakamoto consensus protocol - Mining Incentives – Case Study: Bitcoin vs Bitcoin cash.	
Unit-4 - Decentralized Finance (DeFi)	9 Hour
History of Decentralized Finance (DeFi) - DeFi Foundations – Characteristics - Advantages of DeFi - DeFi Primitives: Transaction Mechanisms - Fungible Token - Non-Fungible Token – Example -Supply and Ownership: Custody – supply Adjustment - incentives Exchanges: Centralized Exchange - decentralized exchange (DEX) - Use cases - Automated Market Makers (AMM) - Uniswap - Collateralized Loan – Flash Loans - Incentives for Liquidity providers	

Unit-5 - Cryptocurrency Techniques **9 Hour**

Privacy for cryptocurrency: Anonymity - Privacy of Digital Payments - Privacy of Digital Payments – demo - Understanding Ethereum - Privacy in Ethereum - Privacy in Bitcoin - Coin Mixing - Litecoin (LTC) - Altcoins – Example unidirectional, bi-directional and UTXO - Examples.

Learning Resources	<ol style="list-style-type: none"> 1. Koushik Raj, "Foundation of Blockchain: The pathway to Cryptocurrencies and Decentralised blockchain applications ", Kindle Edition, 2019. 2. Arvind Narayanan, Joesph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder." Bitcoin and cryptocurrency technologies: A comprehensive Introduction" Princeton University Press, 2016. 3. Gulshan Shrivastava, Dac-Nhuong Le, Kavita Sharma "Cryptocurrencies and Blockchain Technology Applications" Wiley publishers. 4. Daniel Drescher "Blockchain Basics A non-technical Introduction in 25 steps" 2017 A press publishers.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Imthyaz serif, Director IDEASSION Technology solutions, Chennai	1.Dr. L. Ramanathan, Associate Professor, VIT Vellore	1. Dr. SV.Shri Bharathi, SRMIST

Course Code	21CSE332T	Course Name	FUNDAMENTALS OF ETHEREUM	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	recognize the working of Bit coin and Ethereum	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	identify the different components of the Block chain system and interact with them securely															
CLR-3:	Design, build and deploy smart contracts and distributed applications															
CLR-4:	analyse the difference between proof-of-work and proof-of-concept															
CLR-5:	Assess the need of Enterprise Ethereum Block chain Platforms and Use Cases															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	identify the design principles of Bit coin and Ethereum	3	1	2	-	-	-	-	-	-	-	-	-	1	-	3
CO-2:	Interact with a block chain system by sending and reading transactions	3	-	1	-	1	-	-	-	-	-	-	-	-	-	2
CO-3:	Design, build and deploy a distributed application	1	-	2	1	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Develop Ethereum consensus mechanism	2	-	3	-	1	-	-	-	-	-	-	-	-	-	3
CO-5:	Familiarize with Ethereum, smart contracts and related technologies, and solidity language	3	-	2	1	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to Ethereum	9 Hour
Ethereum, three parts of block chain, Ether as a Currency and Commodity, Crypto economics, and Security, EVM Architecture, Mist Browser, Wallets as Computing metaphor, Transactions in Ethereum, Encryption-Asymmetric and Public cryptography, Understanding Denominations, Introduction Solidity	
Unit-2 - The EVM and Introduction Solidity	9 Hour
Virtual machine, Ethereum protocols in banking, Applications of EVM, Smart contracts, State changes Gas-Importance, Specifications, opcodes in EVM, Solidity programming, Design rationale, Importance of formal Proofs Testing, Formatting and Statements, Expressions in solidity	
Unit-3 - Evaluating Ethereum and Block Chain	9 Hour
Ethereum for application, Installing Parity, MetaMask, Developing smart contracts, Contract Compilation and deployment , UI Setting, Fund Raiser Application-Overview, creating project, Initialising,setting beneficiary and custodian, Mappings , Donation Tests, Events, Withdrawing funds ,Fallback Functions	
Unit-4 - Mining Ether	9 Hour
Ether Source, Factors for Block validation, Use of ethereum stale blocks, Ethereum and bitcoin trees, Forking, Dapp deployment-contract data models, Meteor with Ethereum, Contracts, Interface, Prototyping, Creating Private chains, Optional flags, Private block chains,	
Unit-5 - Ethereum application & Crypto economics	9 Hour
Crypto economics - Rules, Ether Issuance Schemes, Attack scenarios Internet of Ethereum things - Retail and E-commerce, Community and government financing, Human and Organizational behaviour, Financial, Insurance Applications, Inventory and Accounting, Gaming, gambling and Investing	

Learning Resources	1. <i>Introducing Ethereum and Solidity</i> - Chris Dannen, Published: 18 March 2017, Apress Berkeley, CA 2. <i>Hands-On Smart Contract Development with Solidity and Ethereum</i> - Kevin Solorio, Randall Kanna & David H. Hoover, 25 November 2019, O'Reilly Media	3. <i>Mastering Ethereum Building smart contracts and Dapps</i> - Andreas M. Antonopoulos Dr. Gavin Wood, 15 December 2018, O'Reilly 4. <i>Ethereum For Dummies</i> - Michael G. Solomon, 28 March 2019 5. <i>The Basics of Bitcoins and Block chains: An Introduction to Crypto currencies and the Technology that Powers Them</i> – Antony Lewis, September 15, 2018
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. B. Yuvaraj Nandhan, Software Engineer, Bank of America	1. Dr. T. Suresh, CSE, Annamalai University	1. Dr. R. Jayaraj SRMIST
		2. Dr. S. Ganesh Kumar, SRMIST

Course Code	21CSE333T	Course Name	AI AND BLOCKCHAIN	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	List the basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Illustrate state core Blockchain concepts, the benefits, and the limitations of blockchain technologies															
CLR-3:	Experiment with technical underpinnings of AI and blockchain technology at sufficient depth to perform analysis															
CLR-4:	Discover the current scope, potential, limitations, and implications of intelligent systems															
CLR-5:	Examine real world challenges that blockchain technologies may assist in solving															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Comprehend the basics of artificial intelligence (AI) and its foundations	3	2	1	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Summarize relevant legal, ethical, and privacy issues and how they might impact policy and actions of organizations or individuals	2	3	1	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Build the decisions about the use of blockchain technology in systems, and support decisions with relevant arguments	2	1	3	-	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Perceive an ability to share in discussions of AI, its current scope and limitations, and societal implications	3	2	-	-	2	-	-	-	-	-	-	-	-	-	2
CO-5:	Apply blockchain concepts to analyze examples, proposals, case studies, and preliminary blockchain system design discussions	2	2	-	-	2	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to AI Landscape	9 Hour
AI – key concepts - History of AI - AI winter - Types of AI : Weak AI , Strong AI ,Super AI- Forms of AI and approaches : Statistical and expert systems, Machine learning, Supervised learning, Unsupervised learning, Reinforcement learning - Neural networks - Evolutionary computation - Swarm computation - AI in digital transformation: Data extraction - Data transformation - Processing - Storyboarding - Data utilization, AI platforms and tools : Tensor Flow - Microsoft Cognitive Toolkit - IBM Watson	
Unit-2 - Overview of Blockchain	9 Hour
Getting Started with Blockchain: Blockchain versus distributed ledger technology versus distributed databases - Comparing the technologies with examples - Public versus private versus permissioned Blockchain - Comparing usage scenarios - Privacy in Blockchain - Understanding Bitcoin - A brief overview of Bitcoin, Ethereum: A brief overview of Ethereum, Introduction to Hyperledger - Overview of the project - Hyperledger Fabric - Hyperledger Saw tooth - Other Hyperledger frameworks and tools	
Unit-3 - Blockchain and Artificial Intelligence	9 Hour
Domain Specific Applications - Applying AI & Blockchain: Healthcare, Supply chain, Financial Services, Information Security, Document management, AI & Blockchain Driven Databases - Centralized versus distributed data, big data for AI analysis, Data Management in a DAO, Emerging patterns for Database Solutions	

Unit-4 - AI and Cryptocurrency	9 Hour
Role of AI in Cryptocurrency - Cryptocurrency Trading: Issues & Considerations, Benefits of AI in Crypto Trading - Making Price Predictions with AI: Issues with Price Prediction, Benefits of AI in Prediction, Time series forecasting with ARIMA, Applications of algorithmic or quant trading in Cryptocurrency	
Unit-5 - Developing and Future of AI with Blockchains	9 Hour
Applying SDLC practices in Blockchain: Introduction to DIApp - Architecture of a DIApp - Developing a DIApp - Testing a DIApp - Deploying DIApp - Monitoring a DIApp, Implementing DIApp - Evolution of decentralized applications, building a sample DIApp, Developing Smart Contracts, Solution approach with AI, Developing: Client code, Backend, Frontend, Future of converging AI & Blockchain in enterprises & Government.	

Learning Resources	1.Kumble, G. P. (2020). <i>Practical Artificial Intelligence and Blockchain: A guide to converging blockchain and AI to build smart applications for new economies</i> . Packt Publishing Ltd 2.Smith, S. S. (2019). <i>Blockchain, artificial intelligence and financial services: Implications and applications for finance and accounting professionals</i> . Springer Nature 3. Nishith Pathak, Anurag Bhandari .(2018).IoT, AI and Blockchain for .NET	4. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, And Steven Goldfeder (2016). <i>BITCOIN AND CRYPTOCURRENCY TECHNOLOGIES</i> 5. Vikram Dhillon, David Metcalf, Max Hooper (2017).Blockchain Enabled Applications
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. S.Gomathi Sankar , Technical Lead .LTIMindtree	1. Dr.Soma Prathibha , Sri Sai Ram Engineering College, Chennai	1. Dr.A.Siva Kumar SRMIST
2. Dhilip Velumani, Module Lead,LTIMindtree	2. Dr.S.V.N Santhosh Kumar , VIT Vellore	2. Dr.S.Ganesh Kumar SRMIST

Course Code	21CSE334T	Course Name	CONTAINER MANAGEMENT			Course Category	E	PROFESSIONAL ELECTIVE						L	T	P	C			
																	3	0	0	3
Pre-requisite Courses		Nil		Co- requisite Courses		Nil		Progressive Courses		Nil										
Course Offering Department		School of Computing			Data Book / Codes / Standards			Nil												
Course Learning Rationale (CLR):		The purpose of learning this course is to:																		
CLR-1:	Comprehend fundamentals of cloud application development																			
CLR-2:	Deployment of Cloud Applications using Cloud Native Services																			
CLR-3:	Design various Cloud Applications																			
CLR-4:	Understand the Cloud Security and Cloud pricing models																			
CLR-5:	Learn the purpose of stream processing and its basic components																			
Course Outcomes (CO):		At the end of this course, learners will be able to:																		
CO-1:	Comprehend Cloud fundamental Concepts																			
CO-2:	Understand virtualization foundations to cater the needs of elasticity, portability, and resilience by cloud service providers.																			
CO-3:	Compare operation and economic models of various trending cloud platforms prevailing in IT industry																			
CO-4:	Learn why automation, culture, and metrics are essential to a successful DevOps																			
CO-5:	Design a cloud framework with appropriate resource management techniques with its security.																			
Unit-1 - Introduction Cloud Computing																				
Introduction-- Cloud Introduction –NIST Definition: Cloud service Models - IaaS/ PaaS / SaaS, Deployment Models –Public, Private, Hybrid and Community, Cloud Characteristics, Cloud Challenges –user, Service Provider end, Applications of Cloud, Cloud federation, Cloud Enabling Technology, - Challenges and Issues-																				
Unit-2 - Virtualization																				
Introduction to Hypervisors – Type 1 Hypervisors – Type 2 Hypervisors – Basics of Virtualization - Types of Virtualizations - Understanding Hypervisors - Implementation Levels of Virtualization -Virtualization Structures - Tools and Mechanisms – Resource sharing and Resource pooling -Desktop Virtualization – Server Virtualization.																				
Unit-3 - Containerization Using Docker																				
Docker, Containers, Usage of containers, Terminology, Docker Run Static sites, Docker Images, Docker File, Docker on AWS, Docker Network, Docker Compose, Development Workflow, and AWS EC Services.																				
Unit-4 - Devops																				
Introduction, Test Driven Development, Continuous Integration, Code coverage, Best Practices, Virtual Machines vs Containers, Rolling Deployments, Continuous Deployment, Auto Scaling. Case Study: Open Stack, Cloud based ML Solutions in Healthcare																				
Unit-5 - Cloud Security																				
Cloud Application Development – Cloud Application Execution, Applications using Containers - Testing the Cloud Application, Case study on Cloud Application – Cloud Security Concepts - Cloud Security Threats, Cloud Security Mechanisms: Encryption, Public Key Infrastructure, Identity and Access Management, Single Sign-On: Kerberos authentication, Mobile Cloud, Green Cloud.																				

Learning Resources	1. Rajkumar Buyya, James Broberg, Andrzej, M. Goscinski, <i>Cloud Computing: Principles and Paradigms</i> , Wiley, 1st Edition, 2013.	5. Buyya, Rajkumar, Christian Vecchiola, and S. Thamarai Selvi. <i>Mastering Cloud Computing: Foundations and Applications Programming</i> , Tata Mcgraw Hill, 1 st Edition, 2017.
	2. Sosinski, Barrie, <i>Cloud Computing Bible</i> , John Wiley & Sons, 1 st Edition, 2011.	6. Ellis B, <i>Real-Time Analytics – Techniques to analyze and visualize streaming data</i> , 1st ed., John Wiley & Sons Inc, 2014
	3. <i>Docker: Up & Running: Shipping Reliable Containers in Production</i> , Sean P. Kane, Karl Matthias, O'Reilly Media Inc, 2015.	7. Mark Wilkins, "Learning Amazon Web Services (AWS): A Hands-On Guide to the Fundamentals of AWS Cloud", 2019.
	4. Thomas Erl, Zaigham Mahmood, Richardo Puttini, "Cloud Computing: Concepts, Technology and Architecture", Fourth Printing, 2014, Prentice Hall/Pearson PTR, ISBN: 9780133387520.	8. https://cloudacademy.com/course/introduction-to-devops/intro-3/

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Rajarajan Sundaramurthy, Zealogics systems, Kakkanad, Kerala	2. Dr. K. Pradeep, Assistant Professor, School of Computer Science and Engineering, VIT Chennai.	3. Dr.N.Manikandan, SRMIST

Course Code	21CSE335T	Course Name	ADVANCED CRYPTOGRAPHY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	comprehend the fundamental knowledge of the cryptographical technologies	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	remember the mathematics behind Cryptography.															
CLR-3:	analyze the design of various cryptographic primitives															
CLR-4:	Apply the process of implementing the cryptographic algorithms															
CLR-5:	Evaluate the foundations of modern cryptography toward practical applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Comprehend the principles of cryptography	-	3	2	1	-	-	-	-	-	-	-	-	1	3	2
CO-2:	realize the current rigorous approaches for evaluating the security of cryptographic constructions	-	3	3	1	-	-	-	-	-	-	-	-	1	-	3
CO-3:	Analyze cryptographic schemes	-	3	2	2	-	-	-	-	-	-	-	-	2	3	2
CO-4:	describe core concepts and terminology concerning use of cryptography	-	3	2	1	-	-	-	-	-	-	-	-	-	-	2
CO-5:	explain the concepts of encryption and authentication	-	1	2	1	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to Cryptography	9 Hour
Classic ciphers—Substitution techniques- Transposition Techniques-Stream Cipher-Properties of Stream Cipher - Model of a stream cipher -Block Cipher- Properties of Block Cipher- Model of a Block cipher	
Unit-2 - Symmetric Key Ciphers	9 Hour
Block Cipher principles- Data Encryption Standard (DES) - Triple 3DES - Advanced Encryption Standard (AES)- RC4- RC5-Blowfish	
Unit-3 - Asymmetric Key Ciphers	9 Hour
Principles of public key cryptography- Integer Factorization Schemes: Rivest-Shamir-Adleman (RSA)- Discrete Logarithm Schemes: Digital Signature Algorithm (DSA)- ElGamal- Elliptic Curve Cryptography (ECC)- Other public key algorithms. Cryptographic Protocols-Diffie-Hellman Key Agreement Protocols - Fiat-Shamir Identification Scheme	
Unit-4 - Message Integrity and Hash Function	9 Hour
Message Authentication Code (MAC)- CBC-MAC – HMAC- DAA-CMAC. Hash Function: Secure Hash Algorithm (SHA)-SHA1-SHA2-SHA3-Message digest-MD4-MD5	
Unit-5 - Cryptographic Applications	9 Hour
Securing the internet- Wireless local area networks- mobile telecommunications-Secure payment card transactions-video broadcasting-identity cards-anonymity-digital currency. The Future of Cryptography- quantum computing- postquantum cryptography- quantum cryptography	

Learning Resources	1. <i>An Introduction to Cryptography, Second Edition (Discrete Mathematics and Its Applications)</i> , Richard A. Mollin, Taylor & Francis, 2006	4. <i>Cryptography Engineering: Design Principles and Practical Applications</i> , Niels Ferguson, Bruce Schneier, and Tadayoshi Kohno, John Wiley & Sons Inc; 1st edition ,2010
	2. <i>Applied Cryptography, Second Edition: Protocols, Algorithms, and Source Code in C</i> , Bruce Schneier, John Wiley & Sons, Inc, 1996	5. <i>Cryptography and Network security Principles and practice</i> , William Stallings Seventh edition, Pearson, 2017
	3. <i>Cryptography: An Introduction (3rd Edition)</i> Nigel Smart, Mcgraw-Hill College,2003	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.V. Gopinath, Solution Architect, Tata Consultancy Service Ltd., Chennai	1. Dr. M. Sugumaran, Professor, Department of Computer Science and Engineering, Puducherry Technological University, Puducherry	1. Dr. Panimalar.K, SRMIST

Course Code	21CSE336T	Course Name	CLOUD COMPUTING WITH BLOCKCHAIN	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	comprehend the fundamentals of cloud computing and blockchain.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	recognize the protection of cloud resources.															
CLR-3:	Know about blockchain as a service.															
CLR-4:	Gain knowledge in cloud data management and smart contracts.															
CLR-5:	Identify the uses of cloud computing and blockchain technology in the industry.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Recognize the concepts of cloud computing and blockchain.	1	1		-	-	-	-	-	-	-	-	-	1	-	3
CO-2:	Describe the Features of cloud computing and implementation of smart contracts	1	2	3	-	-	-	-	-	-	-	-	-	1	-	3
CO-3:	Identify various blockchain business models and its applications.	1	-	2	-	-	-	-	-	-	-	-	-	1	-	3
CO-4:	Explain the cloud data management and implement the integrated services using smart contracts.	1	2	3	-	-	-	-	-	-	-	-	-	1	-	3
CO-5:	Explain the uses of cloud and blockchain technology in the industry.	1	-	2	-	-	-	-	-	-	-	-	-	1	-	3

Unit-1 - Fundamentals of Cloud Computing and Blockchain	9 Hour
Cloud Computing: Concepts, features, Cloud computing delivery services and network operations, Cloud deployment models, Models benefits and challenges – Blockchain: Concepts, features - Introduction to cryptocurrencies and blockchain-based solutions, Configuration of blockchain network.	
Unit-2 - Cloud Resources & Smart Contracts	9 Hour
Features of cloud computing providers, provisioning of cloud computing, storage and networking resources, implementation of cloud-based solutions, Smart contracts functions and its uses, design, and implementation of smart contracts.	
Unit-3 - Blockchain as a Service	9 Hour
Blockchain Business Models, Traditional business models-Types of Blockchain Business Models- Blockchain as A Service (BaaS)-Token Economy- Utility Token Business Model-Blockchain-Based Software Products, P2P Blockchain Business Model-Blockchain Professional Services. Block chain for Banking and Financial transactions, The development of portable, scalable, and extensible cloud resources applications (AWS).	
Unit-4 - Cloud Data Management & Integrated Services Using Smart Contracts	9 Hour
Cloud data protection. Data modernization, databases, and file storage cloud solutions, implement strategies for backup and data recovery, Blockchain offline storage, IPFS, Analyse, design, and implement distributed applications (DApps).	
Unit-5 - Cloud Computing and Blockchain Technology in the Industry	9 Hour
Cloud development operations (DevOps) services, to propose a solution that integrates cloud services and blockchain technology to design and implement a hybrid architecture, Blockchain as a Service - Cloud server security challenges - Cloud computing with BaaS-Hybrid Cloud server with BaaS for Remote Monitoring-Case study: Industries adopting BaaS for security.	

Learning Resources	1. Jai Singh Arun, Jerry Cuomo, Nitin Gaur, <i>Blockchain for Business - For Understanding transformation, growth and new models of Business</i> , First Edition, Pearson, 2019.	4. John W. Rittinghouse, James F. Ransome, <i>Cloud Computing - Implementation, Management, and Security</i> , CRC Press, 2017.
	2. Judith S. Hurwitz, Robin Bloor, Marcia Kaufman, Fern Halper, <i>Cloud Computing for Dummies</i> , Wiley, 2010.	5. <i>Blockchain Architecture Design and Use Cases</i> , IIT Kharagpur, Sandip Chakraborty, Praveen Jayachandran: https://nptel.ac.in/courses/106105184
	3. Andrzej M. Goscinski, James Broberg, Rajkumar Buyya, <i>Cloud Computing Principles and Paradigms</i> , Wiley, 2010.	6. <i>Introduction to Blockchain Technology and Applications</i> , IIT Kanpur Prof. Sandeep Shukla: https://nptel.ac.in/courses/106104220

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. N. Mohanraj, Software Engineer PayPal Inc., Chennai.	1. Dr. M. Vinoth Kumar, Associate Professor, Department of Information Science and Engineering, Dayananda Sagar Academy of Technology & Management, Bengaluru.	1. Dr. M. Prakash, SRMIST

Course Code	21CSE337T	Course Name	WEB3 DEVELOPMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:		comprehend the basics of web technologies, XHTML, and HTML5														
CLR-2:		explore CSS, and JavaScript														
CLR-3:		Explore event handling techniques and Java Servlet														
CLR-4:		Acquire knowledge on XML, AJAX, and JSP														
CLR-5:		develop web services, working with Python, databases, anyone DB Connectivity, MongoDB, ReactJs														
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:		Apply the knowledge of web essentials, XHTML, and HTML5														
CO-2:		Apply CSS Styling, and interactive web design techniques while creating a web page														
CO-3:		Implement and analyze event handling techniques and Java Servlet for web application development														
CO-4:		Create XML document, apply AJAX, and JSP for developing a web application														
CO-5:		Develop web services, apply the basic knowledge of Python, database, anyone DB Connectivity, MongoDB, and NodeJs														

Unit-1 - Web Essentials	9 Hour
Clients, Servers, Communication, The Internet-Basic Internet Protocols -The World Wide Web, Comparison web1.0, Web2.0 and web3.0 and its tool, HTTP request message, Response Message, Web Clients, Web Servers, XHTML. An Introduction to HTML History, Versions, XHTML Syntax and Semantics, Fundamental HTML Elements, Relative URLs-Lists-tables-Div-Frames-Forms, HTML5 : Responsive web design, developing a web page using URLs, imgs, and Lists, developing a web page using HTML tables, divs/frames, creating a HTML Form for maintaining course details.	
Unit-2 - Cascading Style Sheets	9 Hour
Introduction to Cascading Style Sheets- Features-Core, Syntax-Style Sheets and HTML Style, Cascading, Inheritance, Text Properties, Box Model Normal Flow Box Layout, Beyond the Normal Flow, Client- Side Programming, The JavaScript Language, JavaScript in Perspective-Syntax Variables, Implementation of CSS Inheritance, Implementation of Text properties, Implementation of Box model to display distinct paragraphs in three different boxes, Applying JavaScript to create an interactive web page for performing arithmetic calculations.	
Unit-3 - Event Handling	9 Hour
Host Objects, Browsers and the DOM-Introduction to the Document Object Model, DOM History and Levels, Event Handling—Accommodating Noncompliant Browsers, Java Servlet- Architecture, Overview-A Servlet, Generating Dynamic Content, Life Cycle- Parameter Data, Sessions and Cookies, URL Rewriting-Other Capabilities, Data Storage Servlet and Concurrency.	
Unit-4 - XML, AJAX, XSLT, and JSP	9 Hour
XML REPRESENTATION, Representing Web Data, XML-Documents and Vocabularies, Versions and Declaration, Namespaces JavaScript and XML, Ajax-Event Oriented Parsing, SAX-Transforming XML Documents, XPATH-Template based Transformation, XML Schema-Communicating Object Data, XSLT-Displaying XML Documents in Browsers, JSP Technology Introduction-JSP and Servlet, Running JSP Applications, JavaBeans Classes and JSP Tag Libraries. Applying XML & XSLT to display product information.	
Unit-5 - Web Services, and Advanced concepts in Web Development	9 Hour

JAX-RPC-Concepts, writing a Java Web Service, consuming a RESTful Web Service, WSDL- Representing Data Types, SOAP Related Technologies, Software Installation, Working with Python, Basic concepts in Databases, DB Connectivity, working with MongoDB, Working with ReactJs.

Learning Resources	1. Deitel , Deitel and Nieto, "Internet and World Wide Web – How to program", 4th Edition, Pearson Education Publishers, 2009	6. Marty Hall and Larry Brown, "Core web Programming ", Pearson education, 2001
	2. Jeffrey C Jackson "Web Technologies", Pearson Education, 2006	7. Jobinesh Purushothaman, "RESTful Java Web Services" Second Edition, Packt Publishing, 2015
	3. Eric Freeman, Elisabeth Robson, "HTML5 Programming", first edition, O'Reilly Publishers, 2011.	8. https://www.computer-pdf.com/web-programming/javascript/851-tutorial-react-js-notes-for-professionals-book.html
	4. Robert. W. Sebesta, "Programming the world wide web", Fourth Edition, Pearson Education, 2007	9. https://www.tutorialspoint.com/mongodb/mongodb_tutorial.pdf
	5. Bates "Developing Web Applications", Wiley 2006	10. https://www.stat.berkeley.edu/~spector/python.pdf

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Hari hara sudhan M, Tech Lead, Infosys Ltd.	1. Dr. A. Tamizhselvi, Associate Professor, SJCE	1. Dr. K. Dhanasekaran, SRMIST
2. Irrai anbu Jayaraj, Business analyst, CSL pvt ltd	2. Dr. S. Kannimuthu, Professor and Head, AI & DS, KCE	

Course Code	21CSE338T	Course Name	TRUST BASED COMPUTING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Gain knowledge about fundamental technologies behind Trusted Computing	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	comprehend trusted Platform Modules (TPMs) are and what capabilities they can provide both at an in-depth technical level and in an enterprise context	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	learn about how other technologies such as the Dynamic Root of Trust for Measurement (DRTM) and virtualization can both take advantage of TPMs and be used to enhance the TPM's capabilities																											
CLR-4:	apply for use cases related to trusted computing, including machine authentication, data protection, and attestation																											
CLR-5:	Study various software resources that exist today to support TPMs, give a high-level overview of related research and development projects																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Realize the concept of Trust, Security and Game theory	3	3	-	1	-	-	-	-	-	-	-	-	-	-	1												
CO-2:	Obtain general understanding of trust and alternative operations	3	3	-	2	-	-	-	-	-	-	-	-	-	-	2												
CO-3:	Learn about the importance of systems and cryptographic hash functions	3	2	-	2	-	-	-	-	-	-	-	-	-	-	3												
CO-4:	Learn about bitcoin, blockchain and trust lifecycle.	3	2	-	-	-	-	-	-	-	-	-	-	1	-	-												
CO-5:	Analyze risk, trust and control using case studies.	2	3	-	-	-	-	-	-	-	-	-	-	2	-	2												

Unit-1 – Introduction to Trust	9 Hour
Analysing Our Trust Statements - Agency - Trust and Security - Trust as a Way for Humans to Manage Risk - Risk, Trust, and Computing - Defining Correctness in System Behaviour - The Role of Monitoring and Reporting in Creating Trust - Game theory - The Prisoner's Dilemma - Reputation and Generalised Trust - Institutional Trust	
Unit-2 – Trust Operations and Alternatives	9 Hour
Trust Actors, Operations, and Components - Reputation, Transitive Trust, and Distributed Trust - Agency and Intentionality - Alternatives to Trust - Legal Contracts - Enforcement - Verification - Assurance and Accountability - Trust of Non-Human or Non-Adult Actors - Expressions of Trust - Relating Trust and Security - Misplaced Trust	
Unit-3 – importance of Systems	9 Hour
System Design - The Network Stack - Linux Layers - Virtualisation and Containers: Cloud Stacks - Other Axes of System Design - "Trusted" Systems - Trust Within the Network Stack - Trust in Linux Layers - Trust in Cloud Stacks - Hardware Root of Trust - Cryptographic Hash Functions - Measured Boot and Trusted Boot - Certificate Authorities - Internet Certificate Authorities - Local Certificate Authorities - Root Certificates as Trust Pivots	
Unit-4 – Block Chain and Trust	9 Hour
Bitcoin and Other Blockchains - Permissioned Blockchains - Trust without Blockchains - Blockchain Promoting Trust - Permissionless Blockchains and Cryptocurrencies - The Importance of Time - Decay of Trust and Lifecycle - Software Lifecycle - Trust Anchors, Trust Pivots, and the Supply Chain - Direct trust and indirect trust.	

Unit-5 – Case Studies and Applications **9 Hour**

Analysis of risk, trust, and control in cloud computing - Trust in Computational Intelligence Systems - Individual Trust Development in Computer Mediated Collaboration Teams - Development of Trust in a Business Relation - supply chain use case – banking use case– mini projects.

Learning Resources	<ol style="list-style-type: none"> 1. Trust in Computer Systems and the Cloud, Mike Bursell, ISBN: 978-1-119-69232-4, Wiley, Dec 2021. 2. Trusted Computing, by by Dengguo Feng, Tsinghua University Tsinghua University Press, December 2017, Publisher : De Gruyter, ISBN: 9783110476095. 3. A Practical Guide to Trusted Computing, by David Challener, Kent Yoder, Ryan Catherman, David Safford, Leendert Van Doorn, IBM Press, 27 December 2007. 	<ol style="list-style-type: none"> 4. Data Privacy and Trust in Cloud Computing, Building trust in the cloud through assurance and accountability, Edited by Theo Lynn · John G. Mooney Lisa van der Werff · Grace Fox, palgrave macmillian, ISBN 978-3-030-54660-1, 2021. 5. Trusted Computing Platforms: TCPA Technology in Context, by Siani Pearson, Boris Balacheff, Prentice Hall Professional, 2003
--------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Ishan Roy, Director, Metabasu Technologies Private Limited	1. Dr.S. Ganapathy, Associate Professor, Vellore Institute of Technology, Chennai.	1. Dr. Prabhu kavin.B, SRMIST
2. Mr. Rex Aantonny, Founder & CEO, Rex Cyber Solutions Pvt Ltd	2. Dr. S. Muthurajkumar, Assistant Professor / Computer Technology, Madras Institute of Technology Campus, Anna University, Chrompet, Chennai - 600044.	

Course Code	21CSE431T	Course Name	BUILDING PRIVATE BLOCKCHAIN	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	comprehend the basics of distributed database and cryptography	1	2	3	4	5	6	7	8	9	10	11	12			
CLR-2:	Integrate ideas from Blockchain Technology	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-3:	Design, build and deploy smart contracts and distributed applications															
CLR-4:	know the Cloud Security and Cloud pricing models															
CLR-5:	Learn the purpose of stream processing and its basic components															

Course Outcomes (CO):	At the end of this course, learners will be able to:															
CO-1:	Explain the basic concepts of Database systems	-	1	-	-	1	-	-	-	-	-	-	-	-	2	-
CO-2:	Explore the design principles of Bitcoin and Ethereum	-	2	-	-	2	-	-	-	-	-	-	-	1	-	2
CO-3:	Describe emerging abstract models for Blockchain Technology	-	3	2	-	3	-	-	-	-	-	-	-	1	-	3
CO-4:	Implement Hyperledger Fabric and Ethereum platform to Block chain Application	-	3	2	-	3	-	-	-	-	-	-	-	-	-	3
CO-5:	Design, build, and deploy a distributed application	-	2	-	-	2	-	-	-	-	-	-	-	1	-	2

Unit-1 - Introduction	9 Hour
Distributed Database – Hadoop Distributed File System – Distributed Hash Table – ASIC resistance – Cryptography: Hash function – Digital signature – Memory Hard Algorithm	
Unit-2 - Blockchain	9 Hour
Introduction to Blockchain – Advantage over conventional distributed database – Blockchain Network – Mining Mechanism – Distributed Consensus – Merkle Patricia Tree – Gas Limit – Transactions and Fee – Anonymity – Reward – Chain Policy – Life of Blockchain application – Soft & Hard Fork – Private and Public blockchain	
Unit-3 - Distributed Consensus	9 Hour
Nakamoto consensus – Proof of Work – Proof of Stake – Proof of Burn – Difficulty Level – Sybil – Attack – Energy utilization and alternate.	
Unit-4 - Cryptocurrency	9 Hour
History – Distributed Ledger – Bitcoin – Bitcoin protocols – Mining strategy and rewards – Ethereum – Construction – DAO – Smart Contract – GHOST – Vulnerability – Attacks – Sidechain – Namecoin.	
Unit-5 - Cloud Security	9 Hour
Internet of Things – Medical Record Management – Application of Blockchain in Government – Blockchain use cases – Finance.	

Learning Resources	<ol style="list-style-type: none"> 1. Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, <i>Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction</i>, Princeton University Press, 2016. 2. Xu, Xiwei, Weber, Ingo, Staples, Mark, <i>Architecture for Blockchain Applications</i>, Springer, 2019. 3. Andreas M. Antonopoulos, "Mastering Bitcoin: Programming the Open Blockchain", Second Edition, O'Reilly, 2017 4. Pradip Dey, Manas Gosh, "Programming in C", First Edition, Oxford University Press, 2018 	<ol style="list-style-type: none"> 5. Albert Szymgielski, <i>Bitcoin Essentials</i>, 2016 6. Daniel Forrester, Mark Solomon, <i>Bitcoin Exposed: Today's Complete Guide to Tomorrow's Currency</i> 7. Antony Lewis, <i>The Basics of Bitcoins and Blockchains An Introduction to Cryptocurrencies and the Technology that Powers Them</i>, 2018
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Rajarajan Zelogic Systems	1. Dr.K.Pradeep, VIT	1. Dr.N.Manikandan, SRMIST

Course Code	21CSE432T	Course Name	BLOCKCHAIN TECHNOLOGY WITH HYPERLEDGER	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Realize the block chain in industry perspective	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Apply the concepts of hyperledger fabric component designs															
CLR-3:	Apply the hyperledger trade network concepts in business networks															
CLR-4:	Apply the concepts of smart contract transactions and ledger data structures															
CLR-5:	Develop smart contracts for any use case															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	comprehend the enterprise block chain and the basic of hyperledger fabric	3	3	1	-	-	-	-	-	-	-	-	-	-	-	3
CO-2:	Apply the concepts of hyperledger fabric component designs	3	3	1	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Apply the hyperledger trade network concepts in business networks	3	3	2	-	3	-	-	-	-	-	-	-	-	2	-
CO-4:	Apply the concepts of smart contract transactions and ledger data structures	3	3	2	-	3	-	-	-	-	-	-	-	-	-	2
CO-5:	Build smart contracts for real time use cases	-	-	2	-	3	-	-	-	-	-	-	-	-	-	3

Unit-1 - Blockchain – An Enterprise and Industry Perspective	9 Hour
Blockchain in the enterprise - Good fit applications - Enterprise blockchain business evaluation considerations - Enterprise view blockchain - Integrating a blockchain infrastructure for the whole enterprise - Enterprise design principles - Business considerations for choosing a blockchain framework - Exploring Hyperledger Fabric - Building on the foundations of open computing - Fundamentals of the Hyperledger project - Hyperledger frameworks, tools, and building blocks	
Unit-2 - Transactions and Business Networks	9 Hour
Hyperledger Fabric component design - Hyperledger Fabric – the journey of a sample transaction - Actors and components in a Hyperledger Fabric network - CAP theorem - new features - Business Networks - A busy world of purposeful activity - Language for business networks - Defining a business network - Participants - Assets - Transactions – Events - Business network technology	
Unit-3 - Setting the Stage with a Business Scenario	9 Hour
Trading and letters of credit - Business scenario and use case - Designing and configuring a Hyperledger Fabric trade network - Launching a sample trade network - Configuring our development environment for network operations	
Unit-4 - Designing Smart Contract Transactions and Ledger Data Structures	9 Hour
Architecture of the trade solution - Starting the contract development - Creating a contract - Access control - Implementing contract functions - Testing a contract - Advanced contract designs - Transaction mechanisms - Logging output	

Unit-5 - Developing Smart Contracts and Use Cases	9 Hour
Developing Smart Contracts - Use case 1: Blockchain in trade/supply chain: (i) Provenance of goods, visibility, trade/supply chain finance, invoice management discounting, etc., - Use case 2: Blockchain for Government: (i) Digital identity, land records and other kinds of record keeping between government entities, (ii) public distribution system social welfare systems Blockchain Cryptography, Privacy and Security on Blockchain Practical Component Building a Network and Deploying Smart Contract & Security	

Learning Resources	1. <i>Blockchain with Hyperledger Fabric - Second Edition</i> - Nitin Gaur, Anthony O'Dowd, Petr Novotny, Luc Desrosiers, Salman A. Baset, November 2020, Packt, ISBN 9781839218750 2. <i>Hyperledger Fabric In-Depth: Learn, Build and Deploy Blockchain Applications Using Hyperledger Fabric</i> , 1st Edition, Ashwani Kumar 3. <i>Hands-On Smart Contract Development with Hyperledger Fabric V2: Building Enterprise Blockchain Applications</i> , Matt Zand 4. <i>Blockchain for Business with Hyperledger Fabric</i> (English, Undefined, Shah Nakul) 5. <i>Hyperledger Cookbook: Over 40 recipes implementing the latest Hyperledger blockchain frameworks and tools</i> Paperback – Import, 30 April 2019 by Xun (Brian) Wu, Chuanfeng Zhang, Andrew Zhang 6. https://hyperledger-fabric.readthedocs.io/en/latest/tutorials.html
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Ms. Divya, Member Technical staff- Senior Developer, ZOHO	1. Dr.S.P. Siddique Ibrahim, Assistant Professor, VIT-AP University.	2. Dr G. Elangovan, SRMIST

Course Code	21CSE433T	Course Name	BLOCKCHAIN BUSINESS MODELS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn the basics of Blockchain and apply cryptography algorithms	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Learn the consensus methods for an application															
CLR-3:	Use blockchain for business models															
CLR-4:	Apply data structures for blockchain															
CLR-5:	Understand how to develop blockchain business models															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Discuss the basics of Blockchain business models	3	3	-	-	-	-	-	-	-	1	-	-	-	-	3
CO-2:	Apply the cryptography techniques in blockchain	3	3	-	-	-	-	-	-	-	2	-	-	-	-	3
CO-3:	Identify the appropriate consensus methods for application	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Describe the technology stack for Blockchain	3	3	-	1	-	-	-	-	-	-	-	-	2	-	-
CO-5:	Apply the blockchain for business models	3	3	-	3	-	-	-	-	-	-	-	-	1	-	-

Unit-1 – Introduction to Blockchain Technologies	9 Hour
History of Blockchain-Terminologies in Blockchain-Types of Blockchain-Applications of Blockchain- How blockchain works-Ingredients of Blockchain. Case Study: Create Survey report of various types of Blockchain and its real time use cases	
Unit-2 - Cryptography	9 Hour
Introduction to cryptography-Encryption and Decryption-Ciphers-Cryptography using arithmetic modulo primes-hashing algorithms-SHA-256 algorithm-Application of SHA algorithm. Case Study: Implement program to convert given text into hashes using SHA 256 algorithm.	
Unit-3 – Consensus Mechanisms	9 Hour
Introduction to Consensus Methods-Proof of Work (PoW)-Proof of Stake (PoS)-Proof of Burn (PoB)- Proof of Activity (PoA)-Proof of Elapsed Time (PoET)-Simplified Byzantine fault Tolerance-Mining. Case Study: Prepare comparison study report of various Consensus methods for financial transaction.	
Unit-4 – Data Structure of Blockchain	9 Hour
Data structures for Blockchain-Merkle Trees-Shared data- Protocols–Fat Protocols-Platforms- DAPPS-Smart Contracts. Case Study: Create simple smart contract for User identity management using Solidity language.	
Unit-5 – Blockchain Business Models	9 Hour
Introduction to Blockchain Business Models-Need for Blockchain business models- Traditional business models-Types of Blockchain Business Models- Blockchain as A Service (BaaS)-Token Economy- Utility Token Business Model-Blockchain-Based Software Products- P2P Blockchain Business Model-Blockchain Professional Services. Block chain for Banking and Financial transactions. Case Study: Create simple wallet transaction from one account to another account using Metamask.	

Learning Resources	<ol style="list-style-type: none"> 1. <i>Blockchain for Business</i>, 1st edition, Published by Addison-Wesley Professional (May 9th 2019) - Jai Singh Arun, Jerry Cuomo, Nitin Gaur. 2. <i>Blockchain Business Models, A Complete Guide</i>, Gerardus Blokdyk, March 2021. 3. <i>Blockchain Development for Finance Projects</i>, by Ishan Roy, January 2020, Packt Publishing, ISBN: 9781838829094 	<ol style="list-style-type: none"> 4. <i>The Internet of Money: A collection of talks by Andreas M. Antonopoulos</i>, November 2019. 5. <i>The Blockchain Developer - A Practical Guide for Designing, Implementing, Publishing, Testing, and Securing Distributed Blockchain-based Projects</i>, by Elad Elrom, Apress, July 2019, ISBN:9781484248478. 6. <i>The Metaverse: And How It Will Revolutionize Everything</i>, Book by Matthew Ball, July 2022. Publisher : Liveright
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Ishan Roy, Director, Metabasu Technologies Private Limited	1. Dr.S. Ganapathy, Associate Professor, Vellore Institute of Technology, Chennai.	1. Dr. Prabhu kavin.B, SRMIST
2. Mr. Rex Aantonny, Founder & CEO, Rex Cyber Solutions Pvt Ltd	2. Dr. S. Muthurajkumar, Assistant Professor / Computer Technology, Madras Institute of Technology Campus, Anna University, Chrompet, Chennai - 600044.	

Course Code	21CSE434T	Course Name	DISTRIBUTED LEDGER TECHNOLOGY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understanding the fundamentals & basic tools used for DLT regulatory framework	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Employ knowledge in Hyperledger Fabric and Cryptographic Approaches for Hyperledger															
CLR-3:	Demonstrate the services and techniques in Smart Contracts and Communication Technologies															
CLR-4:	Implement and analyze the different Leading Blockchain and DLT Protocols															
CLR-5:	Categorize the different Case studies related to DLT															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Recognize the knowledge of Distributed ledger technology	3	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO-2:	Design and illustrate the Hyper ledger Fabric and cryptographic approaches	3	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO-3:	Analyze the characteristics of End-to-End Encryption in Hyper ledger	3	3	-	-	-	-	-	-	-	-	-	-	2	-	2
CO-4:	Choose the DLT protocols & deploying smart contracts on block chain	3	3	-	-	2	-	-	-	-	-	-	-	2	-	3
CO-5:	Manipulate Block chain applications with Hyper ledger applications	3	3	-	-	2	-	-	-	-	-	-	-	2	-	3

Unit-1 – Fundamentals of DLT	9 Hour
Introduction to Distributed ledger technology, DLT designs and its types, Key features of DLT, Blockchain – DAG, Hash Graph, Holo Chain – Tempo (Radix), Permission less Distributed Ledgers vs. Permissioned Distributed Ledgers, Advantages of DLT, Challenges Related to DLT, Risks Related to DLT.	
Unit-2 - Hyperledgers Fabric and Cryptographic Approaches	9 Hour
Hyperledgers Fabric and Cryptographic Approaches for Hyperledger, Hyperledger Fabric - Architecture, Functionalities, Hyperledger Fabric Model, Hyperledger Fabric Network, Identity, Security-hole in Hyperledger, End-to-End Encryption in Hyperledger, Hash functions, Digital Signatures.	
Unit-3 - Smart Contracts and Communication Technologies	9 Hour
Introduction to Smart Contracts, Ledger Development-Endorsement, Valid transactions, Channels, Intercommunication, System chain code, Networking protocol, Various communication frameworks, Communication in IoT, Smart contract templates	
Unit-4 – DLT Protocols, Architecture and Testing	9 Hour
Leading Blockchain and DLT Protocols, Quorum - Ripple, MultiChain, Symbiont, OpenChain, Cardano, IOTA, EOS - HashGraph, Corda Architecture, Installation - Development, Deployment Unit, and Functional Testing.	
Unit-5 – DLT Case Studies and Applications	9 Hour
DLT Case Study, Blockchain applications with Hyperledger applications, Agriculture, Healthcare and the Life Sciences, Financial Sector and Banking, Digital Identity, Media and Entertainment, Supply Chain, Law, Government and Real estate, Telecom domain, Healthcare—Corda and Ethereum Hybrid Use Case.	

Learning Resources	<ol style="list-style-type: none"> 1. Alexander Lipton and Adrien Treccani, <i>Blockchain and Distributed Ledgers: Mathematics, Technology, and Economics</i>, World Scientific Edition, 2022. 2. Horst Treiblmaier and Trevor Clohessy, <i>Blockchain and Distributed Ledger Technology Use Cases: Applications and Lessons Learned</i>, Springer, 1st edition, 2020. 3. Imran Bashir, <i>Mastering Blockchain: Deeper insights into decentralization, cryptography, Bitcoin, and popular Blockchain frameworks</i>, 2018 - Packt Publishing ,ISBN-10: 1788839048. 4. Roger Wattenhofer, <i>Distributed Ledger Technology - The Science of the Blockchain</i>, Second Revised Edition, 2017, Inverted Forest Publishing, ISBN-13 978-1544232102. 5. Focus Group on Application of Distributed Ledger Technology, https://www.itu.int/en/ITU/focusgroups/dlt/Pages/default.aspx
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Vinod Potty, Project Manager / Infosys	1. Dr. M. Subramaniam, Professor/CBIT	1. Dr. T. Nadana Ravishankar, SRMIST

Course Code	21CSE435T	Course Name	SMART CONTRACTS AND APPLICATION DEVELOPMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand and evaluate the stack of protocols that will form the future Web 3.0 and its decentralized nature	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Demonstrate a local Ethereum Network with Geth, and get familiar with a various development environment															
CLR-3:	Organize the inner workings of smart contracts as means for developing decentralized applications															
CLR-4:	Examine a set of technologies that support the backbone decentralized storage network															
CLR-5:	Evaluate the components of blockchain-based technologies which support Turing-complete languages															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Recall to Construct decentralized applications using the Web3 stack	3	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO-2:	Outline the smart contract development lifecycle	1	2	3	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Identify to reuse common implementation patterns, like modifiers and contract driven development	-	1	2	3	-	-	-	-	-	-	-	-	-	2	-
CO-4:	Discover smart contracts using the Solidity programming language	-	2	2	1	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Determine the deep understanding of the Ethereum model and applications of blockchain	-	3	2	1	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Blockchain Concepts	9 Hour
Blockchain Evolution- Blockchain Structure- Blockchain Characteristics- Blockchain Application Example: Escrow- Blockchain Stack- From Web 2.0 to the Next Generation Decentralized web- Domain Specific Blockchain Applications- Blockchain Benefits & Challenges.	
Unit-2 - Smart Contracts	9 Hour
Structure of a Contract- Setting up and Interacting with a Contract using Geth Client- Gas- Logs- Events- Setting up and Interacting with a Contract using Mist Wallet- Smart Contract Examples- Smart Contract Patterns.	
Unit-3 - Blockchain Application Templates & Ethereum Development Tools	9 Hour
Blockchain Application Components- Design Methodology for Blockchain Applications- Blockchain Application Templates- Ethereum Clients- Go-Ethereum Client (geth)- Python Ethereum Client (pyethapp)- Ethereum Languages- TestRPC- Mist Ethereum Wallet- MetaMask- Truffle- External Owned Account (EOAs)- Contract Account- Keypairs- Working with EOA Accounts- Working with Contract Accounts	
Unit-4 - Decentralized Applications, Mining & Swarm	9 Hour
Implementing Dapps- Case Studies- Consensus on Blockchain Network- Mining- Block Validation- Setting up Mining Node- State Storage in Ethereum- Swarm Architecture and Concepts- Incentive Mechanisms in Swarm- Swarm Setup- Working with Swarm- Case Study: Stock Photos Dapp.	
Unit-5 - Advanced Topics on Blockchain	9 Hour
Double-Spending Problem- Byzantine Fault Tolerance- Proof-of-Work vs Proof-of-Stake, - Consistency, Availability & Partition Tolerance (CAP)- Turing Completeness- Greedy Heaviest- Observed Sub-Tree (GHOST)- Sybil Attack- Mining Pools and Centralization- Smart Contracts Vulnerabilities- Blockchain Scalability	

Learning Resources	1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). <i>Bitcoin and cryptocurrency technologies: a comprehensive introduction</i> . Princeton University Press.	4. Singhal, B., Dhameja, G., & Panda, P. S. (2018). <i>Beginning Blockchain: A Beginner's guide to building Blockchain solutions</i> . Apress.
	2. Antony Lewis, <i>The Basics of Bitcoins and Blockchains An Introduction to Cryptocurrencies and the Technology that Powers Them</i> , 2018	5. Albert Szmigielski, <i>Bitcoin Essentials</i> , 2016
	3. Andreas M. Antonopoulos, <i>Mastering Bitcoin Programming the Open Blockchain</i> , 2017	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. S.Gomathi Sankar , Technical Lead .LTIMindtree	1. Dr. Soma Prathibha Sri Sai Ram Engineering College, Chennai	1. Dr.A.Siva Kumar SRMIST
2. Dhilip Velumani, Module Lead, LTIMindtree	2. Dr.S.V.N. Santhosh Kumar VIT Vellore	2. Dr.S. Ganesh Kumar SRMIST

Course Code	21CSE436T	Course Name	BITCOIN ESSENTIALS AND USE CASES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand what Bitcoin is, how it works and how to start using it safely and effectively.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	understand the mechanism of Bitcoin with both hardware and software															
CLR-3:	analyze how to store and use bitcoin															
CLR-4:	Evaluate the use cases of Blockchain today with a deep dive on cryptocurrencies like Bitcoin															
CLR-5:	evaluate the use of bitcoin in various applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the fundamentals of Bitcoin	1	2	-	-	3	-	-	-	-	-	-	-	2	1	-
CO-2:	Deal with the methods of Bitcoin transactions	1	2	-	-	3	-	-	-	-	-	-	-	1	2	-
CO-3:	Gain knowledge about various operations associated with bitcoin mining	2	3	-	-	2	-	-	-	-	-	-	-	-	1	2
CO-4:	Learn and educate about bitcoin use cases	1	3	-	-	3	-	-	-	-	-	-	-	-	-	2
CO-5:	Gather knowledge on Bitcoin storage and protocols	2	3	-	-	1	-	-	-	-	-	-	-	-	-	3

Unit-1 - Bitcoin (BTC) Introduction	9 Hour
features- Bitcoin's Predecessors- Roots of bitcoin -Bitcoin's Ecosystem- Bitcoin wallets- Types of wallets- Building A Bitcoin payment system: Getting started with Bitcoin, Building a payment gateway	
Unit-2 - Bitcoin Network	9 Hour
Store and use bitcoins- Hot and Cold storage--Getting bitcoin- Spending Bitcoin-Saving bitcoin- Investing Bitcoin-Protecting bitcoin- Transferring Bitcoin-Accepting bitcoin- Decentralization in Bitcoin- Bitcoin protocol limitations and improvements-Distributed consensus- Incentive Mechanism-Block Reward-Transaction fee	
Unit-3 - Bitcoin Mining	9 Hour
Bitcoin Mining Hardware- Bitcoin Mining software-CPU Mining-GPU Mining-FPGA Mining -ASIC Mining -Solo Mining- Pool Mining- Large scale mining-Energy consumption and ecology	
Unit-4 - Mechanics of Bitcoin	9 Hour
Bitcoin transactions- Bitcoin Transaction Standards- Constructing a transaction- Types of transaction- Bitcoin scripts- applications of bitcoin scripts- Bitcoin blocks- Bitcoin Security- Bitcoin addresses	
Unit-5 - Bitcoin use case	9 Hour
Bitcoin as a Platform- Bitcoin as an append-only log- Bitcoins as "smart property"- Secure multiparty lotteries in bitcoin- Bitcoin as a public randomness source- Prediction markets and real-world data feeds- Bitcoin as a Currency- Bitcoin as an Investment. Future of bitcoin: Decentralized Institution	

Learning Resources	1. Narayanan, A., Bonneau, J., Felten, E., Miller, A., and Goldfeder, S. (2016). <i>Bitcoin and cryptocurrency technologies: a comprehensive introduction</i> . Princeton University Press. 2. Andreas M. Antonopoulos, <i>Mastering Bitcoin Programming the Open Blockchain</i> , 2017 3. Pedro franco, <i>Understanding Bitcoin Cryptography, Engineering and Economics</i> , 2015 4. Albert Szmigielski, <i>Bitcoin Essentials</i> , 2016 5. Daniel Forrester, Mark Solomon, <i>Bitcoin Exposed: Today's Complete Guide to Tomorrow's Currency</i> 6. Antony Lewis, <i>The Basics of Bitcoins and Blockchains an Introduction to Cryptocurrencies and the Technology that Powers Them</i> , 2018
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Dr.V. Gopinath, Solution Architect, Tata Consultancy Service Ltd., Chennai	Dr.R.Manoharan, Professor, Department of Computer Science and Engineering, Puducherry Technological University, Puducherry,	1. Dr. Panimalar.K, SRMIST

Course Code	21CSE437T	Course Name	DECENTRALIZED APPLICATIONS ON BLOCK CHAIN	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Discover the fundamentals & basic technologies used for DAPP	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Acquire knowledge in Smart contracts and Ethereum technologies															
CLR-3:	Exploring the services and techniques in Ethereum Technologies															
CLR-4:	Analyze and implement the different leading DAPP's															
CLR-5:	Compare & contrast the different Case studies related to DAPP's															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Summarize the knowledge of Decentralized Applications (DAPP's)	3	-	-	-	-	-	-	-	-	-	-	-	2	-	2
CO-2:	Interpret the features and technologies of DAPP	3	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO-3:	Analyze and design smart contracts & Geth.	3	3	2	-	-	-	-	-	-	-	-	-	2	-	3
CO-4:	Generate DAPP's using Ethereum platform	3	3	-	-	2	-	-	-	-	-	-	-	2	-	3
CO-5:	Design and synthesize Decentralized Block chain applications	3	3	2	-	2	-	-	-	-	-	-	-	2	-	-

Unit-1 – Basics of Decentralized Applications	9 Hour
Introduction to decentralized application, bitcoin, Features of DAPP, History of DAPP, Dapps Vs. Conventional centralized applications, Anatomy of a Dapp, Basic terminologies, Enabling technologies, Good and bad DAPPs, A five-minute Dapp implementation.	
Unit-2 – Flourishing DAPP Ecosystem	9 Hour
Decentralized - data, wealth, Identity, Computing, Bandwidth, Decentralized markets for Decentralized assets, Practical decentralization, A deeper look at Decentralized applications, Block chain technologies and Ethereum technologies.	
Unit-3 – Ethereum Platform	9 Hour
Connecting to Ethereum through the wallet, Smart contracts; the brain of DAPPs, Connecting to Ethereum with geth, managing accounts with geth, Revisiting simple coin's contract.	
Unit-4 – Building Your First DAPP	9 Hour
Decentralized architecture, Introduction to IPFS, DAPP building, setup, Routing, Data storage and retrieval, DAPP economics, Private networks, Human-readable names.	
Unit-5 – Platforms and Case Studies	9 Hour
Basics of Ethereum ecosystem, Managing life cycle, Security considerations, OpenBazaar, LightHouse, and La'Zooz.	

Learning Resources	1. Shahid Shaiikh, "Building Decentralized Blockchain Applications", 2021, BPB Publications, ISBN: 978-9389898620 2. Roberto Infante, "Building Ethereum DApps_ Decentralized Applications on the Ethereum Blockchain", 2019, Manning Publications. 3. Elad Elrom, "The Blockchain Developer", 2019, Apress Publication, ISBN: 9781484248478.	4. Siraj Raval, "Decentralized Applications Harnessing Bitcoin's Blockchain Technology", 2016, O'Reilly, ISBN: 9781491924549. 5.. Free to use forum rusted and used by top Blockchain projects. https://www.dapp.com/app/eos-forum
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mrs. Malathy Selvaraj, Team Lead / TCS	1. Dr. R. Shriram, Professor / VIT Bhopal	1. Dr. T. Nadana Ravishankar SRMIST

Course Code	21CSE438T	Course Name	WEB SECURITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	Identify the basics of Web Security and detailed exploration of computers, communication links and that makeup the web												
CLR-2:	Understand the science of Cryptography and the Web and specifically looks at the encryption algorithms.												
CLR-3:	Explore the privacy protecting techniques to increase the privacy while using the web												
CLR-4:	Address the physical security for web servers to protect the Computer Hardware												
CLR-5:	Understand the access control of the web content in the web server.												
Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	Identify the basics of Web Security and detailed exploration of World Wide Web												
CO-2:	Understand the science of Cryptography with emphasis on Public Key Algorithms												
CO-3:	Explore the techniques to increase your privacy while using the web												
CO-4:	Addressing physical security for web servers for protecting the Computer Hardware												
CO-5:	Focuses on issuing security to the web content of the web server												

Program Outcomes (PO)												Program Specific outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
3	-	-	-	-	-	2	-	-	2	-	-	2	-	-
3	-	3	-	2	-	-	-	-	-	-	-	1	-	-
-	3	-	2	3	-	-	-	-	-	-	-	-	3	-
-	2	2	-	-	-	-	1	-	-	-	-	-	-	2
2	-	-	3	-	-	-	2	-	-	-	-	-	2	-

Unit-5 - Security for Content Providers **9 Hour**

Controlling Access to Your Web Content-Client-Side Digital Certificates-Code Signing and Microsoft's Authenticode-Pornography, Filtering Software, and Censorship-Privacy Policies, Legislation, and P3P- Case Study: Securing Web Applications, Web Vulnerability Scanners: A Case Study.

Learning Resources	1. Izzat Alsmadi "The NICE Cyber Security Framework" Springer, ISBN: 978-3-030-02359-7, 2019	4. William Stallings "Cryptography and Network Security" 6th Edition, PEARSON, ISBN-13: 978-0-13-335469-0, 2013
	2. Richard Fox, Wei Hao, "Internet Infrastructure, Networking Web Services and Cloud Computing" CRC Press, ISBN-13: 978-1-1380-3991-9, 2017	5. Peter Morville, Louis Rosenfeld "Information Architecture" 3rd Edition, O'REILLY, ISBN-13: 978-0-596-52734-1, 2006
	3. John Paul Mueller, "Security for Web Developers" 1st Edition, O'REILLY, ISBN: 978-1-491-92864-6, 2015.	6. Simson Garfinkel, Gene Spafford "Web Security, Privacy and Commerce" 2nd Edition, O'REILLY, ISBN: 978-0-596-00045-5, 2002

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
Mr. Winston Nesayyan, Senior Associate Software Engineer, JP Morgan, Philadelphia	1. Dr Dheeba J, Associate Professor, Department of Analytics, Vellore Institute of Technology Vellore	1. Dr Jeba Sonia J, SRMIST

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume - 11J

**(Syllabi for Computer Science and Engineering w/s in
Gaming Technology Programme Courses)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC306J	Course Name	SOFTWARE ENGINEERING PERSPECTIVES IN COMPUTER GAME DEVELOPMENT	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	0	2	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the games and software engineering research	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Utilize the game jam organization															
CLR-3:	Apply the casual games and development process															
CLR-4:	Implement the evaluation and design of games															
CLR-5:	Analyze the mixed reality game cards															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Acquire knowledge on fundamentals of games and software engineering research	3	1	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-2:	Perform the game jam organization and evaluate it	2	2	-	-	3	-	-	-	-	-	-	-	-	-	3
CO-3:	Perform casual games process	-	2	3	-	3	-	-	-	-	-	-	-	-	-	-
CO-4:	Identify evaluation and design framework	-	3	-	2	3	-	-	-	-	-	-	-	-	-	3
CO-5:	Understand how reality game cards implemented	-	2	3	2	3	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction	12 Hour
The Interdisciplinary Nature of Computer Games- A Brief History of Computer Games- Recent Advances in Games and Software Engineering Research	
Unit-2 – Software Engineering Perspective	12 Hour
Case Studies and Practices in Local Game Jam Software Development Organization: A Software Engineering Perspective- Introduction- Organizational Forms for Local Game Jams and Related Game Creation Events- Local Game Jam and Game Production Field Studies- Observations, Lessons Learned, And Learnable Lessons for Game Jam Organizational Forms- Game Software Development Competitions	
Unit-3 – Game Development Process	12 Hour
Building Casual Games and APIs for Teaching Introductory Programming Concepts- Introduction- GAMES AND CS1/2 Classes- API Design Guidelines- The Development Processes- GTCS Foundations Game Engine- The Space Smasher API- The Corrupted API.	
Unit-4 – Game Design Framework	12 Hour
Evolution of a Model for The Evaluation of Games for Software Engineering Education- MEEGA- Learning with The Body: A Design Framework for Embodied Learning Games and Simulations- The Embodiment Problem-Toward A Design Framework for Embodied Learning Games and Simulations- Applying the Design Framework	
Unit-5 – Case Study and Future Research	12 Hour
Using Ideation Cards for Designing Mixed Reality Games- ideation cards- mixed reality game cards- Design Lessons for Ideation Cards- Theme Cards- Role-Playing Game to Exergame- Survey on Software Architecture, Creativity, And Game Technology- Future Research Opportunities	

Lab Experiments	
<ol style="list-style-type: none"> 1. Formal Game Development Proposal Stage-1 Includes the Steps Game 2. Description Overview, Background Story, and Design Decision 3. Formal Game Development Proposal Stage-2 Includes Technical 4. Achievement, Development Schedule, Layered Task Breakdown, Functional 5. Minimum, Task List, Timeline and Assessment 6. Prototype setup for the game described 7. Testing - prototype's playing experience 8. Prototype's experience findings and conclusion 	<ol style="list-style-type: none"> 9. Report on development progress, challenges, and future work 10. Alpha release after partial game development progress, challenges, and future work 11. Conduct playtesting session with different play test methods 12. Record the play testing questions and comments 13. Design revisions based on play test 14. Results, experience, and conclusions 15. Reports on personal impressions

Learning Resources	<ol style="list-style-type: none"> 1. Software Engineering Perspectives in Computer Game Development, Kendra M. L. Cooper, 2021. 2. Scacchi, Walt. "Case Studies and Practices in Local Game Jam Software Development Organization: A Software Engineering Perspective." Software Engineering Perspectives in Computer Game Development. Boca Raton and London: CRC Press, 2020. 37-57. 	<ol style="list-style-type: none"> 3. Chau, Brian, et al. "Building Casual Games and APIs for Teaching Introductory Programming Concepts." FDG. 2015. 4. Wang, Alf Inge, and Njål Nordmark. "Survey on Software Architecture, Creativity, and Game Technology." Software Engineering Perspectives in Computer Game Development. Chapman and Hall/CRC, 2021. 253-278.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council	1. Dr.S. Venkatesan, IIITM, Alahabad	1. Dr. A. Murugan, SRMIST
2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.		

Course Code	21CSC307T	Course Name	DEEP LEARNING IN GAMING AND APPLICATION	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basics of Deep Learning and Neural networks.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Build, train, and test basic Convolutional and Recurrent Networks.															
CLR-3:	Relate the working knowledge on GAN for Games.															
CLR-4:	Examine Reinforcement Learning tasks and the core principals behind the Deep Reinforcement Learning.															
CLR-5:	Recognize the applications of deep learning in Gaming development.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Identify the importance of deep learning architecture and its applications.	3	1	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-2:	Appreciate the importance of Convolutional and Recurrent Networks in game development.	3	2	2	-	3	-	-	-	-	-	-	-	-	-	3
CO-3:	Identify and apply foundational theories and approaches of GANs for Game development.	2	2	3	-	1	-	-	-	-	-	-	-	-	-	2
CO-4:	Implement Code common algorithms in Deep Reinforcement Learning.	3	3	2	2	3	-	-	-	-	-	-	-	-	-	2
CO-5:	Apply the power of Deep Learning to build complex reasoning tasks.	2	3	3	3	3	-	-	-	-	-	-	-	-	2	1

Unit-1 - Deep Learning for Games	9 Hour
The Past, Present and Future of DL-Neural Networks the Foundation- Multilayer Perceptron in TensorFlow- TensorFlow Basics- Training Neural Networks with Back propaganda – The Cost Function – Partial differentiation and the chain rule – Building an autoencoder with Keras – Training the model – Examining the output	
Unit-2 - Convolutional and Recurrent Networks	9 Hour
Convolutional neural networks – Monitoring training with Tensor Board – Understanding Convolution – Building a self-driven CNN- Spatial Convolution and pooling – The need for Dropout – Memory and recurrent networks – Vanishing and exploding gradients rescued by LSTM – Playing Rock, Paper, Scissors with LSTMs.	
Unit-3 - GAN for Games	9 Hour
Introducing GANs – Coding a GAN in Keras – Training a GAN – Optimizers – Generating textures with a GAN – Batch Normalization – Leaky and other ReLUs – A GAN for creating music – Training the music GAN – Generating Music via an alternative GAN.	
Unit-4 - Deep Reinforcement Learning	9 Hour
Introduction to Deep Reinforcement learning – The multi-armed bandit – Contextual bandits – RL with the Open AI Gym – A Q-Learning model – Markov decision process and the Bellman equation – Q-learning – Q-learning and exploration – Frist DRL with Deep Q-learning – RL experiments – Keras RL.	
Unit-5 - Building a Deep Learning Gaming Chatbot	9 Hour
Neural Conversational Agents-General conversational Models-Sequence to Sequence Learning-Building the chatbot server-Running the chatbot in Unity-Case studies related to Development of Games using Deep Learning	

Learning Resources	1. <i>Hands-On Reinforcement Learning for Games: Implementing self-learning agents in games using artificial intelligence techniques</i> , Michael Lanham, Packt Publishing, and Year: 2020.	3. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 2016 (available at http://www.deeplearningbook.org)
	2. <i>Hands-On Deep Learning for Games</i> , Michael Lanham, Packt Publishing, Year: 2019	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council	1. Dr. Anbuchelian - Ramanujan Computing Center, Anna University	1. Ms.S. Sindhu, SRMIST
2. Mr Ajay Kumar, Consultant, Scopik edutech private limited		

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSE235T	Course Name	GAME DESIGN, PROTOTYPING AND DEVELOPMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Identify the basic concepts of game prototypes and design	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Describe the key components and making a prototype around it															
CLR-3:	Illustrate the programming skills, Identify the fun and the goal of the game, Design the content and rules of the game															
CLR-4:	Analyze and identify the bugs of the game															
CLR-5:	Predict how game development is a combination of Design, Engineering, and Production															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Recognize knowledge in prototyping, designing, and testing	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Apply the knowledge of programming	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Identify the array of game development techniques	-	3	2	2	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Prepare creatively in every level of game and present interactive game concepts with clarity	-	3	3	2	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Employ the techniques used in the design, development, and documentation of games	-	-	3	3	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Introduction to Game Development	9 Hour
Game Development Overview and Introduction, Game Design and Paper Prototyping: Thinking like a designer, Game Analysis Frameworks, Game Analysis Frameworks, Overview of Layers and Design Goal, Inscribed Layer, Dynamic Layer, Cultural Layer and cultural impact of a game, Game Design Document: GDD to unity, giving controls to user, Prototyping Non player characters, UI coordinate systems: Choosing the correct coordinate system, Building UI Canvas, UI Scripting, Profiling and Localization	
Unit-2 - Game Testing	9 Hour
Why Playtest, Methods of Playtesting, Importance of Playtesting, many faces of testing, Testing life cycle, Design, prototype, alpha, beta testing, Math and Game Balance, Installing Apache OpenOffice Calc, Examining Dice Probability with calc, Math of Probability, Randomizer technologies in paper games, Weighted distributions, permutations, positive and negative feedback.	
Unit-3 - Game Design	9 Hour
Scott Kim on Puzzle Design, Puzzle examples in action Games, Guiding the player, Direct Guidance, Methods in Direct Guidance, Indirect Guidance, Methods in Indirect Guidance, Guiding Skills and concepts, Digital Game Industry, About DGI, Game Education, Getting into the Industry	
Unit-4 - Prototyping	9 Hour
Digital Prototyping: Thinking in digital systems, Systems Thinking: Game Analysis Learning Development Environment, Introducing C#: variables and components, Boolean Operations and conditionals Loop, List and Arrays, Functions and Parameters, Debugging, Classes, Object Oriented Thinking, Agile Software Development, Scrum Methodology, Burn down charts	
Unit-5 - Testing	9 Hour
Game Testing Disciplines, Bugs: Bugs Severity Levels, Balance testing, Decision Makers: Overview, Game Producers, Game Testers, Bug Categories, Documentation, Test Plan, Bug Spotting/ Hunting, Reports and Verifications, Mobile Games Testing-Process of Testing Mobile Games and Phases of Mobile Game Testing	

Learning Resources	1. Jeremy Gibson Bond, "Introduction to Game Design, Prototyping, and Development: From Concept to Playable Game with Unity and C#", 2nd Edition, 2017. 2. Stephen Gose, " Phaser Game Prototyping: Building 100s of games using Game Prototyping templates in HTML5 and Phaser JavaScript Framework", 2017 3. Luis Levy, Jeannie Novak, " Game Development Essentials: Game QA & Testing", Cengage Learning, Inc, 2009.	4. https://www.gamedesigning.org/learn/unity/ 5. https://www.testbytes.net/blog/game-testing-tutorial/
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.D.Saravanan, Senior Manager, Cashkaro.com	1. Dr.P. Siddique Ibrahim, VIT, AP	1. Dr.D.Rajeswari, SRMIST

Course Code	21CSE236T	Course Name	GPU PROGRAMMING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Identify the fundamentals of GPUs & its basic architecture	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Illustrate the Data Parallelism and CUDA and its execution model															
CLR-3:	Study the CUDA Memories, floating point, and performance consideration															
CLR-4:	Understand and Learn OpenCL programming for parallel processing															
CLR-5:	Analyze the parallel patterns problem and heterogeneous computing															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Study on the fundamentals of GPU, Architecture and APIs	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-2:	Analyze the knowledge and functions on CUDA C and acquire the ability to use parallelism	1	2	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-3:	Obtain the knowledge on CUDA memory types and floating-point operations	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-4:	Apply OpenCL programs for designing parallel programs with CUDA	-	2	2	-	2	-	-	-	-	-	-	-	-	-	-
CO-5:	Illustrate the knowledge gained on parallel patterns and heterogeneous computing clusters towards application development	1	2	3	-	3	-	-	-	-	-	-	-	-	-	2

Unit-1 - Basic of GPU	9 Hour
Introduction to GPU, Heterogeneous Parallel Computing, Architecture of a Modern GPU, Need of speed, Speeding Up Real, Applications, Parallel Programming Languages and Models, Overarching Goals, History of GPU Computing, GPGPU - GPU Computing, Scalable, Recent Developments, Future Trends, Introduction APIs, CUDA C, OpenCL, Brook, OpenACC, APIs	
Unit-2 - Data Parallelism and CUDA Structure	9 Hour
Introduction to Data Parallelism and CUDA C, CUDA Program Structure, A vector addition kernel, Device Global Memory, Programming Exercise – Hello World, Data Transfer, Kernel Functions and Threading Example, Data Parallel Execution Model – CUDA Thread Organization, Mapping Threads to Multidimensional Data, Matrix Multiplication, Synchronization, Transparent Scalability, Assigning Resources to Blocks, Querying Device Properties, Thread Scheduling and Latency Tolerance- example	
Unit-3 - CUDA Memory Concepts	9 Hour
CUDA Memories and its efficiency, Importance of Memory Access, CUDA Device Memory Types, Comparison with Von Neumann and shared buffers, A Strategy for Reducing Global Memory Traffic, Carpooling Example, A Tiled Matrix - Matrix Multiplication Kernel., Illustration, Memory as a Limiting Factor to Parallelism, Performance Consideration – Warps and Thread Execution, Example, Global Memory Bandwidth, Illustration.	
Unit-4 - Open CL Program	9 Hour
OpenCL basics, Introduction, Platform model, Execution mode, Kernels and OpenCL programming model, Vector addition using OpenCL, Image rotation and convolution, using OpenCL, The kernel execution domain, Work Item, Workgroups, NDRanges, Application: Image clustering using OpenCL	

UNIT-5 - MPI Concepts		9 Hour
Parallel Patterns, Convolution, Prefix sum, Sparse Matrix, Vector Multiplication, Application: Advanced MRI reconstruction, A running example, MPI basics MPI point-to-point Communication types, programming a heterogeneous computing cluster, Overlapping Computation and Communication, MPI Collective Communication		
Learning Resources	1. David B. Kirk, Wen-mei W. Hwu, <i>Programming Massively Parallel Processors – A Hands-on Approach</i> , Third Edition, Morgan Kaufmann, 2016 2. Shane Cook, <i>CUDA Programming: – A Developer’s Guide to Parallel Computing with GPUs (Applications of GPU Computing)</i> , First Edition, Morgan Kaufmann, 2012	3. David R. Kaeli, Perhaad Mistry, Dana Schaa, Dong Ping Zhang, – <i>Heterogeneous Computing with OpenCL</i> , 3rd Edition, Morgan Kauffman, 2015

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council	1. Assistant Professor in Computer Science and Engineering at National Institute of Technology Srinagar Venington K	1. Dr.M.Ramprasath, SRMIST
2. Mr Ajay Kumar, Consultant, Scopik edutech private limited	2. Dr.K.Sitara Assistant Professor in Computer Science and Engineering at National Institute of Technology, Trichy	2. Dr. R. Rajkumar, SRMIST

Course Code	21CSE237T	Course Name	ART CREATION FOR GAMES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Introduce the skills needed by game designer	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Illustrate the idea needed for a game															
CLR-3:	Analyze the most common types of game balance															
CLR-4:	Explain the interest curves and shadows and colors															
CLR-5:	Create the 2D and 3D animations															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	understand the game design, production, and development	3	-	2	-	2	-	-	-	-	-	-	-	2	2	-
CO-2:	Identify navigation and manipulating objects	2	-	2	-	-	2	-	-	-	-	-	-	2	2	-
CO-3:	Introduce to camera properties	3	2	2	-	-	-	-	-	-	-	-	-	2	-	2
CO-4:	Create material and apply texturing	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Animate and Manipulate materials	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Game Design and Production	9 Hour
What is game development, Different type of game and use cases (FPS, RPG, Racing, Fighting, Casual, and Money spinner, Casino, Massively Multiplayer Online (MMO) These games are played over a LAN (local area network) or via the Internet? Simulations. Adventure. Real-Time Strategy (RTS). Puzzle. Action. Stealth Shooter. Combat) Revert Settings, Launching Your First Project, importing a Project, Switching Between Projects, Customizing The UI	
Unit-2 - Objects Navigation and Manipulating	9 Hour
How to do Navigation, Manipulating Objects -Taking different type of objects, how to create invisible object that hides objects behind it, How to position Game Objects, How to place Light Probes	
Unit-3 - Introduction to Camera	9 Hour
Adjusting camera target, Camera Tracking, different types of camera-dolly, camera colour filter, camera zoom extend, switching cameras, get current camera, set as active camera, look around	
Unit-4 - Material and Texturing	9 Hour
Creating simple shadows- creating planar shadows- creating projected shadows-Using grid in virtools-creating grid collision-Creating a background-creating a background colour using a background image	
Unit-5 - Animating and Manipulating Material	9 Hour
Basic texture animation-creating pseudo-3D characters using sprites, animating material movement,2Dinterface, creating a 2D sprite-creating a 2D frame	

Learning Resources	1. <i>Fundamentals of Game Design</i> , 3e Paperback – 2015 by Adams (Author)	3. https://www.udemy.com/unitycourse
	2. <i>Drawing Basics and Video Game Art: Classic to Cutting-Edge Art Techniques for Winning Video Game Design</i> by Chris Solarisk	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.K.Selvakumar, Team Lead, TCS	1. Dr.N.Bhalaji, Asso.Prof, SSNCE	1. Dr.A.Chinnasamy, SRMIST

Course Code	21CSE238T	Course Name	STORYTELLING FOR MARKETING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the fundamentals of Storytelling	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Analyze the uses of various Marketing															
CLR-3:	Analyze the Storytelling Methods															
CLR-4:	Evaluate the Business Applications of Storytelling															
CLR-5:	Create the Storytelling as a Marketing Tools and its goal															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand Historical & Scientific Context of Storytelling	2	-	-	2	-	-	-	-	-	-	-	-	2	2	-
CO-2:	understand audience relationship in storytelling and marketing	2	-	-	2	-	-	-	-	-	-	-	-	2	2	-
CO-3:	Recognize storytelling frameworks & techniques	2	-	-	2	-	-	-	-	-	-	-	-	2	2	3
CO-4:	apply business applications of storytelling	2	-	2	2	-	-	-	-	-	-	-	-	2	-	-
CO-5:	implement marketing applications of storytelling	-2	-	2	2	-	-	-	-	-	-	-	-	2	2	-

Unit-1 - Introduction to Historical & Scientific	9 Hour
Context of Storytelling, Oral Tradition of Storytelling: Definition, History & Examples, Role of Storytelling in Human Development, The Power of Storytelling for Building Business Relationships, The Neuroscience of Storytelling, Relatability & Psychology of Storytelling, Novelty in Storytelling: Significance & Impact	
Unit-2 - The Audience Relationship in Storytelling Marketing	9 Hour
Relating to Your Business' Target-Market Audience, Story Matrix: Components & Marketing Application, Story-Relationship Funnel: Concept & Application, Storytelling Flywheel: Create, Connect & Optimize, How to Build Deep Audience Relationships Through Storytelling	
Unit-3 - Storytelling Frameworks & Techniques	9 Hour
The Hero's Journey: Campbell's Archetype, Harmon's Story Circle: Explanation & Example, Ben Franklin's Deconstruction & Reconstruction Method, Conciseness in Writing: Definition & Meaning	
Unit-4 - Business Applications of Storytelling	9 Hour
Using Storytelling to Enhance Business Relationships, Using Storytelling to Build Effective Business Presentations, What is Idea Generation? - Definition, Process & Techniques, Creating a Culture of Storytelling at Work	
Unit-5 - Marketing Applications of Storytelling	9 Hour
Storytelling as a Marketing Tool, Developing Goals & Strategies for Digital Content Marketing, Creating a Product Image Through Storytelling, Storytelling for Non-Profit Marketing, What is Viral Marketing? - Definition, Techniques & Examples, Experiential Marketing: Definition, Strategies & Example, What is Movement Marketing? - Definition & Examples	

Learning Resources	1. <i>Storytelling in business NYU Stern School of Business Ron Shacha MBA Summer 2019</i>
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. <i>Dr.K.C.Suresh,Projectb Head, mindtree technologies private limited</i>	1. <i>Dr.P.Selvakumari, Asso.Prof, CIT</i>	1. <i>Mr.C.Arun, SRMIST</i>
		2. <i>Dr.A. Chinnasamy SRMIST</i>

Course Code	21CSE339T	Course Name	GAME ARTIFICIAL INTELLIGENCE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn the basics of Artificial Intelligence and challenging factors in developing games	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the different algorithms for game development															
CLR-3:	Observe the methodology of path finding															
CLR-4:	Summarize the commands and tools to develop the game															
CLR-5:	Design games using artificial intelligence techniques															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Explain the basic concepts of artificial intelligence and its challenging factors	3	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Describe the various algorithms in game development	2	3	3	-	-	-	-	-	-	-	-	-	-	2	2
CO-3:	Illustrate the different methodologies of path finding	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Choose the suitable tool for game design	-	2	2	-	3	-	-	-	-	-	-	-	-	-	2
CO-5:	Select the appropriate design for artificial intelligence games	-	-	3	-	3	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to Game AI	9 Hour
Introduction of AI and Games, models of game AI, Kinds of AI Games, complexity, and constraint, Speed, Memory, AI Engine	
Unit-2 - Movement Techniques	9 Hour
Basics of Movement Algorithms, Steering Behaviors, Combining Steering Behaviors, Predicting physics, Motor Control, Movement in the Third Dimension	
Unit-3 - Pathfinding Methods	9 Hour
Basic Pathfinding and waypoints, Graphs -Dijkstra, A*, Representation, Continuous Time path finding, Movement Planning	
Unit-4 - Decision Making and Diagnostic tools	9 Hour
Decision Making, Finite state Machine, Fuzzy Logic, Rule based AI, AI Commands, AI diagnostic Tools, Building an AI Diagnostic Tools, A Data-Driven Architecture for Animation Selection	
Unit-5 - Designing Game AI	9 Hour
Designing Game AI- The Design- Shooters- Driving- Real-Time Strategy- Sports- Turn-Based Strategy Games, case study: heuristic cost calculation for 4 queens, tic tac toe problem	

Learning Resources	1. <i>Paul Roberts Artificial Intelligence in Games, 1st Edition</i>), Published by CRC Press, July 28, 2022 ISBN 9781032033228	4. <i>AI Game Programming Wisdom, Thomson Learning, Inc. – a series of books on various aspects of game development</i>
	2. <i>Ian Millington, John Funge, Artificial intelligence for Games, Third edition, CRC Press publishers, 2019, ISBN: 9781351053280</i>	5. <i>David M. Bourg, Glenn Seemann, AI for Game Developers, O'Reilly Series, 2004, ISBN: 9780596005559.</i>
	3. <i>Georgios N. Yannakakis, and Julian Togelius, Artificial Intelligence and Games, (1st Edition), Springer, 2018, ISBN 978-3-319-63519-4</i>	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. <i>Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council</i>	1. <i>Dr.B.Surendiran, NIT, Pondicherry</i>	1. <i>Dr.G.Premalatha, SRMIST</i>
2. <i>Mr Ajay Kumar, Consultant, Scopik edutech private limited.</i>		

Course Code	21CSE340T	Course Name	ANALYTICS AND DECISION MAKING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
Understand the fundamental terms, concepts and theories associated with the phases of Decision Support Systems		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:																
Highlight the uses of various mathematical models, data warehousing and mining																
CLR-3:																
Gather the skills in analysis, design, and implementation of group support																
CLR-4:																
Link expert system as a subsystem of DSS																
CLR-5:																
Track the knowledge representation methods.																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:		2	-	-	-	-	2	-	-	-	-	-	-	2	-	-
Explain the fundamental terms, concepts and theories associated with the phases of decision support systems																
CO-2:		-	3	2	-	-	-	-	-	-	-	-	-	-	-	-
Describe the uses of various mathematical models, data warehousing and mining																
CO-3:		2		2	-	3	-	-	-	-	-	-	-	2	-	-
Discuss and develop skills in the analysis, design, and implementation of group support																
CO-4:		2	2	-	-	-	-	-	-	-	-	-	-	-	2	-
Illustrate expert system as a subsystem of DSS																
CO-5:		2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Present the knowledge representation methods.																

Unit-1 - Introduction	9 Hour
Managerial decision making, system modeling and support – preview of the modeling process, phases of decision-making process.	
Unit-2 - Analysis	9 Hour
DSS components- Data warehousing, access, analysis, mining, and visualization-modeling and analysis-DSS development.	
Unit-3 - Support Systems	9 Hour
Group support systems- Enterprise DSS- supply chain and DSS – Knowledge management methods, technologies, and tools.	
Unit-4 - Expert System	9 Hour
Artificial intelligence and expert systems - Concepts, structure, types - Knowledge acquisition and validation - Difficulties, methods, selection.	
Unit-5 - Semantic Network	9 Hour
Representation in logic and schemas, semantic networks, production rules and frames, inference techniques, intelligent system development, implementation, and integration of management support systems.	

Learning Resources	<ol style="list-style-type: none"> 1. S.Christian Albright, Wayne L.Winston <i>Business Analytics: Data Analysis and Decision Making</i>, 5TH edition, Cengage Learning, 2015. 2. Vicki L. Sauter, "Decision Support Systems for Business Intelligence", 2nd Edition, Wiley 2012. 3. 23 Efraim Turban and Jay E Aronson, "Decision Support and Business Intelligent Systems", PHI, Eighth edition, 2010. 	<ol style="list-style-type: none"> 4. Elain Rich and Kevin Knight, "Artificial intelligence", TMH, 1993. 5. S S Mitra, "Decision support systems, tools and techniques", John Wiley, 1996.
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council	1. Dr.Selvakumar, NIT Trichy	1. Dr.G.Premalatha, SRMIST
2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.		

Course Code	21CSE341T	Course Name	COMPUTER GRAPHICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Gain knowledge about graphics hardware devices and software used	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the two/ three-dimensional graphics and their transformations															
CLR-3:	Get knowledge about various object representation methods and visible surface detection methods															
CLR-4:	Understand the clipping techniques															
CLR-5:	Understand the illumination and color models															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Illustrate the importance of generating various output primitives	3	3	-	-	-	-	-	-	-	-	-	-	1	-	1
CO-2:	Possess the ability to represent various curves and surfaces	3	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO-3:	understand various visible surface detection algorithms and color models	3	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO-4:	Apply the knowledge to install and explore the interfaces of Unity	3	2	-	-	-	-	-	-	-	-	-	-	2	-	3
CO-5:	Possess the ability to design and implement Surface Detection using Unity	2	2	-	-	-	-	-	-	-	-	-	-	2	-	3

Unit-1 - Introduction	9 Hour
Computer Graphics Applications - Graphics System Overview - Raster scan systems, Random scan systems - Input, Output devices - Line drawing Algorithm-DDA - Line drawing Algorithm- Bresenham's - Midpoint Circle Algorithm - Pixel addressing - Filled area primitives - Boundary Fill algorithms - Flood fill algorithms	
Unit-2 - 2D Transformations	9 Hour
Geometric Transformations - Matrix Representation - Homogenous and Composite - 2D Viewing- pipeline and coordinate reference - window to viewport transformation - 2D Viewing function - Clipping - Point Line - Cohen Sutherland - Liang Barsky, NLN, Polygon Clipping - Sutherland Hodgeman - Weiler-Atherton - Curve, Text, Exterior Clipping - Exterior Clipping	
Unit-3 - 3D Transformations	9 Hour
3D Concepts - Object representation - Polygon surfaces and tables - Plane equations and meshes - Parallel Projection, Perspective Projection - Depth Cueing - Curved line & surfaces - Quadratic surfaces - Blobby objects - Spline representation - Bezier Curves and surfaces - B-Spline Curves and surfaces - Quadratic surfaces	
Unit-4 - 3D geometric Transformations	9 Hour
3D geometric and modeling transforms - 3D Viewing - Viewing Pipeline - Viewing Coordinates & Projections - 3D Clipping - Visible Surface Detection methods - Back face detection - Z-buffer method, A-buffer method - A Scan line method, Painter's algorithms - Area subdivision method - Octree - Ray casting method - BSP	
Unit-5 - Illumination Effects	9 Hour
models of illumination - Halftone- Dithering techniques - Constant Intensity Shading-Gouraud Shading - Phong Shading - Ray Tracing Methods - Properties of Light - RGB, CMY Color Model - YIQ Color Model - HLS Color Model - HSV Color Model - Color selection - Computer Animation	

Learning Resources	1. Gabriel Gambetta, "Computer graphics from scratch: a programmer's introduction to 3D rendering" San Francisco, California: No Starch Press, Inc., [2021], ISBN :1718500777	4. Donald Hearn & M. Pauline Baker, –Computer Graphics C Version II, 2nd Edition, Pearson Education, 2010, ISBN 978-93-325-3587-9
	2. Samit Bhattacharya, "Computer Graphics, 2015. Oxford University Press, ISBN 13: 978-0-19-809619-1	5. Peter Shirley, Michael Ashikhmin and Steve Marschner, "Fundamentals of Computer Graphics", 3rd Edition, 2009, ISBN: 9781568814698
	3. John F. Hughes, Andries Van Dam, Morgan McGuire, David F. Sklar, James D. Foley, Steven K. Feiner, Kurt Akeley, II Computer Graphics: Principles and Practice II, 3rd Edition, Addison-Wesley Professional, 2013	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Deepan Chakravarthy, Project Manager, Temnos	1. Dr.S. Muthuraj kumar, Associate Professor, Anna university	1. Dr. Anand M, SRMIST

Course Code	21CSE342T	Course Name	GAMING STUDIO FOR BUSINESS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:		Experience the roles and structure of a game development team as you realize your own games from brainstorming to final delivery.														
CLR-2:		Learn the application of game design concepts to generate a new product														
CLR-3:		Outline the development processes of rapid prototyping and iterative design														
CLR-4:		Explore the structure, methods, and economics of the games industry for decision-making and development.														
CLR-5:		Develop entertaining games and analyse with marketing tools														
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:		Identify the plan and functionalities for game studio setup														
CO-2:		Practice the game design concepts to generate a new product														
CO-3:		Choose the suitable approaches for game production														
CO-4:		Evaluate the games with different testing strategies														
CO-5:		Describe the team, resources, finances, marketing, community of players, operations, and development processes														

Unit-1 - Introduction to Game Development	9 Hour
Development Tools and Resources- Game Development Systems- Unity- GameMaker Studio- Unreal Engine 4- Game Salad- App Game Kit, Art and Design Resources, Audio Resources, Outsourcing, Development Tools, and Resources- Microsoft BizSpark- Adobe Creative Cloud	
Unit-2 - Introduction to prototype Design	9 Hour
Creating the Prototype- Laying the groundwork-stakeholder mapping, milestones -milestone plan, Case Study—Creating a Prototype in Unity- Developing First Unity Game	
Unit-3 - Game publishers on Different OS	9 Hour
Self-Publishing- Base Game Projects, Publishing on PC- Playable Free Alpha Demo- Early Access Release- Installers- Selling a PC Game, Publishing on Apple and Android, Partnering with Games Publishers	
Unit-4 - Testing on Usability	9 Hour
Making the game-user experience (UX)- Audio-Localization-QA testing-QA Bug Tracking -Bug Tracking Software- Working with External QA- Language Translations- Age Ratings, PR and Reaching Out to the Press- Copywriting Tips- Press Releases- Press Distribution Services	
Unit-5 - Case Study	9 Hour
Marketing, Analytics- App Annie- Flurry- Swrve- Apmetrix, Advertising, Websites, Forums and Source Control, Funding, Tax, Legal and Other Odds and Ends.	

Learning Resources	1. <i>The Game Production Toolbox</i> By Heather Maxwell Chandler · 2020, CRC Press	3. <i>The Game Production Handbook</i> By Heather Maxwell Chandler 2009, Infinity Science Press
	2. <i>The Indie Game Developer Handbook</i> , Richard Hill-Whittall 2017	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council	1. Dr.B.Surendiran, NIT, Pondicherry	1. Dr.G.Divya, SRMIST
2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.		

Course Code	21CSE343T	Course Name	WEB SERVICES DEVELOPMENT FOR GAMES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Identify the architecture and building blocks of web services	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	understand SOAP messages and XML															
CLR-3:	Illustrate the UDDI and WSDL for web services															
CLR-4:	Demonstrate the rust and web assembly for game development															
CLR-5:	Identify the animation, collision detection for endless runner															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Distinguish the different web service and its architecture	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Create SOAP messages and XML for communication	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Evaluate UDDI and WSDL for web services	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Develop games using rust and web assembly	-	3	-	-	2	-	-	-	-	-	-	-	-	-	2
CO-5:	Evaluate animation, collision detection for creating endless runner	-	2	-	-	2	-	-	-	-	-	-	-	-	-	3

Unit-1 - Web Service Architecture	9 Hour
Web Service Architecture – Web services Architecture and its characteristics, core building blocks of web services, standards, and technologies available for implementing web services, web services communication, and basic steps of implementing web services. Describing Web Services – WSDL introduction, nonfunctional service description, WSDL 1.1 Vs WSDL 2.0, WSDL document, WSDL elements, WSDL binding, WSDL tools, WSDL port type, limitations of WSDL	
Unit-2 - Overview of XML	9 Hour
XML Document structure, XML namespaces, Defining structure in XML documents, Reuse of XML schemes, Document navigation and transformation. SOAP: Simple Object Access Protocol, Inter-application communication and wire protocols, SOAP as a messaging protocol, Structure of a SOAP message, SOAP envelope, Encoding, Service Oriented Architectures, SOA revisited, Service roles in a SOA, Reliable messaging, The enterprise Service Bus, SOA Development Lifecycle, SOAP HTTP binding, SOAP communication model, Error handling in SOAP	
Unit-3 - Registering and Discovering Services	9 Hour
Registering and Discovering Services: The role of service registries, Service discovery, Universal Description, Discovery, and Integration, UDDI Architecture, UDDI Data Model, Interfaces, UDDI Implementation, UDDI with WSDL, UDDI specification, Service Addressing and Notification, Referencing and addressing Web Services, Web Services Notification	
Unit-4 - Introduction to Rust, Web Assembly	9 Hour
Web assembly, A Rust project skeleton, drawing to the canvas, rendering a sprite- Loading images, Canvas coordinator, Drawing Images, JavaScript callbacks, Async Rust, Sprite sheets – Loading JSON, Parsing JSON, Drawing with cookie cutter, Adding Animation.	

Unit-5 - Creating Endless Runner	9 Hour
Creating a game loop- Request Animation Frame, Loading assets, Cleaner drawing, Integrating the game loop, State machine – definition, types, Managing Animation – Transitioning between states, managing, integrating the state machine, Adding running state, Transitioning to sliding and back again, Creating a real scene, Axis aligned bounding boxes, Trimming the sprite sheet, Colliding with an obstacle, Refactoring for endless running.	

Learning Resources	<ol style="list-style-type: none"> 1. Eric Smith, <i>Game Development with Rust and WebAssembly</i>, Packt Birmingham, 2022 2. Kelvin Sung, Jebediah Pavleas, Fernando Arnez, and Jason Pace, <i>Build Your Own 2D Game Engine and Create Great Web Games</i>, Apress, 2015. 3. <i>Web Services & SOA Principles and Technology</i>, Second Edition, Michael P. Papazoglou, 2012. 4. <i>XML, Web Services, and the Data Revolution</i>, F.P.Coyle, Pearson Education, 2002. 5. <i>Building web Services with Java</i>, 2nd Edition, S. Graham and others, Pearson Education, 2004. 6. <i>Java Web Services</i>, D.A. Chappell & T. Jewell, O'Reilly, SPD, 2002.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.P.Mohan, Project Lead, Aspire Systems	1. Dr.V. Ilayaraja, VIT, Vellore	1. Dr. Rajeswari, SRMIST

Course Code	21CSE344T	Course Name	3D GAME DEVELOPMENT WITH UNITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the Game development fundamentals	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Explore the game objects in User interface															
CLR-3:	Introduce scripting with unity basic features															
CLR-4:	Apply various 3D models in UNITY															
CLR-5:	Create C# code with optimization															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Study the threatening genre and user interface	2	1	-	-	3	-	-	-	-	-	-	-	2	-	-
CO-2:	Explore the unity scripting	2	2	-	-	3	-	-	-	-	-	-	-	2	-	2
CO-3:	Design the environment in UNITY	3	2	-	-	3	-	-	-	-	-	-	-	2	3	
CO-4:	Analyse the functionality in UNITY	2	2	2	2	3	-	-	-	-	-	-	-	2	3	
CO-5:	Create the maze and menus in UNITY	3	3	3	2	3	-	-	-	-	-	-	-	2	2	3

Unit-1 - Genre and UI Basics	9 Hour
Graphical Adventure - Intriguing locations - Compartmentalizing environments - Parallax - Animation -, Genre - Unity UI Basics - Layout - Tool bar - Selecting and Focus - Transform Objects - 3D Objects.	
Unit-2 - Unity Scripting	9 Hour
Installing Unity - Versions of Unity - New Project - New Scene - The Layout - Game Window - Components of Script - Anatomy of a function - Picking objects - Mouse Picks - Conditionals and state - Order of Evaluation.	
Unit-3 - Test Environment	9 Hour
Terrain Generation - Fly through Scene Navigation - Topography - Paint Texture - Paint Details - Creating own terrain assets - Terrain Settings - Shadows - Fog.	
Unit-4 - Navigation and Functionality	9 Hour
Navigation - Arrow Navigation and input - Fun with Platforms - Plan - Collision Walls - Object names - Defining Boundaries - Cursor control - Custom Cursors - GUI Layer - Plot - Walk-through - Items - Flow Chart - Interaction and State	
Unit-5 - Maze and Menus	9 Hour
Relationship with Crypto - Top crypto and metaverse projects - NFT Games - Virtual real estate - NFT impact on Metaverse - Virtual real estate trend, Physical and virtual real estate - Cryptocurrencies.	

Learning Resources	1. <i>Game Development Patterns with Unity 2021: Explore practical game development using software design patterns and best practices in Unity and C#, 2nd Edition, 30 July 2021, by David Baron.</i>	4. <i>Game Development Essentials: Game Interface Design Misc. Supplies – 1 April 2017, by Jeannie Novak (Author), Kevin Saunders</i>
	2. <i>Julia Naomi Rosenfield Boeira, Lean Game Development Apply Lean Frameworks to the Process of Game Development, ISBN: 978-1-4842-3216-3, 2017.</i>	5. <i>Game Engine Architecture, Third Edition 3rd Edition, by Jason Gregory (Author) Advanced Game Design: A Systems Approach, 22 December 2017, by Michael Sellers.</i>
	3. <i>Alan Thorn, Pro Unity Game Development with C#, Apress Springer, 2014.</i>	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	100%	-	5%	-	-	-
	Total	100%		100%		100%	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Sudara Raman, Scopik Ltd, Chennai.	1. Prof. Indrakishor, Department of Computer Science and Engineering, Poomima Institute of Engineering & Technology, Jaipur, Rajasthan.	1. Dr. R. Rajkumar, SRMIST

Course Code	21CSE345T	Course Name	GAME SYSTEM INTEGRATION				Course Category	E	PROFESSIONAL ELECTIVE				L	T	P	C						
																2	1	0	3			
Pre-requisite Courses	Nil		Co- requisite Courses	Nil				Progressive Courses	Nil													
Course Offering Department		School of Computing				Data Book / Codes / Standards				Nil												
Course Learning Rationale (CLR):		The purpose of learning this course is to:						Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Study fundamentals of Lean game design						1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3			
CLR-2:	Work with product design																					
CLR-3:	Integrate the different gaming systems																					
CLR-4:	Design the games and its challenges																					
CLR-5:	Develop the game development platform																					
Course Outcomes (CO):		At the end of this course, learners will be able to:																				
CO-1:	Study about Game Development						2	1	-	-	3	-	-	-	-	-	-	-	1			
CO-2:	Explore the Minimum Viable Product in Game Development						2	2	-	-	3	-	-	-	-	-	-	-	2			
CO-3:	Extract the continuous integration						3	2	-	-	3	-	-	-	-	-	-	-	-			
CO-4:	Analyse the performance measure of games						2	2	2	2	3	-	-	-	-	-	-	-	2			
CO-5:	Create game development using C#						3	3	3	2	3	-	-	-	-	-	-	-	3			
Unit-1 - Lean Game Development																			9 Hour			
Lean Inception - Lean DevOps - Kanban -, Test Driven Development - Lean and Games - An Inception in Practice - Anatomy of Inception - Developing Personas - Brainstorming - Creating Hypothesis																						
Unit-2 - Minimum Viable Product																			9 Hour			
MVP - Building Prototypes - Thinking Simplest First - Splitting the MVG - Generating Hypotheses - Test driven Development - Applying TDD to Games - Making TDD Better.																						
Unit-3 - Continuous Integration																			9 Hour			
Team responsibilities regarding Continuous Integration - Code Versioning - Automated Build - Design and Build - A little bit of build - Test, Code - Test - Coding Game Artwork - Test Automation.																						
Unit-4 - Measuring and Analysis																			9 Hour			
Feedback - Ways of Measuring - Analyzing - Measuring Hypotheses - Creating Ideas for Iterating - First Ideation - Second Ideation - Limitations on Game Development.																						
Unit-5 - Metaverse Investments																			9 Hour			
Designing and Preparing - Event Handling - Power - Ups and Singletons - Player Controller - Weapons - Anime -, Graphical User Interfaces - Refinement and Improvements.																						

Learning Resources	<ol style="list-style-type: none"> 1. <i>Game Development Patterns with Unity 2021: Explore practical game development using software design patterns and best practices in Unity and C#, 2nd Edition, 30 July 2021, by David Baron.</i> 2. <i>Alan Thorn, Pro Unity Game Development with C#, Apress Springer, 2019.</i> 3. <i>Julia Naomi Rosenfield Boeira, Lean Game Development Apply Lean Frameworks to the Process of Game Development, ISBN: 978-1-4842-3216-3, 2017.</i> 	<ol style="list-style-type: none"> 4. <i>Game Development Essentials: Game Interface Design Misc. Supplies – 1 April 2018, by Jeannie Novak (Author), Kevin Saunders</i> 5. <i>Game Engine Architecture, Third Edition 3rd Edition, by Jason Gregory (Author) Advanced Game Design: A Systems Approach, 22 December 2017, by Michael Sellers</i>
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	100%	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Ravikumar, CEO at Hackwit Technologies Pvt Ltd, Chennai.	1. Prof. Indrakishor, Department of Computer Science and Engineering,	1. Dr. R. Rajkumar, SRMIST
	2. Poornima Institute of Engineering & Technology, Jaipur, Rajasthan	

Course Code	21CSE346T	Course Name	DESIGN ART AND THEORY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Introduce the skills needed by game designer	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Illustrate the idea needed for a game.															
CLR-3:	Determine the most common types of game balance															
CLR-4:	Explain the interest curves and patterns within patterns															
CLR-5:	Determine the concepts of aesthetics															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the skills needed by game designer to handle approaches for game design	3	2	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-2:	Analyze ideas behind game design	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Apply the common types of game balance to make the goal easily understood.	3	2	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-4:	Acquire knowledge on interest curves and what comprise interests	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Utilize the concepts of aesthetics to govern the design	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction	9 Hour
Introduction, Skills needed by Game designer, five kinds of listening, Three practical approaches to designing games, Introspection: Power, Perils and Practice, Dissect one's feelings, Essential Experience, Definitions, What is a game? Four Basic elements, Unifying themes, Resonance	
Unit-2 - Overview of Idea	9 Hour
Game begins with an idea - Inspiration, Problem Statement, The silent partner, Choosing an idea, Eight filters, Rule of the loop, Short history of software engineering, Risk assessment and prototyping, eight tips for productive prototyping, Closing the loop, Einstein's violin, Project yourself, Demographics, Psychographics, Modeling, Focus, Empathy, Imagination, Motivation, Judgement, Space, Nested spaces, Object, attributes, states, Actions, Rules, Skill	
Unit-3 - Types of Game Balance	9 Hour
Twelve most common types of game balance - fairness, Challenge vs Success, Meaningful choices, Skill vs Chance, Head vs Hands, Short vs Long, Rewards, Punishment, Freedom vs Controlled Experience, Simple vs Complex, Detail vs Imagination, The Puzzle of puzzles, Good puzzles, Puzzle principles - Make the goal easily understood, Make it easy to get started, Give a sense of progress, Give a sense of solvability, Increase difficulty gradually, Parallelism lets the player rest, Pyramid structure, Hints, Answer, Perceptual shifts, Loop of interaction, Channels of information, List information, channels, Map information, Review dimensions, Modes	
Unit-4 - Game Interest	9 Hour
Interest curves, Pattern inside patterns, What comprise interests, Interest factor examples, Story/Game duality, Myth of passive entertainment, dream, reality, problems, dream reborn, story tips of game designers, feeling of freedom, Indirect methods, Collusions, Transmedia worlds, power of pokemon, Transmedia worlds properties, Nature of game characters, Avatars, Creating compelling characters, Purpose of architecture, Organizing game space, Christopher Alexander's ideas, Real vs Virtual architecture, Level design	

Unit-5 - Aesthetics	9 Hour
Value of aesthetics, Learning to see, Let aesthetics govern the design, Use Audio, Balancing art and technology, Why we play with others, Tips for strong communities, Challenge of Griefing, Secret of successful teamwork, Designing together, Team communication, Purpose of design documents, Document types, Engineering, Management, Writing, Players, Playtesting, questions- why, who, where, what, how, Technology at last, Foundational vs Decorational, Hype cycle, Innovator's dilemma, Singularity, Look into crystal ball	

Learning Resources	<ol style="list-style-type: none"> 1. Kramarzewski, Adam, and Ennio De Nucci. <i>Practical game design: learn the art of game design through applicable skills and cutting-edge insights</i>. Packt Publishing Ltd, 2018. 2. Burgun, Keith. <i>Game design theory: A new philosophy for understanding games</i>. CRC Press, 2012. 3. Schell, Jesse. <i>The Art of Game Design: a Book of Lenses</i>. Amsterdam; Boston: Elsevier/Morgan Kaufmann, 2008.1. 4. Hiwiller, Zack. <i>Players making decisions: Game design essentials and the art of understanding your players</i>. New Riders, 2015. 5. Rouse III, Richard. <i>Game Design: Theory and Practice</i>. Jones & Bartlett Learning, 2004.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	15%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Bhaskar Sahu, Schneider Electric Ltd,	1. Dr. K. S. Swarup, IIT Madras	1. Dr.P.C.Karthik, SRMIST
2. Dr.S.Paramasivam, ESAB,	2. Dr.S.Chandramohan ,Professor, CEG, Anna university	2. Dr.A. Murugan SRMIST

Course Code	21CSE439T	Course Name	VIRTUAL REALITY AND AUGMENTED REALITY	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Illustrate the fundamentals concepts of VR	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Remember about standard Color models	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Discuss about VR Environment Concepts																
CLR-4:	Apply and use of 3D Manipulation and interaction																
CLR-5:	Understand the usage of Augmented Reality																
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	Discuss Virtual Reality Fundamentals	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-2:	Illustrate various color models concepts	1	-	2	-	-	-	-	-	-	-	-	-	2	-	-	
CO-3:	Apply the knowledge in VR Environment	1	2	1	-	-	-	-	-	-	-	-	-	2	-	2	
CO-4:	Identify the concepts of 3D features	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-5:	Apply Virtual Reality applications	2	-	-	2	3	-	-	-	-	-	-	-	-	-	3	

Unit-1 - Introduction to VR	9 Hour
Historical development of VR, Scientific landmarks Computer Graphics, Real-time computer graphics, Flight simulation, Virtual environments, Requirements for VR, Visual Displays, Auditory Displays, Haptic Displays, Choosing Output Devices, Building Objects, Complex Shapes. Generation of fractal curves and landscapes using algorithms, Illustrate the aliasing and anti-aliasing techniques, Generation of Mandelbrot and Julia set fractals.	
Unit-2 - Color Models	9 Hour
Standard Primaries and the Chromaticity Diagram, Intuitive Color Concepts, RGB and CMY color models, HSV Colour Model, Colour Selection and Applications, World Space, World Coordinate, World Environment example, VR Environment Example. Construct the primitives with different color models and simulate the conversion from one model to another, Develop a new texture and apply various mapping on 3D objects Implementation of ray tracing concepts with the collection of 3D models	
Unit-3 - Basic of VR Data Base	9 Hour
R Database, Tessellated Data, LODs, Lights and Cameras, Cullers, Occluders, Scripts, Graphical User Interface, Control Pane, VR toolkits, Software' s for VR, Available operating systems, Available software, Example, illustration	
Unit-4 - Basic of 3D Task	9 Hour
3D Manipulation tasks, Example and Case study, Manipulation Techniques, Input Devices, Interaction Techniques for 3D Manipulation, 3D Travel Tasks, Environment Centered Wayfinding Support, Theoretical Foundations of Wayfinding, Overview of Augmented Reality, Tracking for Augmented Reality, Augmented Reality Interaction, Collaborative Augmented Reality	
Unit-5 - Basic of Augmented Reality	9 Hour
3D Augmented Reality Interfaces, Augmented Surfaces, and Tangible Interfaces, Agents in AR, Transitional AR-VR Interfaces, Heterogeneous user interfaces, Mobile Augmented Reality, annotating environment, Annotating environment, Applications, Optical AR, Video AR, Heterogeneous AR, Mixed Reality case studies: Electronic circuit, Virtual class room, interior design, healthcare etc.	

Learning Resources	<ol style="list-style-type: none"> 1. <i>Virtual Reality Systems</i>, By John Vince, Pearson Education 2002 2. <i>Virtual Reality Technology</i>, 2nd, by Grigore C. Burdea (Author), Philippe Coiffet (Author), Wiley Publications. June 2003 3. <i>Augmented Reality: Principles & Practice Paperback</i> – 12 Oct 2016 by Schmalstieg/Hollerer (Author) 4. <i>Virtual & Augmented Reality for Dummies</i> by Paul Mealy, Publication by John Wiley & Son July 2018 5. Daniela, Linda. "New perspectives on virtual and augmented reality." Available at: https://www.taylorfrancis.com/books/edit/10.4324/9781003001874/new-perspectives-virtual-augmented-reality-lindadaniela, 2020. 	<ol style="list-style-type: none"> 6. Steve Aukstakalnis, "Practical Augmented Reality: A Guide to the Technologies, Applications, and Human Factors for AR and VR" 2016, Publisher(s): Addison-Wesley Professional 7. Course on Virtual Reality, IIT Madras https://nptel.ac.in/courses/106/106/106106138/ 8. Foundation Course on Virtual Reality and Augmented Reality, IIT Madras, NPTEL https://elearn.nptel.ac.in/shop/iit-workshops/completed/foundation-course-on-virtual-reality-and-augmented-reality/, 3rd ed, Pearson, 2016
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council	1. Mr.Venington K Assistant Professor in Computer Science and Engineering at National Institute of Technology Srinagar	1. Dr. M. Ramprasath, SRMIST
2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.	2. Dr.K.Sitara Assistant Professor in Computer Science and Engineering at National Institute of Technology, Trichy	2. Dr. Athira M Nambiar, SRMIST

Course Code	21CSE440T	Course Name	COMPUTER ANIMATION AND SIMULATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Illustrate concepts, approaches, and issues in the field of Animation & Simulation	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Increase the awareness of the students to the questions raised in the disciplines of computer science, Animation, Simulation															
CLR-3:	Focus on the interaction of these disciplines in approaching the study of gaming															
CLR-4:	Make specialization on topics central to Installation, Editing, navigation, animation & simulation.															
CLR-5:	Learn other Simulation techniques in gaming technology.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the game graphics	1	2	2	2	-	-	-	-	-	-	-	-	-	-	1
CO-2:	Analyze the editing, navigation, and workspaces	1	2	1	2	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Evaluate the techniques of Animation & Simulation	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-4:	Create Animation & simulation	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply Computer Animation & simulation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Understanding the Interface	9 Hour
Download & Installation - Understanding the Interface - The Blender Screen (GUI - Headers- How to Quit Blender- How to Start Over-3D View Editor- Sidebar – Object Properties Panel- The Manipulation and Tool-Outliner Editor- The Properties Editor- Editor Types- The User Preferences Editor- Overlays in the 3D View Editor- Scene Manipulation)	
Unit-2 - Editors, Workspaces, Navigation	9 Hour
Editor Types- Resizing Editors- Splitting Editors- Cancel an Editor- Workspaces- Multiple Scenes- Files and Folders- Saving a File- Window File Explorer- Blender File Browser- Navigation- Editor Features- Make a New Folder- Saving Your Work- The Concept of Files- The Append or Link Command- Importing Objects- Activating Import File Types- Packing Data	
Unit-3 - Editing Tools	9 Hour
The Tool Panel- The Add Cube Tool- The Last Operator Panel- Extrusion- The Extrude Region Tool- Inset Faces- The Inset Faces Tool- The Bevel Tool- Edge and Loop Selection- The Loop Cut Tool- The Knife Tool- The Poly Build Tool- The Spin Tool- Creating a Spin Profile- Spin Duplication- The Screw Tool- The Smooth Tool- The Edge Slide Tool- The Shrink Fatten Tool- The Rip Region Tool	
Unit-4 - Animation	9 Hour
The Animation Screen- Movement in the 3D View Editor- Planning the Animation- Keyframes Time and Interpolation- Animation Speed and Length- Inserting Keyframes- Playing the Animation- Automatic Keyframing- Controlling the Animation- The Graph Editor- Editing the Graph- Other Types of Curves- The Curve Properties Panel- Animating Rotation- Rotation Using F-Curves- Animating Other Features- Keying Sets- Animation Follow Path- Displacement Sound Animation- Sound Effect and Cast Modifier.	
Unit-5 - Physics and Simulation	9 Hour
Modifiers and Physics- Force Field- Collision Physics- Cloth Physics- Soft Body Physics- Fluid Simulation- Fluid Simulation Examples- Fluid Particles	

Learning Resources	1. <i>The Complete Guide to Blender Graphics Computer Modeling & Animation</i> CRC press Fifth Edition by John.M. Blain,2019 2. <i>Game Graphics Programming</i> by Allen Sharrod 2008 edition 3. <i>Hands-On C++ Game Animation Programming: Learn Modern Animation Techniques from Theory to Implementation with C++ and OpenGL</i> by Gabor Szauer 2020 edition.	4. <i>Fundamentals of Construction and Simulation Game Design</i> by Ernest Adams 5. <i>Simulation and Serious Games for Education</i> Yiyu Cai, Sui Lin Goei, Wim Trooster 2016 Edition.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council	1. Dr M Kumaraesan Professor / CSE, Jain University	1. Dr.Monica Bhavani M , SRMIST
2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.		

Course Code	21CSE441T	Course Name	MOBILE GAME DEVELOPMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the solid foundation in software engineering for mobile games	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	understand UNITY, C# and its tools and plugins															
CLR-3:	Familiarize themselves with mobile usability and design concerns															
CLR-4:	Implement several individual game project prototypes															
CLR-5:	Implement a larger, demo-able game project in a team environment															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Acquire the knowledge on the fundamentals of game development techniques	3	3	-	-	-	-	-	-	-	-	-	-	1	-	1
CO-2:	Acquire the ability to apply the tools and plugins	3	2	-	-	-	-	-	-	-	-	-	-	1	-	1
CO-3:	Utilize the design and mobile usability on various problems	3	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO-4:	Acquire the ability to prototype the game project	3	2	-	-	-	-	-	-	-	-	-	-	2	-	2
CO-5:	Apply the knowledge gained on larger game projects	2	2	-	-	-	-	-	-	-	-	-	-	2	-	3

Unit-1 - Introduction	9 Hour
Game Design and Paper Prototyping - Game Analysis Frameworks - Inscribed Layer, Dynamic Layer - Cultural Layer, Design Goals - Paper Prototyping, Puzzle Design - The Digital Game Industry, Digital Prototyping - Introducing Our Development Environment: Unity - Thinking in Digital Systems - Introducing Our Language: C# - Variables and Components - Boolean Operations and Conditionals - Lists and Arrays, Classes, Functions and Parameters	
Unit-2 - Game Objects	9 Hour
Basics of Game Development - Scenes, Objects, Components - Working with Unity 2D & 3D - 2D graphics, Camera - Sprites a Texture Atlases - Animation - Scrolling - Overview of vector math - Physics principles - 3D math primer - Basics of 3D World, 3D rendering essentials - Using Unity for 3D development	
Unit-3 - Game Interface	9 Hour
Mobile Game Input - Designing for Mobile - Basic Touch - Multi Touch Gestures - Accelerometer, Virtual joypads - Usability - Designing for the impatient gamer, Audio - Particle Effects - Alternate Game Development Solutions - Cross-platform game engines - Platform specific game creation tools	
Unit-4 - Game Prototype	9 Hour
Game Designing and Prototyping - MDA: Mechanics - Dynamics, Aesthetics - Formal, Dramatic - Dynamic Elements - The Elemental Tetrad - The Layered Tetrad - Artificial Intelligence, Tile maps - AI behavior - Pathfinding - Augmented - Virtual Reality Games	
Unit-5 - Advanced Graphics Development	9 Hour
Advanced Graphics - Native Development - Shaders on mobile - Advanced 3D effects - Plugins - Publishing - Advanced Deploying on the App Store - Software Engineering for Games - Game Architecture and Implementation Patterns - Optimization - Pipelines and Tools - Profiling, Build Systems, Testing	

Learning Resources	1. John P. Doran, "Unity 2020 Mobile Game Development Discover Practical Techniques and Examples to Create and Deliver Engaging Games for Android and IOS", 2nd Edition, Packt Publishing, 2020, ISBN: 9781838980993	4. Jeremy Gibson, "Introduction to Game Design, Prototyping, and Development: From Concept to Playable Game with Unity and C#" ISBN-10:0321933168. 2014
	2. Paris Buttfield-Addison, Jon Manning, Tim Nugent, "Unity Game Development Cookbook: Essentials for Every Game" O'Reilly Media, 2019. ISBN: 9781491999127 3. Jonathon Manning, Paris Buttfield-Addison, "Mobile Game Development with Unity: Build Once, Deploy Anywhere", O'Reilly Media Inc., 2017	5. Sanjay Madhav, "Game Programming Algorithms and techniques", Addison-Wesley, 2013

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Deepan Chakravarthy, Project Manager, Temnos	1. Dr.S.Muthuraj kumar, Associate Professor, Anna University	1. Dr. Anand M, SRMIST

Course Code	21CSE442T	Course Name	GAME MONETIZATION TECHNIQUES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basic concepts of gaming in social life	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Analyze Industry terminologies, metrics in social games															
CLR-3:	Apply game Users and Monetization model															
CLR-4:	Understand Virtual Goods and Currency in game play															
CLR-5:	Analyze game Users and Monetization model															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Identify gaming concepts and social games	3	3	2	3	-	-	-	-	-	-	-	-	-	-	2
CO-2:	Determine the Industry terminologies, metrics in social games	3	3	2	3	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Differentiate type of game Users and Monetization models	2	3	-	2	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Implement Virtual Goods in games and Currency in game play	3	3	1	3	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Apply game Feedbacks and AI Characters in game design	3	3	1	3	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Introduction	9 Hour
The changing tide- What Is A Social Game- Are mobile games social- history of game monetization- what do we mean by monetization-a brief history of game monetization-the three grand eras of gaming- social and mobile games put a lot of power in the hands of the developers-social games make the developer responsible- social games give power to the users-used retail game sales - Monetize your Game or App with Ads	
Unit-2 - Industry and Social Games	9 Hour
Industry Terms and Metrics- Measuring Player Population-Measuring Monetization- Social Network Advertising- Mobile Terms- General Terms- Why These Metrics Matter- Case Study: Ravenwood Fair And The Use of Metrics In Game Design- Science of Social Game Design- Social Network: Make any Game Social- The Average Social Gamer- The Average- Mobile Gamer- Popular Social Networks Today- Games Are Global- It's All About Scale- Using Social Networks To Extend Traditional Games- Creating Social Networks As A Platform Holder - Monetize your Game or App with In-App Purchases	
Unit-3 - Users and Monetization	9 Hour
Acquire, Keep and Regain Users: Build It So They'll Come- The Purchase Funnel- Acquisition: How To Get Players- Acquiring New Users on Facebook- Acquiring New Users on Mobile Platforms- Advertising Efficiently- The Rising Cost of CPI- Virality- Redirecting Users For Increased Virality- How to Retain Users- Tracking Retention- Using Leaderboards And Messaging To Add Stickiness- Using Messages To Remind Users To Return- Only The Last Inch Matters-Monetization Strategies: Show Us The Money- Classic Premium Download Model- Subscriptions- Freemium- Play The Numbers- Combinations- Case Study: Hunters Episode One And Different Monetization Methods - Avoid Giving Players Real Money- Transitioning Models - Which Models Fit Best For Which Type of Game - Make your first Downloads - Tips & Tricks	
Unit-4 - Virtual Goods and Currency	9 Hour
Virtual Goods: fake estates- selling premium goods- functional advantages- game balance considerations- aesthetic "vanity" items- rarity Currency: Greenspan for the win- single currency models- dual currency models- closed and open economies- addressing the matter of "honest" gameplay- Web 3 Gaming: Crypto- Play to Earn- NFT - Upload your Game or App on Google Play and Apple Store	

Unit-5 - Feedbacks and AI Characters	9 Hour
Input and Feedback Mechanisms: Mouse And Keyboard- Controllers- Gestures- Eye Tracking As Input- Cameras- Drones- Finger Taps- More Advanced Anatomically Integrated Input- Thought Control- Speech- Haptic Feedback-Displays- Glasses And VR Headsets Contacts And Retina Projection, Artificially Intelligent Characters :Virtual Characters Take over The World Soon-On AI Characters- Building AI Companions- The Character Visuals- The Dialog- Text To Speech- Indistinguishable From Real Humans-Avatars- The Future of Avatars Artificial And Intelligent Characters - Motivating Players to Buy	

Learning Resources	<ol style="list-style-type: none"> 1. Fields, Tim. <i>Mobile & Social Game Design: Monetization Methods and Mechanics</i>, Second Edition. United Kingdom, Taylor & Francis, 2014. 2. Fields, Tim. <i>Game Development 2042: The Future of Game Design, Development, and Publishing</i>. United Kingdom, CRC Press, 2022. 3. Fields, Tim, and Cotton, Brandon. <i>Social Game Design: Monetization Methods and Mechanics</i>. Netherlands, CRC Press, 2011. 4. <i>Advances in Human Factors in Wearable Technologies and Game Design: Proceedings of the AHFE 2019 International Conference on Human Factors and Wearable Technologies, and the AHFE International Conference on Game Design and Virtual Environments</i>, July 24-28, 2019, Washington D.C., USA. Germany, Springer International Publishing, 2019.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council	1. Dr M Kumaraesan Professor / CSE, Jain University	1. Dr P. Saravanan, SRMIST
2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.		

Course Code	21CSE443T	Course Name	GAME PRODUCTION AND PUBLISHING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Recognize various steps involved in game production.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Explore the different kinds of prototyping in game production															
CLR-3:	Introduce the game pitch and steps in process															
CLR-4:	Elaborate the Developer and publisher overview in game publishing															
CLR-5:	Recognize the steps in testing and expose to various case studies in real time Game production.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Predict the trends in game development cycle.	3	1	-	-	3	-	-	-	-	-	-	-	-	-	1
CO-2:	Identify and apply various prototyping in Game development	2	2	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-3:	Apply the process of pitching in game development.	-	2	3	-	3	-	-	-	-	-	-	-	-	2	-
CO-4:	Design Game plan and Publishing	-	3	-	2	3	-	-	-	-	-	-	-	-	-	2
CO-5:	Plan and produce their own video game in a conscientious manner.	-	2	3	2	3	-	-	-	-	-	-	-	-	-	2

Unit-1 - Introduction	9 Hour
Game production Overview-SWOT analysis-Production Cycle-Preproduction-Game Concept-Game Requirements-Game Plan—Production-Plan Implementation-tracking progress-Task Completion-Production Checklist-Testing-Plan Validation-Code Release-Testing checklist-Post Production-Learn from experience-Archive plan-post production checklist--Different Roles on the Team	
Unit-2 - Prototyping	9 Hour
Eight kinds of prototype-Paper Prototype-Physical Prototype-Playable prototype-Art and sound prototype-Interface Prototype-Code/Tech Prototypes-Core Game Prototypes-Complete Game Prototypes-Documenting the prototypes.	
Unit-3 - Pitching your game	9 Hour
Preparing for the pitch-Elevator Pitch-Executive Summary-Demo-Trailer-Developer Backgrounds-Market Research-Production Plan-Making the pitch-Contract Negotiation-Vetting process	
Unit-4 - Developer and Publisher Overview	9 Hour
Introduction-Function of Developer-Art-Design-Engineering-Audio-User Experience (UX)-Quality Assurance-Function of producer-Background and Training-Career Progression-Types of Producers-Function of publisher-Background and Training- Career Progression-Types of Producers-Publishing your Game-Self Publishing-Publishing Partner-Publishing Relationship.	
Unit-5 - Moving from Design to production	9 Hour
Testing process-Informal Playtesting-Design process Testing-QA Testing-Automated Testing-Public facing testing-Case Studies-The Metagame-The Path-Johann Sebastian Joust-How to know when the design is done-Getting Ready for production	

Learning Resources	1. <i>A Playful Production Process: For Game Designers (and Everyone)</i> by Richard Lemarchand, October 2021, MIT Press.	4. <i>Games, Design and Play A Detailed Approach to Iterative Game Design</i> By Colleen Macklin, John Sharp, 2016, Addison-Wesley.
	2. <i>The Game Production Toolbox Paperback</i> 2020, by Heather Chandler, CRC Press. 3. <i>Introduction to Game Design, Prototyping, and Development: From Concept to Playable Game with Unity and C#, Jeremy Gibson Bond, 2017, Pearson Education.</i>	5. <i>Fundamentals of Game Development</i> by Heather Chandler, Rafael Chandler, August 2011, Jones & Bartlett Learning

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council	1. Dr. Anbuchelian - Ramanujan Computing Center, Anna University	1. Ms.S. Sindhu, SRMIST
2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.		

Course Code	21CSE444T	Course Name	APPLIED GAMIFICATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand game design principles and frameworks	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Explain gamification in learning strategies															
CLR-3:	recognize gamification in Physiotherapy, sentiment analysis and recycling practice															
CLR-4:	Design novel gamification approaches															
CLR-5:	Analyze problems on gamification and implementation															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Identify gamification principles and applications	1	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO-2:	Differentiate about various Learning Gamification Strategies	2	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Analyze gamification in Physiotherapy, sentiment analysis and recycling practice	2	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Determine novel gamification approaches	-	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Apply solution to problems on gamification and implementation	-	3	3	1	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Game Design Principles	9 Hour
Gamification Standardization: Gamification Frameworks- Gamification Systematic Study- Use of Gamification on Enterprises: Human Resource Management- Gamification In Human Resources- Gamification Applied To Human Resources- Case Study: Genre Differences in Soft Skills Perception	
Unit-2 - Learning Gamification Strategies	9 Hour
Strategy to Implement Gamification In LMS: Serious Games- Gamification of Learning- Pedagogical Approaches- Theories and Models- Serious Games in Learning Management Systems- Model for Structural Gamification of Learning. Case Study: Gamification of E-Learning In African Universities- Theoretical Foundation And Hypothesis- Gamified Learning: Gamification Mechanisms- The Theory of Gamified Learning- Studying The Influence of Gamification on Learning Outcomes- Solutions And Recommendations	
Unit-3 - Serious Games and Apps	9 Hour
Game to Enhance Physiotherapy Student's Clinical Reasoning: Petrho+ Serious Game- Goals- Theoretical Framework- and Strategy-Establishing Physiotherapy Diagnosis- Using Sentiment Analytics to Understand Learner Experiences: Enjoyment in Serious Game- Sentiment Analytics- Enjoyment Analytics Framework- Motivating Sustainable Recycling Practices: Gamified Recycling Applications- Technologies of Persuasion and Application of Gamification Processes-Solution Conception and Game Logic	
Unit-4 - Gamification Novel Approaches	9 Hour
Artificial Intelligence and Big Data Techniques to Enhance Gamified Financial Services: The Importance of Gamification- Fintech and Gamification- Gamified Healthcare Services and Devices: The Acceptance of Technology- Healthcare and Gamification- Gamified Healthcare Wearable Technology- Augmented Reality Games: Augmented Reality and Gamification- Serious Games and Gamification- Augmented Reality in the Gaming Industry-Game Transfer Phenomenon	

Unit-5 - Gamification Mindset	9 Hour
Problems with Applying Gamified Thinking into a Product: Do You Need to Gamify? - Shallow Gamification- Do You Need to Be a Game Designer to Make a Gamification?- Games Are Cool Gamification Is Not Dull or Juicy Game Feel- Gamification Problems- Ethical Problems- Do Not Forget Algorithms and Big Data- How Can Real-Time Use of Gamification Drive Performance or Not?- Game Design Principles Usable in Gamification: Game Thinking- Game Design Framework- Game Design Elements- Game Dynamics- Embedded Narrative- Emergent Narrative- Game Theory—And It's Not Gamification- Game Theory as a Tree-Game-Inspired Design- Game Player in a Wider Context	

Learning Resources	1. Filipe Portela, Ricardo Queirós, Next-Generation Applications and Implementations of Gamification Systems, IGI Globa, - 2022 2. Ole Goeth, Gamification Mindset, springer, 20192. 3. Wells, Simon & Kotkanen, Henri & Schlafli, Michael & Gabrielli, Silvia & Masthoff, Judith & Jylhä, Antti & Forbes, Paula. (2014). Towards an Applied Gamification Model for Tracking, Managing, & Encouraging Sustainable Travel Behaviours. ICST Transactions on Ambient Systems. 1. E2. 10.4108/amsys.1.4. e2. 4. Transforming Society and Organizations Through Gamification: From the Sustainable Development Goals to Inclusive Workplaces. Germany, Springer International Publishing, 2021.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council	1. Dr M Kumaraesan Professor / CSE, Jain University	1. Dr P.Saravanan, SRMIST
2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.		

Course Code	21CSE445T	Course Name	METaverse FUNDAMENTALS	Course Category	E	PROFESSIONAL ELECTIVE										L	T	P	C					
																2	1	0	3					
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil																	
Course Offering Department		School of Computing			Data Book / Codes / Standards			Nil																
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes						
CLR-1:	Study the various application of metaverse				Engineering Knowledge	1	2	Problem Analysis	3	Design/development of solutions	4	5	6	7	8	9	10	11	12	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-2:	Classify VR and AR possibilities in Metaverse																							
CLR-3:	Discover the challenges for implementation																							
CLR-4:	Identify the hardware and software for closely real time usage																							
CLR-5:	Justify the possibilities of brain computing interface with the applications of VR																							
Course Outcomes (CO):		At the end of this course, learners will be able to:				2	1	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-	-	
CO-1:	Study about the Metaverse and Gaming				2	1	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-2:	summarize the hardware and software possibilities				2	2	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2	
CO-3:	Review about the challenges in NFT				2	2	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-4:	Analyse the future of Metaverse				2	2	2	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-5:	Develop investments in metaverse				3	3	3	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
Unit-1 - Introduction to Metaverse																							9 Hour	
Introduction to Metaverse - Rise of Metaverse - Future of Metaverse - Meta - Microsoft - Epic Games - Roblox - Minecraft - Milestones of Metaverse – ramifications- Various applications in Metaverse																								
Unit-2 - Virtual Reality and Augmented Reality in Metaverse																							9 Hour	
VR in Metaverse - Recruitment - Coordination - New Target - Preparation for virtual Reality - AR updates via spark - Ecommerce using Augmented Reality - AR in Military - Ubiquitous Computing - AR and VR in Metaverse																								
Unit-3 - NFT's In the Metaverse																							9 Hour	
Introduction to NFT - NFT's effect on Metaverse - NFT's Becoming identity in Metaverse - Avoid Risk and Challenges in Metaverse - Legal Ramifications - Data exchange - AI Regulation- NFT and Metaverse																								
Unit-4 - The Future of Metaverse																							9 Hour	
Current states of metaverse market - Shopping and Business - Education - Advertising - Healthcare -, Workplace and Office - Entertainment and Media - Revive History - Social Experience - Enterprise activities- The future of Metaverse																								
Unit-5 - Metaverse Investments																							9 Hour	
Relationship with Crypto - Top crypto and metaverse projects - NFT Games - Virtual real estate - NFT impact on Metaverse - Virtual real estate trend, Physical and virtual real estate – Cryptocurrencies- Metaverse in enterprises																								

Learning Resources	<ol style="list-style-type: none"> 1. Metaverse for Beginners -A Guide to Help You Learn About Metaverse, Virtual Reality and Investing In NFTs, Andrew Clemens (2022). 2. Jesse Glover, Jonathan Linowes – Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications. Packt publishing, 17th April 2019. ISBN -13: 978-1838648183 3. Jonathan Linowes, Krystian Babilinski – Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt publishing, 9th October 2017. ISBN-13: 978-1787286436), "Retail Analytics: The Secret Weapon", Wiley, ISBN- 978-1-118-09984-1 	<ol style="list-style-type: none"> 4. Jesse Glover, Jonathan Linowes – Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications. Packt publishing, 17th April 2019. ISBN -13: 978-1838648183 5. Jonathan Linowes, Krystian Babilinski – Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt publishing, 9th October 2017. ISBN-13: 978-1787286436
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Ravikumar, CEO at Hackwit Technologies Pvt Ltd, Chennai.	1. Prof. Indrakishor, Department of Computer Science and Engineering, Poomima Institute of Engineering & Technology, Jaipur, Rajasthan.	1. Dr. R. Rajkumar, SRMIST

Course Code	21CSE446T	Course Name	DIGITAL MARKETING AND PUBLISHING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the various digital marketing platforms	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Practice the tools available for creating an effective digital marketing strategy															
CLR-3:	Explain technical skills to design and develop an integrated digital marketing plan for an organization.															
CLR-4:	Highlight the publishing strategies and key issue agreements in game Industry															
CLR-5:	Develop entertaining and intuitive experiences for emerging platforms															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the role of digital marketing in marketing strategy	-	-	-	-	-	2	-	-	3	2	-	-	-	-	-
CO-2:	Identify the key elements of a digital marketing strategy	2	-	3	-	-	2	-	-	-	-	-	-	-	-	-
CO-3:	Analyze the role that social marketing plays in the digital marketing	2	-	-	-	-	3	-	-	-	-	-	-	-	-	-
CO-4:	Explore the structure, methods, and key issues in games industry	2	-	-	2	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Create and publishing of a game	-	-	3	-	-	2	-	-	-	3	-	-	-	-	3

Unit-1 - Introduction to Digital marketing	9 Hour
Introduction to Digital Marketing: Introduction - Original and Development of Digital Marketing - Internet Users: Penetration and Kind of Internet Use - Digital Marketing strategy – Digital Advertising Marketing Plan - Ethical and legal of framework of Digital Marketing - Skills Required in Digital Marketing - Digital Advertising: Introduction - Concept of display advertising - Digital Metrics - Types of Digital Ad - Targeting in digital marketing - Challenges faced by display marketing	
Unit-2 - Marketing Strategies	9 Hour
Search Engine Advertising: Introduction – Why pay for search advertising? – Understanding Ad Placement – Understanding Ad Ranks – Why is the Ad rank important? – Create your first Ad Campaign – Google Ads Account – Best practices for creating effective Ads - Enhance your Ad Campaign – Performance Reports – E-Commerce Social Media Marketing -Introduction - Strategy - Implementation - Measure - Improve - Social Entertainment - Different forms of social entertainment – Gamification	
Unit-3 - Social Media Marketing Strategies	9 Hour
Face book Marketing: Introduction – Organic Marketing – Paid Marketing – Facebook Insights LinkedIn: Introduction - LinkedIn Strategy - Content Strategy - LinkedIn Native Videos - LinkedIn Analytics - Asset Copying - LinkedIn Sales Navigator – Ad-campaign - Emerging Platforms: Instagram – Pinterest	
Unit-4 - Publishing and Legal agreement	9 Hour
Game publishing-Introduction-overview of Indie PC and console market-types of publishers-, publishing strategies, Game publishing agreement-Publisher's Objectives-Developer's objectives- Key legal issues in game publishing agreement	
Unit-5 - Case Study	9 Hour
case study - Business process-promoting games-Case studies-practical and Ethical Concerns in usability testing with children- Usability testing of a Three -Dimensional library Orientation Game	

Learning Resources	1. Kevin Hartman <i>Digital Marketing Analytics: In Theory and In Practice</i> Ostmen Bennett Bridge Publishing Services 2nd Edition, 2020 2. <i>The Publishing Challenge for Independent Video Game Developers A Practical Guide</i> By Odile Limpach 2020 3. Simon Kingsnorth <i>Digital Marketing Strategy: An Integrated Approach to Online Marketing</i> 2nd Edition Kogan Page 2nd Edition, 2019.	4. Seema Gupta <i>Digital Marketing</i> McGraw Hill Education 2 nd Edition, 2018 5. <i>Games User Research A Case Study Approach</i> 2017, CRC Press
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	15%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr Jai Naresh, South Region Head, Media Entertainment Cell, and council	1. Dr.Selvakumar,NIT Trichy	1. Dr.G.Divya, SRMIST
2. Mr Ajay Kumar, Consultant, Scopik edutech private limited.		

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 11K

**(Syllabi for Computer Science and Engineering w/s in
Big Data Analytics and Data Science Programme Courses)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

Engineering Science Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSS202T	Course Name	FUNDAMENTALS OF DATA SCIENCE	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							3	2	0	5

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn the different data structures and their packages in Python	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Know to create functions to access and manipulate numbers, strings and datetime data															
CLR-3:	Utilize the Numpy library to analyse numbers															
CLR-4:	Learn the Pandas library to analyse data frames															
CLR-5:	Explore the visualization tools for different kinds of input data formats															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Distinguish the different data structures using the various packages	-	1	-	-	-	-	-	-	-	-	-	-	1	1	-
CO-2:	Create functions to access and manipulate numbers, strings and datetime data	-	2	-	-	-	-	-	-	-	-	-	-	1	1	-
CO-3:	Implement the code for numbers using Numpy	-	3	-	-	-	-	-	-	-	-	-	-	1	1	-
CO-4:	Develop code for data frames using Pandas	-	3	-	-	-	-	-	-	-	-	-	-	1	1	-
CO-5:	Visualize different kinds of data using matplotlib and seaborn	-	2	-	-	-	-	-	-	-	-	-	-	1	1	-

Unit-1 - Introduction to Data Science	15 Hour
Benefits and uses of Data science, Facets of data, The data science process-Introduction to Python Libraries: Numpy, creating array, attributes, Numpy Arrays objects: Creating Arrays, basic operations (Array Join, split, search, sort), Indexing, Slicing and iterating, copying arrays, Arrays shape manipulation, Identity array, eye function, Universal function, Linear algebra with Numpy, eigen values and eigen vectors with NumPy, NumPy Random: Data Distribution, Normal, Exponential, Binomial, Poisson, Uniform and Chi-square distributions. T1: Using Numpy implement Array Indexing and slicing, T2: Using Numpy implement Array basic operations, T3: Using Numpy implement Linear algebra and Random package	
Unit-2 - Introduction to Python Debugging	15 Hour
Debug python scripts using PDB and IDE, Classify Errors, Develop Unit Tests, Create project Skeletons, Implement Database using SQLite, Perform CRUD operations, SQLite database, JSON file – Read, Write and Parse JSON file - JSON Conversion – to dictionary, to JSON, to JSON String, JSON schema – Schema Validation, Resolving JSON Reference, Extending Validator Classes - Virtual Environment, Floating point Arithmetic – Issues and Limitations, Implement Regular Expression and its Basic Functions - findall(),search(),split(),sub(),Use Classes, Objects, and Attributes, Develop applications based on Object Oriented Programming and Methods. T4: Implement programs to handle JSON files, T5: Implement programs to work with Regex functions and classes, T6: Implementing Debugging and creating projects in python IDE	
Unit-3 - Introduction to Python	15 Hour
Django Web Framework: Web development basics and Features of Django, Installing Django and MVC model, HTTP webserver concepts - Use HTTP request and response objects, Create Views, Use URLConf - URL Mapping, Introduction to Django Template System, Load Template Files, Render Templates, Create Forms, Process Form Data and Customize Form Field Validation, Introduction to Django Models, Use Model Fields, populate a Database, CRUD, Use QuerySets for data retrieval, Use jQuery and AJAX with Django to create Dynamic websites T7: Implement Django framework using python – creating basic Django App, T8: Create a simple View using Django, T9: Implement Django app for real-time applications using MVC model	

Unit-4 - Handling Data	15 Hour
<p>Problem faced when handling large data-General techniques for handling large volume of data- General programming tips for dealing large data sets Introduction to Pandas, Data Structure in pandas – dataframe and series, Accessing and slicing of series and dataframes - Arithmetic and logical operations on dataframe, Accessing and slicing of series, And dataframes - Arithmetic and logical operations on dataframe, Groupby operations on Dataframe, Pivot tables to understand the relationship between variables in the data, with different aggregation-Crosstab to understand the relationship between variables in the data, Handling missing data – Time series – date functionality, Time delta Vectorization concept implementation using pandas – I/O tools of Pandas, Indexing, multi indexing concepts - Application. Data handling – Categorical data, Integer data. Computational tools – Statistical functions, windowing operations, Chart and Table Visualization in Pandas.</p> <p>T10: Building programs to access the csv files as a dataframe and analyze the dataframe, T11: Perform different arithmetic, logical, and filtering operations on dataframes</p> <p>T12: Perform group by, pivot and crosstab aggregation on the dataframes</p>	

Unit-5 - Visualization	15 Hour
<p>Advantages and usecases, working with Matplotlib to plot different visuals, Working with Seaborn to plot different visuals, Univariate graphs for numeric and categorical data, Bivariate graphs for numeric and categorical data, Multivariate Graphs, Choosing appropriate graphical techniques, using graph to explore the data insights, Introduction to dashboards.</p> <p>T13: Building programs to visualize the dataframe in matplotlib and seaborn, T14: Building programs to visualize the univariate, bivariate and multivariate relation</p> <p>T15: Case study with all the appropriate graphs to visualize the relationship in the data</p>	

Learning Resources	<ol style="list-style-type: none"> 1. Grus, J. (2019). Data Science from Scratch, 2nd Edition. O'Reilly Media, Inc. 2. Davy Cielen, Arno Meysman, Mohamed Ali – Introducing Data Science: Big Data, Machine Learning, and, more, using Python tools, ManningPublications,2016 3. McKinney, W. (2018). Python for data analysis: Data wrangling with pandas, NumPy, and IPython. O'Reilly Media, Inc. 4. Vanderplas, J. T. (2017). Python data science handbook: Essential tools for working with data. O'Reilly Media, Inc. 5. Magnus Lie Hetland, "Beginning Python: From Novice to Professional", Apress, Second Edition, 2005. 6. Shai Vaingast, "Beginning Python Visualization Crafting Visual Transformation Scripts", Apress, 2nd edition, 2014. 7. Wes Mc Kinney, "Python for Data Analysis", O'Reilly Media, 2012. 8. Wesley J.Chun, "Core Python Applications Programming,3rd ed,Pearson,2016
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. A.G.Rangaraj, Deputy Director (Technical), R&D, RDAF and SRRA Division, National Institute of Wind Energy (NIWE)	Dr.I.Joe Louis Paul, Associate Professor, SSN College of Engineering	Dr.G.Vadivu, SRMIST

Course Code	21CSS301T	Course Name	FULL STACK DEVELOPMENT	Course Category	S	ENGINEERING SCIENCES	L	T	P	C
							1	1	0	2

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn the basics of JavaScript and importance of MERN stack	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Learn the role of React in designing front-end components															
CLR-3:	Understand the design issues in the development of backend components using Node.js and Express															
CLR-4:	Learn the significance of using MongoDB as a database system															
CLR-5:	Explore the advanced features of full stack development															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Setting up MERN environment for node.js	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Apply the knowledge of react based web programming	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-3:	Deal with Node based programming and Express	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Analyze Express based web development	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO-5:	Create a Mongodatabase for DDL commands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

Unit-1 – Basics of MERN Stack	10 Hour
MERN Introduction-MERN Components - React - Node.js - Express - MongoDB - Need for MERN - Server-Less Hello World - Server Setup - npm - Node.js npm. MongoDB - MongoDB Basics - Documents - Collections - Query Language - Installation - The mongo Shell - Schema Initialization - MongoDB Node.js Driver - Reading from MongoDB - Writing to MongoDB	
Tutorial: <ul style="list-style-type: none"> Setting up MERN environment Simple programs in MERN environment Setting up MongoDB and handling data manipulation 	
Unit-2 - React	10 Hour
React Introduction - React ES6 - React Render HTML - React JSX - Components -React Classes - Composing Components - Passing Data - Dynamic Composition - React state - setting State - Async State Initialization - Event Handling Communicating from Child to Parent - Stateless Components - Designing components- React Forms - React CSS - React SaaS	
Tutorial: <ul style="list-style-type: none"> REACT based programming Exploring stateless components 	
Unit-3 - Node.JS and Express	10 Hour
Node.js basics - Local and Export Modules - Node Package Manager - Node.js web server - Node.js File system - Node Inspector - Node.js Event Emitter - Frameworks for Node.js. Express.js Web App - Serving static Resource - Node.js Data Access - Express REST APIs - REST - Resource Based - HTTP Methods as Actions - JSON- Express - Routing - Handler Function – Middleware-Rest API	

Tutorial:

1. Node based web development Handling of various APIs associated with Node.js
2. Express based web development Handling of various APIs associated with Node.js

Mini Project (Tentative Title):

1. E-commerce Website
2. Food Delivery App
3. Social Media App
4. Chat Messaging App
5. Content Management System
6. Blog Site
7. Workout Tracker App
8. Project Management Dashboard

Learning Resources	1. Pro MERN Stack, Full Stack Web App Development with Mongo, Express, React, and Node, Vasam Subramanian, A Press Publisher, 2019.	3. Mardan, A. (2014). Express.js Guide: The Comprehensive Book on Express.js. Azat Mardan.
	2. Bradshaw, S., Brazil, E., & Chodorow, K. (2019). MongoDB: the definitive guide: powerful and scalable data storage. O'Reilly Media.	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Dr.P.Kanmani, SRMIST

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC206P	Course Name	ADVANCED OBJECT ORIENTED AND PROGRAMMING	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Explore JAVA compiler and build domain model for real-time programs	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Apply the OOP concepts in JAVA programs	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Utilize interfaces and packages in java applications																
CLR-4:	Develop java applications using collection interface and Array list class with exception handling																
CLR-5:	Design applications using Graphical User Interfaces and explore JDBC																
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	Infer the concepts of Object-Oriented Programming with JAVA	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-2:	Construct programs using Class and Inheritance	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-3:	Create interface and package in java programs	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-4:	Apply collection interface and Array list class in programs and explore multithreading	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-5:	Design and build simple Graphical User Interfaces and execute queries to store and retrieve data in database	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	

Unit-1 - Introduction to Java	9 Hour
Java programming Environment and Runtime Environment, Development Platforms -Standard, Enterprise, Java Virtual Machine (JVM), Java compiler, Bytecode, Java applet, Java Buzzwords, Java program structure, Comments, Garbage Collection, Lexical Issues. Primitive Data types -Type Conversion and Casting, Variables, Arrays, Strings, Vector class. -Operators -Control Statements-- Selection Statements, Iteration Statements and Jump Statements.	
Tutorial:	
1. Simple JAVA program using control structures, arrays, and Vector Class	
2. Sum of series $(1 + 2 + 3 + \dots + n, 1 + 1/2 + 1/3 + \dots + 1/n, 1^2 + 2^2 + 3^2 + \dots + n^2)$	
Unit-2 - Object Oriented Programming in Java	9 Hour
Class Fundamentals, Declaring Objects, Object Reference, Introduction to Methods, Constructors, this Keyword, Method Overloading, Using Objects as Parameters, Returning Objects, Recursion, Access Control, Static Members, Final Variables, Inner Classes, Command Line Arguments, Variable Length Arguments. Inheritance - Super Class, Sub Class, The Keyword super, protected Members, Calling Order of Constructors, Method Overriding, the Object class, Abstract Classes, and Methods, using final with Inheritance.	
Tutorial:	
1. Create Bank class with suitable methods to create objects as account holders	
2. Program with static members and final variable	

Unit-3 - Packages and Interfaces	9 Hour
Defining Package, CLASSPATH, Access Protection, Importing Packages, Interfaces. Exception Handling - Checked Exceptions, Unchecked Exceptions, try Block and catch Clause, Multiple catch clauses, Nested try Statements, throw, throws and finally Input/Output - I/O Basics, Reading Console Input, Writing Console Output, Print Writer Class, Object Streams and Serialization, Working with Files. Tutorial: 1. Create an interface and implement it in a class 2. Create a package and import it in multiple classes	
Unit-4 - Java Library	9 Hour
String Handling – String Constructors, String Length, Special String Operations -Character Extraction, String Comparison, Searching Strings, Modifying Strings, using valueOf(), Comparison of StringBuffer and String. Collections framework - Collections overview, Collections Interfaces- Collection Interface, List Interface. Collections Class – ArrayList class. Accessing a Collection via an Iterator. Event handling - Event Handling Mechanisms, Delegation Event Model, Event Classes, Sources of Events, Event Listener Interfaces, Using the Delegation Model. Multithreaded Programming - The Java Thread Model, The Main Thread, Creating Thread, Creating Multiple Threads, Synchronization, Suspending, Resuming and Stopping Threads. Tutorial: 1. Programs using Collection Interface and ArrayList Class 2. Programs to implement event handling and exception handling	
Unit-5 - Swings Fundamentals	9 Hour
Swing Key Features, Model View Controller (MVC), Swing Controls, Components and Containers, Swing Packages, Event Handling in Swings, Swing Layout Managers, Exploring Swings –JFrame, JLabel, The Swing Buttons, and JTextField. Java Data Base Connectivity (JDBC) - JDBC overview, Creating and Executing Queries – create table, delete, insert, select. Tutorial: 1. Form Design with Swing 2. Program with Java Data Base Connectivity (JDBC)	

Learning Resources	1. Herbert Schildt, Java: The Complete Reference, 8/e, Tata McGraw Hill, 2011.	4. Y. Daniel Liang, Introduction to Java Programming, 7/e, Pearson, 2013.
	2. Rajib Mall, Fundamentals of Software Engineering, 4th edition, PHI, 2014.	5. Nageswararao R., Core Java: An Integrated Approach, Dreamtech Press, 2008.
	3. Paul Deitel, Harvey Deitel, Java How to Program, Early Objects 11th Edition, Pearson, 2018.	

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	-	20%	-	40%	-	-
Level 2	Understand	40%	-	-	20%	-	40%	-	-
Level 3	Apply	10%	-	-	20%	-	10%	-	-
Level 4	Analyze	10%	-	-	20%	-	10%	-	-
Level 5	Evaluate	-	-	-	10%	-	-	-	-
Level 6	Create	-	-	-	10%	-	-	-	-
	Total	100 %		100 %		100%		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.Harisekharan, Praya AI Lab		1. Dr.Paul T Sheeba .,SRMIST
		2. Dr.T.Karthick SRMIST

Course Code	21CSC307P	Course Name	MACHINE LEARNING FOR DATA ANALYTICS	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:											
CLR-1:	Understanding Human learning aspects.												
CLR-2:	Acquaintance with primitives in the learning process by computer.												
CLR-3:	Develop the linear learning models and classification in machine learning												
CLR-4:	Implement the clustering techniques and their utilization in machine learning												
CLR-5:	Implement the tree-based machine learning techniques and to appreciate their capability												
Course Outcomes (CO):		At the end of this course, learners will be able to:											
CO-1:	Demonstrate knowledge of learning algorithms and concept learning through implementation for sustainable solutions of applications.												
CO-2:	Evaluation of different algorithms on well formulated problems along with stating Valid conclusions that the evaluation supports.												
CO-3:	Formulate a given problem within the Bayesian learning framework with focus on Building lifelong learning ability.												
CO-4:	Analyze research-based problems using Machine learning techniques and apply different clustering algorithms used in machine learning to generic datasets and Specific multidisciplinary domains.												
CO-5:	Evaluate decision tree learning algorithms.												

Program Outcomes (PO)												Program Specific outcomes		
1	2	3	4	5	6	7	8	9	10	11	12			
Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Demonstrate knowledge of learning algorithms and concept learning through implementation for sustainable solutions of applications.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Evaluation of different algorithms on well formulated problems along with stating Valid conclusions that the evaluation supports.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Formulate a given problem within the Bayesian learning framework with focus on Building lifelong learning ability.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Analyze research-based problems using Machine learning techniques and apply different clustering algorithms used in machine learning to generic datasets and Specific multidisciplinary domains.	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-5:	Evaluate decision tree learning algorithms.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

Unit-1 - Introduction and Types of Learning	9 Hour
Introduction: Machine Learning: What & Why? - Examples of Machine Learning applications, Training versus Testing, Positive and Negative Class, Cross-validation. Types of Learning: Supervised, Unsupervised and Semi-Supervised Learning. The Curse of dimensionality-Over fitting and under fitting-Linear regression-Bias and Variance Tradeoff-Regularization-Learning Curve-Classification-Error and noise-Parametric vs. non-parametric models-Linear Algebra for machine learning	
T1: Building programs to work with the data pre-processing in python, T2: Building programs to work with linear regression in python, T3: Building programs to work with cross validation in Python	
Unit-2 - Design and Analysis of Machine Learning Algorithms	9 Hour
Guidelines for machine learning experiments, Cross Validation (CV) and resampling – K-fold CV, bootstrapping, measuring classifier performance, assessing a single classification algorithm, and comparing two classification algorithms – t test, McNemar's test, K-fold CV paired t test Performance metrics-MSE, accuracy, confusion matrix, precision, recall, F1- score-Linear Regression with multiple variables-Logistic Regression-spam filtering with logistic regression	
T4: Building programs to performance metrics in python, T5: Building programs work with linear regression with multiple variables in Python, T6: Building programs work with logistic regression in python	
Unit-3 - Distance Based Models	9 Hour
Ridge Regression-Maximum likelihood estimation (least squares)- Principal component analysis- K nearest neighbour classification –Gaussian Naive Bayes Classification-Multinomial Naive Bayes classification- Bernoulli Naive Bayes Classification-Comparison of Gaussian, Multinomial, Bernoulli naive bayes classification -Support vector machine-Support vector machine + kernels-Multi class classification- -Application: face recognition with PCA.	
T7: Building python programs to use principal component analysis, T8: Building python programs to use Naive Bayes classification, T9: Building programs to use Support Vector Machine	

Unit-4 - Clustering Techniques	9 Hour
Measuring (dis)similarity-Evaluating output of clustering methods-Spectral Clustering-Hierarchical Clustering-Agglomerative Clustering-Divisive Clustering-Choosing the number of clusters-Clustering data points and features-Bi-clustering-multi-view clustering-K-Means clustering-K-medoids clustering-Application: image segmentation using K-means clustering T10: Building programs to implement Hierarchical clustering , T11: Building programs to implement K-Means clustering, T12: Building programs to perform cluster evaluation	
Unit-5 - Tree Based Models	9 Hour
Decision tree representation-Basic decision tree learning algorithm-Inductive bias in decision tree Decision tree construction-Issues in decision tree-Classification and regression trees (CART)- Random Forest-Random Forest with scikit-learn Minority Class, Impurity Measures – Gini Index and Entropy, BestSplit -Multivariate adaptive regression trees (MART)- Introduction to Artificial Neural Networks-Perceptron learning T13: Building programs to implement decision tree algorithm, T14: Building programs to implement random forest algorithm , T15: Building programs to implement Artificial Neural Networks	

Learning Resources	1. Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Fourth Edition, 2020. 2. Stephen Marsland, "Machine Learning: An Algorithmic Perspective, "Second Edition", CRC Press, 2014. 3. Kevin P. Murphy, —Machine learning: A Probabilistic Perspectivell, MIT Press, 2012. 4. Tom Mitchell, "Machine Learning", McGraw-Hill, 1997. Sebastian Raschka, Vahid Mirjalili, llPython Machine Learning and deep learningll, 2nd edition, kindle book, 2018 5. Carol Quadros, llMachine Learning with python, scikit-learn and Tensorflowll, Packet Publishing, 2018. 6. Gavin Hackeling, ll Machine Learning with scikit-learnll, Packet publishing, O'Reily, 2018.
---------------------------	---

Learning Assessment									
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)						Final Examination (0% weightage)	
		Formative CLA-1 Average of unit test (20%)		Project Based Learning CLA-2 (60%)		Report and Viva Voce (20% weightage)			
		Theory	Practice	Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	-	15%	-	-
Level 2	Understand	25%	-	-	20%	-	25%	-	-
Level 3	Apply	30%	-	-	25%	-	30%	-	-
Level 4	Analyze	30%	-	-	25%	-	30%	-	-
Level 5	Evaluate	-	-	-	10%	-	-	-	-
Level 6	Create	-	-	-	5%	-	-	-	-
	Total	100 %		100 %		100 %		-	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. E Nagarajan, R&D Head, Solvedge Technology	1. Dr. Anandhakumar P Professor, Madras Institute of Technology, Chrompet	1. Dr.M.Lakshmi, SRMIST
		2. Dr.Shobanadevi, SRMIST

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSE222T	Course Name	BIG DATA TOOLS AND TECHNIQUES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:								Program Outcomes (PO)												Program Specific outcomes				
CLR-1:	Gain knowledge about the various tools and techniques used in big data analytics	CLR-2:	Learn the fundamentals of Hadoop and the related technologies	CLR-3:	Understand the basics of development of applications using MapReduce, HDFS, YARN	CLR-4:	Learn the basics of Pig, Hive and Sqoop	CLR-5:	Learn the basics of Apache Spark, Flink and understand the importance of NoSQL databases	1	2	3	4	5	6	7	8	9	10	11	12					
										Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
Course Outcomes (CO):		At the end of this course, learners will be able to:								-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
CO-1:	Use the various tools and techniques in big data analytics	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	
CO-2:	Apply Hadoop and related technologies to big data analytics	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	
CO-3:	Apply MapReduce, HDFS and YARN develop big data applications	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	
CO-4:	Develop applications using Pig, Hive and Sqoop	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	
CO-5:	Apply Apache Spark and Flink to applications and understand the importance of NoSQL databases	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-	

Unit-1 - Overview of Big Data Analytics	9 Hour
Introduction to data analytics and big data-Big data mining-Technical elements of the Big Data platform, Analytics Toolkit, Components of the analytics toolkit -Distributed and Parallel Computing for Big Data-Cloud computing and Big Data-In-Memory Computing Technology for Big Data-Fundamentals of Hadoop-Hadoop Ecosystem-The core modules of Hadoop-Introduction to Hadoop MapReduce-Introduction to Hadoop YARN.	
Unit-2 – Big Data Frame Work	9 Hour
MapReduce-Analyzing data with Unix tools and Hadoop-Scaling Out – Data Flow, CombinerFunctions-Hadoop Streaming-HDFS-Hadoop filesystems-Java Interface to Hadoop-YARN-Job Scheduling-Hadoop I/O-Data Integrity-Compression-Serialization-File based Data Structures-Developing a MapReduce Application.	
Unit-3 – Big Data Ecosystem	9 Hour
Setting up a Hadoop Cluster-Cluster specification and setup-Hadoop configuration-YARN configuration-Introduction to Pig-Installing and running pig-Basics Pig Latin -Example Programs-Introduction to Hive-Installing and running Hive-Introduction to HiveQL-Create-Drop-Alter-order by-Group by-Joins-Introduction to Zookeeper-Installing and running Zookeeper-Creating different types of Znodes-Flume Architecture-Introduction to Sqoop.	
Unit-4 – Database in Big Data Framework	9 Hour
Introducing Oozie-Apache Spark-Limitations of Hadoop and overcoming the Limitations-Core components and architecture of Spark-Introduction to Apache Flink-Installing Flink-Batch analytics using Flink-Big Data Mining with NoSQL-Why NoSQL? -NoSQL databases-Introduction to MongoDB,-Basi queries in MongoDB-Introduction to Cassandra.	
Unit-5 – Visualization	9 Hour
Enterprise Data Science Overview-Data Science Solutions in the enterprise-Enterprise data science – Machine Learning and AI-Enterprise Infrastructure Solutions-Visualizing Big Data-Using Python and R for visualization-Big Data Visualization Tools-Data Visualization with Tableau-Case Studies: Hadoop-Case Studies: Spark-Case Studies: NoSQL.	

Learning Resources	1. Herbert Schildt, 'C++ - T Bjarne Stroustrup, 'The C++ Programming Language', Addison Wesley, 2000.	4. Kris Jasma, 'Java Programming – A Complete Reference', Galgotia publication, 1994.
	2. The Complete Reference', Tata McGraw Hill, 1997.	5. Cay S. Horstmann, Gary Cornell, –Core Java Volume –I FundamentalsII, 9th Edition, Prentice Hall, 2013.
	3. Herbert Schildt, – Java The complete referencell, 8th Edition, McGraw Hill Education, 2011	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	50%	-	50%	-	50%	-
Level 2	Understand	50%	-	50%	-	50%	-
Level 3	Apply	-	-	-	-	-	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.R. SivaKumar, Sr. Consultant,rsivakoumar@gmail.com A2O Integrated services Pvt., Ltd., Chennai	1. Dr.S Muthurajkumar, Asst. Professor, Department of Computer Technology, muthuraj@annauniv.edu, MIT Campus, Anna University, Chromepet, Chennai-600044.	1. Mrs.S.Sindhu, SRMIST

Course Code	21CSE224T	Course Name	COMPUTER ARCHITECTURE	Course Category	E	PROFESSIONAL ELECTIVE										L	T	P	C		
																3	0	0	3		
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil														
Course Offering Department		School of Computing		Data Book / Codes / Standards		Nil															
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes			
CLR-1:	Understand the Fundamentals of computers, Memory operations and Addressing Modes				1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3				
CLR-2:	Know about Functions of Arithmetic and Logic unit																				
CLR-3:	Explore the Operations of Control Unit, Execution of Instruction and Pipelining																				
CLR-4:	Classify the Need for Parallelism, Multicore and Multiprocessor Systems																				
CLR-5:	Understand the Concepts and functions of Memory unit, I/O unit																				
Course Outcomes (CO):		At the end of this course, learners will be able to:																			
CO-1:	Identify the computer hardware and how software interacts with computer hardware				2	1	1	-	-	-	-	-	-	-	-	-	-	-	-		
CO-2:	Apply Boolean algebra as related to designing computer logic, through simple combinational and sequential logic circuits				2	2	1	-	-	-	-	-	-	-	-	-	-	-	-		
CO-3:	Examine the detailed operation of Basic Processing units and the performance of Pipelining				2	3	1	-	-	-	-	-	-	-	-	-	-	-	-		
CO-4:	Analyze concepts of parallelism and multi-core processors.				2	3	1	-	-	-	-	-	-	-	-	-	-	-	-		
CO-5:	Classify the memory technologies, input-output systems and evaluate the performance of memory system				2	2	1	-	-	-	-	-	-	-	-	-	-	-	-		
Unit-1 - Introduction to Number System and Logic Gates																	9 Hour				
Number Systems- Binary, Decimal, Octal, Hexadecimal; Codes- Grey, BCD, Excess-3, ASCII, Parity; Binary Arithmetic- Addition, Subtraction, Multiplication, Division using Sign Magnitude,1's compliment, 2's compliment, BCD Arithmetic; Logic Gates-AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR.																					
Unit-2 - Basic Structure of Computers																	9 Hour				
Functional Units of a computer, Operational concepts, Bus structures, Memory addresses and operations, assembly language, Instructions, Instruction sequencing, Addressing modes. Case study: 8086. Design of ALU: De Morgan's Theorem, Adders, Multiplier – Unsigned, Signed, Fast, Carry Save Addition of summands; Division–Restoring and Non-Restoring; IEEE 754 Floating point numbers and operations.																					
Unit 3 - Control Unit																	9 Hour				
Basic processing unit, ALU operations, Instruction execution, Branch instruction, Multiple bus organization, Hardwired control, Generation of control signals, Micro-programmed control; Pipelining: Basic concepts of pipelining, Performance, Hazards-Data, Instruction and Control, Influence on instruction sets																					
Unit-4 - Types of Memories																	9 Hour				
Need for a hierarchical memory system – Cache memories– Memory Mapping – Improving Cache Performance – Virtual Memory – Memory Management Techniques – Accessing I/O devices – Programmed Input/output – Interrupts – Direct Memory Access.																					
Unit-5 - Parallelism																	9 Hour				
Need, types, applications & challenges, Architecture of Parallel Systems-Flynn's classification – Optimization techniques for Parallel Structures; ARM Processor: The thumb instruction set, Processor and CPU cores, Instruction Encoding format, Memory load and Store instruction, Basics of I/O operations. Case study: ARM 5 ,ARM 7 and ARM Neon Architecture																					

Learning Resources	1. Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Computer Organization, 5th ed., McGraw-Hill, 2015	5. William Stallings, Computer Organization and Architecture—Designing for Performance, 10th ed., Pearson Education, 2015
	2. Kai Hwang, Faye A. Briggs, Computer Architecture and Parallel Processing", 3rd ed. McGraw Hill, 2016	6. David A. Patterson and John L. Hennessy Computer Organization and Design—A Hardware software interface, 5th ed., Morgan Kaufmann, 2014
	3. Ghosh T.K., Computer Organization and Architecture, 3rd ed., Tata McGraw-Hill, 2011	7. Neon – Arm @ https://www.arm.com/technologies/neon
	4. P. Hayes, Computer Architecture and Organization, 3rd ed., McGraw Hill, 2015.	8. Neon – Arm Developer @ https://developer.arm.com/Architectures/Neon

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Dr S. Janakiraman, Pondicherry University	1. Dr M. Lakshmi, SRMIST
	2. Dr P. Thyagarajan, Rajiv Gandhi National Institute of Youth Development	2. Dr G. Vadivu, SRMIST

Course Code	21CSE321T	Course Name	DATA WAREHOUSING AND DATA MINING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Introduce the concepts of Data Warehousing, difference between database and data warehousing.		Engineering Knowledge	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2:	Describe OLAP Model and the Star Schema to design a Data Warehouse.																
CLR-3:	Introduce data mining principles and techniques.																
CLR-4:	Introduce data mining as a cutting-edge business intelligence tool.																
CLR-5:	Develop and apply critical thinking, problem solving and decision-making skills.																
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	Design and implement a quality data warehouse or data mart effectively and administer the data resources in such a way that it will truly meet management's requirements.		-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO-2:	Learn OLAP operations and data warehousing tools.		-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Use data mining tools for projects and to be familiar with open-source tool		-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-4:	Evaluate standards and new technologies to determine their potential impact.		-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-5:	Use data mining tools for projects and to build reliable products as per demand.		-	-	-	-	-	-	-	-	-	-	-	-	-	1	-

Unit-1 - Data Warehousing	9 Hour
Overview, Definition, Delivery Process, Difference between Database System and Data Warehouse, Multi-Dimensional Data Model, Data Cubes, Stars, Snow Flakes, Fact Constellations, Concept hierarchy, Process Architecture, 3 Tier Architecture, Data Marting.	
Tutorial:	
T1: Create SnowSQL login in open-Source environment	
T2: Creation of Snowflake Objects	
T3: Use Time travel feature in snowflake	
Unit-2 - OLAP	9 Hour
Aggregation, Historical information, Query Facility, OLAP function and Tools. OLAP Servers, ROLAP, MOLAP, HOLAP, Data Mining interface, Security, Backup and Recovery, Tuning Data Warehouse, Testing Data Warehouse.	
Tutorial:	
T4: Implementation of OLAP operations – Roll up, Drill Down	
T5: Implementation of OLAP operations – Slice and dice	
T6: Implementation of OLAP operations – Rotate	

Unit-3 - Overview of Data Mining						9 Hour	
Data Mining-Definition & Functionalities, Data Processing, Form of Data Preprocessing, Data Cleaning: Missing Values, Noisy Data, Inconsistent Data, Data Integration and Transformation. Data Reduction: - Data Cube Aggregation, Dimensionality reduction, Data 35 Compression, Numerosity Reduction, Clustering, Discretization and Concept hierarchy generation. Overview of open-source tool - Orange Tutorial: T7: Data Cleaning on Data Set using Orange T8: Data Reduction on Data Set using Orange T9: Data Transformation using Orange							
Unit-4 - Concept Description						9 Hour	
Definition, Data Generalization, Analytical Characterization, Analysis of attribute relevance, Mining Class comparisons, Statistical measures in large Databases. Measuring Central Tendency, Measuring Dispersion of Data, Graph Displays of Basic Statistical class Description, Mining Association Rules in Large Databases, Association rule mining- Apriori Algorithm. Tutorial: T10: Generate Association Rules using the Apriori Algorithm using orange T11: Demonstrate Statistical Analysis on Dataset using Orange T12: Demonstrate performing Regression on data sets							
Unit-5 - Cluster Analysis						9 Hour	
Cluster Analysis: Data types in cluster analysis, Categories of clustering methods, Partitioning methods. Hierarchical Clustering- CURE and Chameleon, Density Based Methods-DBSCAN, OPTICS, Grid Based Methods- STING, CLIQUE, Model Based Method –Statistical Approach, Outlier Analysis Tutorial: T13: Implementation of Outlier Analysis using orange tool T14: Implementation of k-means algorithm for Iris Dataset using orange tool T15: Demonstration of clustering rule process on data-set iris.arff using simple k-means using orange tool.							
Learning Resources		1. H.Dunham,"Data Mining: Introductory and Advanced Topics" Pearson Education. 2. Sam Anahory, Dennis Murray, "Data Warehousing in the Real World: A Practical Guide for Building Decision Support Systems, Pearson Education.			3. Jiawei Han, Micheline Kamber," Data Mining Concepts & Techniques" Elsevier. 4. Mallach," Data Warehousing System", McGraw –Hill. 5. https://orangedatamining.com/		
Learning Assessment							
Bloom's Level of Thinking		Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice		
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
Total		100 %		100 %		100 %	
Course Designers							
Experts from Industry		Experts from Higher Technical Institutions			Internal Experts		
					1. Dr.P.Kanmani, SRMIST		

Course Code	21CSE322T	Course Name	MULTIVARIATE TECHNIQUES FOR DATA ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes					
CLR-1:	Utilize data characteristics in the form of distribution of the data structures	CLR-2:	Learn the statistical data reduction techniques	CLR-3:	Understand the usage of multivariate techniques for the problem under the consideration.	CLR-4:	Draw valid inferences and to plan for future investigations	CLR-5:	Optimize the different solutions that maximize returns and minimize cost	1	2	3	4	5	6				7	8	9
				Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3			
				-	-	-	-	-	-	-	-	-	-	-	-	1	-	-			
CO-1: Understand the characteristics of data and its properties				-	-	-	-	-	-	-	-	-	-	-	-	-	-	2			
CO-2: Effectively select and use the data reduction techniques				-	-	-	-	-	-	-	-	-	-	-	-	-	-	-			
CO-3: Deploy the multivariate techniques to solve the real-world problems				-	-	-	-	-	-	-	-	-	-	-	-	2	-	-			
CO-4: Acquire information and inferences from data to predict future output				-	-	-	-	-	-	-	-	-	-	-	-	2	-	-			
CO-5: Achieve optimal solutions that maximize returns				-	-	-	-	-	-	-	-	-	-	-	-	-	-	1			

Unit-1 - Introduction to Multivariate Analysis	9 Hour
Meaning of Multivariate Analysis - Measurements Scales - Metric measurement scales and non-metric measurement scales - Classification of multivariate techniques – Dependence Techniques - Inter-dependence Techniques - Applications of multivariate techniques - Applications of multivariate techniques -Examples - Applications of multivariate techniques – Demo and Examples. T1: Exploration of data sets and characteristics in PYTHON T2: Implementation of dependent and interdependence techniques in PYTHON T3: Explore scope of multivariate analytics in different applications using PYTHON	
Unit-2 - Factor Analysis	9 Hour
Factor Analysis Introduction - Meanings, Objectives – Assumptions - Designing a factor analysis - Designing a factor analysis – Example - Designing a factor analysis – Demo – Deriving factors and assessing overall factors - Interpreting the factors and validation of factor analysis - Interpreting the factors and validation of factor analysis – Demo and Examples. T4: Implementation of factor analysis in PYTHON T5: Interpreting and Validating factor analysis in PYTHON	
Unit-3 - Cluster Analysis	9 Hour
Cluster Analysis Introduction - Objectives and Assumptions - Research design in cluster analysis - Deriving clusters - Assessing overall fit - Deriving clusters – Demo and examples - Hierarchical methods - Non-Hierarchical Methods – Combinations. T7: Implement Django framework using python – creating basic Django App T6: Implementation of cluster analysis in PYTHON T7: Interpretation and Validation of cluster analysis in PYTHON and R	

Unit-4 - Discriminant Analysis	9 Hour
Linear Programming problem Introduction - Linear Programming problem Applications - Formulation of LPP - Graphical method - Simplex method - Graphical and simplex methods – Problems, examples and demo - Graphical and Simplex - Integer Programming - Transportation problem - Assignment problem T10: Formulating a LPP in PYTHON from a data set T11: Solving LPP in PYTHON – Graphical and Simplex T12: Implementation of transportation of assignment problem in PYTHON.	

Unit-5 - Visualization	9 Hour
Linear Programming problem Introduction - Linear Programming problem Applications - Formulation of LPP - Graphical method - Simplex method - Graphical and simplex methods – Problems, examples and demo - Graphical and Simplex - Integer Programming - Transportation problem - Assignment problem T10: Formulating a LPP in PYTHON from a data set T11: Solving LPP in PYTHON – Graphical and Simplex T12: Implementation of transportation of assignment problem in PYTHON.	

Learning Resources	<ol style="list-style-type: none"> 1. Joseph F Hair, William C Black et al, "Multivariate Data Analysis" (2016). , "Multivariate Data Analysis". Pearson Education, 7th edition, 2. Anderson, T.W., 2003. "An introduction to statistical multivariate analysis", 3rd Edition", Wiley. 3. Dillon, W.R. and Goldstein, M., 1984. Multivariate analysis: Methods and applications. New York (NY): Wiley. 4. Malhotra, N.K. and Dash, S., 2011. Marketing Research: An Applied Orientation (; Pearson, Ed.). 5. Hamdy A Taha, (2012) "Operations Research", Pearson, 8th Edition. 6. S. R. Yadav, A. K. Malik (2014) "Operations Research", Oxford University Press. 7. https://python-for-multivariate-analysis.readthedocs.io/ "A Little Book of Python for Multivariate Analysis"
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers			
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts	
1. Mrs.Sivasankari.S , Freelance Software consultancy on Big data, analytics	1. Dr.JeyaShree, Professor, Rajalakshmi Institute of Technology	1. Dr.A.Shobanadevi, SRMIST	

Course Code	21CSE323T	Course Name	MARKETING ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Learn to build brand architecture on brand value	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Know to create functions to access and manipulate numbers, strings and date time data	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Know the emphasis on scaling for brands																
CLR-4:	Utilize the information for strategic marketing alternatives																
CLR-5:	Explore the experiments for digital marketing efforts																
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	analyse user Generated Contents	-	-	-	-	-	-	-	3	-	3	-	-	1	-	-	
CO-2:	analyse the digital products	-	-	-	-	-	-	-	3	-	3	-	-	2	-	-	
CO-3:	understand customer Lifetime Value	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	
CO-4:	analyse the marketing with ML models	-	-	-	-	-	-	-	3	-	-	-	-	2	-	-	
CO-5:	communicate with digital analytics	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	

Unit-1 - User Generated Contents	9 Hour
Marketing Analytics, Data for Marketing Analytics, Business Intelligence, Analytics, and Data Science, Analysis, Exploratory Data Analysis, Descriptive Analysis, Predictive Analytics, Prescriptive Analytics, Benefits of Customer Analytics, Factors Essential for Obtaining Benefits from Customer Analytics, Segmentation Analytics, Cluster Analysis.	
T1: Data for Marketing Analytics	
T2: Predictive Analytics	
T3: Segmentation and cluster analysis	
Unit-2 - Product Analysis	9 Hour
Product Analytics, Perceptual Mapping, White Spaces, Umbrella Brands, Multidimensional Scaling, Analyzing Digital Products, Analyzing Non-Digital Products,	
T4: Product analysis	
T5: Multimodel scaling	
T5: Digital and Non - digital Products	
Unit-3 - Customer Lifetime Value	9 Hour
Customer Lifetime Value (CLV), Calculating CLV, Understanding the CLV Formula, Applying the CLV Formula, Extending the CLV Formula, Using CLV to Make Decisions, A Forward-Looking Measure.	
T7: Customer Lifetime Value (CLV)	
T5: Applying the CLV Formula,	
T6: Using CLV to Make Decisions	
Unit-4 - Market Analysis	9 Hour

Market Mix Modeling, Variables in Market Mix Modeling, Techniques of Market Mix Modeling, Metrics for Tracking Customer Experience, Upgrading Customers: Use Case of Upselling, Logistic Regression Analysis, Use of Logistic Regression as a Classification Technique T10: Regression Analysis T11: Multivariable Regressions T12: Marketing Mix Models
Unit-5 - Digital Analytics 9 Hour
Search Engine Marketing, Search Engine Optimization, Social Media Analytics, App Marketing Metrics, Importance of AI in Marketing, Random Forests, Model Evaluation Using ROC, AUC, and Confusion Matrix, Simple Feed-Forward Network, Deep Neural Network, Recommendation Systems, Necessity of Data Visualization, Visualizations Useful with Common Data Science Techniques T13: Search Engine Marketing T14: AI in Marketing T15: Data Visualization Techniques

Learning Resources	1. Seema Gupta, Avadhoot Jathar, "Marketing Analytics", ISBN: 9789354242625 2. Brea Cesar (2014), "Marketing and Sales Analytics: Proven Techniques and Powerful Applications from Industry Leaders", FT Press, ISBN-0133761711 3. Emmett Cox (2012), "Retail Analytics: The Secret Weapon", Wiley, ISBN- 978-1-118-09984-1	4. Fok Dennis (2003), "Advanced Econometric Marketing Models", ERIM, ISBN 90-5892-049-6 5. Mireles Carlos Hernandez (2010), "Marketing Modeling for New Products", ERIM, ISBN 978-90-5892-237-3 6. Rackley Jerry (2015), "Marketing Analytics Roadmap: Methods, Metrics, and Tools", Apress, ISBN-1484202597
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
2. Dr.K.Jafar Ali MBA, Ph.D. Consultant, iSpark Learning Solutions, Chennai.	2. Angelina Gautami Fernando, Associate Professor (Marketing & Analytics) at Great Lakes Institute of Management	2. Dr. R. Rajkumar, SRMIST

Course Code	21CSE325T	Course Name	APPLIED SOCIAL NETWORK ANALYSIS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes						
CLR-1:	Understand mathematical concepts of a network and centrality	CLR-2:	Find the importance of social influence	CLR-3:	Know about balance networks	CLR-4:	Learn the concepts and methods of social networks	CLR-5:	Understand about the algorithms related to web graph searching	1	2	3	4	5				6	7	8	9
			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3				
Course Outcomes (CO):		At the end of this course, learners will be able to:																			
CO-1:	Find the important node in each graph network		-	-	-	-	-	-	-	-	-	-	-	-	1	-	-				
CO-2:	Implement to find communities in the graph network		-	-	-	-	-	-	-	-	-	-	-	-	-	2	-				
CO-3:	Convert unstable to stable network		-	-	-	-	-	-	-	-	-	-	-	-	2	-	-				
CO-4:	Detecting the communities in the network		-	-	-	-	-	-	-	-	-	-	-	-	-	-	2				
CO-5:	Code page ranking algorithms for web graph		-	-	-	-	-	-	-	-	-	-	-	-	-	-	1				

Unit-1 - Introduction to Social Network	9 Hour
SNA Introduction - Basic Network Concepts, Adjacency Matrices, Graphs, and Notation, Nodes and Links – Centrality Measures - “What is “Centrality” and why do we Study IT, Calculating Nodal Centrality Measures, Directed Networks and Centrality Measures, Location in the Network - Graph Level Measures – Density, Diameter, Centralization, Average Centralities, Network Topology. T1: Introduction to networkx T2: Finding connectedness of a graph T3: Implementation of centrality measures	
Unit-2 - SNA Algorithms	9 Hour
SNA Algorithms -Node assortativity coefficients and correlation measures, Directed Acyclic Graphs & Topological Sort, Dinitz’s algorithm and its applications, Euler’s Algorithm – Graph Generators - Geometric Generator Models, Sudoku, and Graph coloring. T4: Calculate the assortativity coefficient T5: Implement programs for Directed Acyclic Graphs & Topological Sort T6: Implement Maximum flow problem	
Unit-3 - Establishing Stable Networks	9 Hour
Exploring Social Networking Data Sets - Establishing a Social Network, Connectivity of Users in Social Networks, Case Study of Facebook. Signed Networks - unstable network to stable network T7: Code to find unstable network T8: Find the number of unstable triangles T9: Solution to convert unstable into stable network	

Unit-4 - Communities in the Network	9 Hour
Community Detection - Strength of Weak Ties, Triadic Closure, Detecting Communities in a Network, Girvan-Newman Algorithm Modularity, Minimum Cut Trees, Tie Strengths in Mobile Communication Network, Exact Betweenness Centrality T10: Detect the communities in the graph T11: Code for Triadic Closure T12: Explore the strong and weak ties in the network	
Unit-5 - Link Analysis in Web	9 Hour
The Structure of the Web - The World Wide Web, Information Networks, Hypertext, and Associative Memory, The Web as a Directed Graph, The Bow-Tie Structure of the Web, The Emergence of Web - Link Analysis and Web Search - Searching the Web: The Problem of Ranking, Link Analysis Using Hubs and Authorities, PageRank, Applying Link Analysis in Modern Web Search – Power Law. T13: Implement points distribution method T14: Code for random walk method T15: Explore the tools related to SNA	

Learning Resources	<ol style="list-style-type: none"> 1. Ian McCulloh (2013), <i>Social Network Analysis with Applications</i>, Wiley 2. https://networkx.org/nx-guides/index.html 3. Edited by Mohammad Gouse Galety Chia Al Atroshi Bunil Kumar Balabantaray and Sachi Nandan Mohanty (2022), <i>Social Network Analysis, Theory and Applications</i>, Wiley 	<ol style="list-style-type: none"> 4. Krishna Raj P. M., Ankith Mohan, and K. G. Srinivasa (2018), <i>Practical Social Network Analysis with Python</i>, Springer. 5. David Easley Cornell University Jon Kleinberg Cornell University (2010), <i>Networks, Crowds, and Markets Reasoning about a Highly Connected World</i> Cambridge University Press.
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mrs.Sivasankari.S , Freelance Software consultancy on Big data, analytics	1. Dr.A.Bhuvaneswari, Professsor, VIT, School of Computer Science and Engineering, Chennai	1. Dr.G.Vadivu, SRMIST

Course Code	21CSE326T	Course Name	ARTIFICIAL NEURAL NETWORKS			Course Category	E	PROFESSIONAL ELECTIVE					L	T	P	C					
																3	0	0	3		
Pre-requisite Courses	Nil		Co- requisite Courses	Nil			Progressive Courses	Nil													
Course Offering Department		School of Computing			Data Book / Codes / Standards			Nil													
Course Learning Rationale (CLR):		The purpose of learning this course is to:					Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the biological background and basic concepts of neural networks					1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3			
CLR-2:	Gain knowledge about perceptron and back propagation																				
CLR-3:	Know about various training rules and error minimization																				
CLR-4:	Learn the concepts of unsupervised neural networks																				
CLR-5:	Explore the fine-tuning procedures and case studies for designing neural network models																				
Course Outcomes (CO):		At the end of this course, learners will be able to:																			
CO-1:	Explain the basic concepts of neural networks					-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	
CO-2:	Describe perceptron and back propagation					-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	
CO-3:	Apply various training rules in neural networks					-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO-4:	Explain unsupervised neural networks					-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
CO-5:	Fine tune the neural networks					-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
Unit-1 - Introduction to Neural Networks																		9 Hour			
History of neural network research- Biological inspiration: Neural computation, Models of computation, Elements of computing models- Network of neurons: structure, Information processing at neurons and synapses, Information storage, Neurons as self-organizing systems- Artificial Neural Networks: Network of primitive functions, approximation of functions- Neuron Model: Single and multiple input neurons, Transfer functions- Network architectures: Single layered and multi layered neurons, Recurrent Networks																					
Tutorials:																					
3. Implement various neural network architectures																					
4. Implement and study the effect of various activation functions																					
Unit-2 - Perceptron																		9 Hour			
Introduction to Perceptron- Perceptron Architecture: Single Neuron Perceptron, Multi Neuron Perceptron- Perceptron learning rule: Constructing Learning rules, Unified Learning rule, Training multi neuron perceptron- Complexity of perceptron learning-Computational Limits of Perception-Linearly separable functions- Learning XOR-Feed forward Networks- Back propagation: Chain of rule Calculus, Back-Propagation Computation in Fully-Connected Multi-layer Perceptron																					
Tutorials:																					
3. Implement Feed forward networks																					
4. Implement back propagation																					

Unit-3 - Learning and Training	9 Hour
Paradigms of Learning - Using training samples - Gradient Optimization Procedure- Batch Gradient Descent, Stochastic Gradient Descent, Mini-Batch Gradient Descent - Hebbian learning rule – Delta learning rule- Convergence and local minima, representational power of feed forward networks, hypothesis search space and inductive bias, generalization, overfitting and stopping criterion-Error functions, Error minimizing procedures-Hebbian learning Tutorials: 5. Implementation of gradient descent 6. Implementation of delta learning rule	
Unit-4 - Unsupervised Neural Networks	9 Hour
Unsupervised learning in neural networks: Hebbian learning rule, Principle Component Learning, Learning Vector Quantizer-I- Self Organizing Maps: Functionality, Training, Topology Function, Decreasing Learning Rate, Variations of SOMs, Neural gas, Multi-SOM, Multi-neural gas, Growing neural gas- Adaptive Resonance Theory, Orienting subsystems, Learning Laws 7. Implementation of Principle Component analysis 8. Implementation of Self Organizing Maps	
Unit-5 - Tuning the Neural Networks	9 Hour
Pretraining the model: Data selection, Preprocessing, Selection of network architecture- Training the network: Initializing weights, Choice of training algorithm, stopping criteria, Choice Of performance function, Committees of Networks-Post Training Analysis: Fitting, Pattern Recognition, Clustering- Time delay and Recurrent Neural Networks-Case Studies: Smart Sensor system with function approximation- Myocardial Infarction Recognition using pattern recognition-Forest cover problem using Clustering	

Learning Resources	1. Martin T. Hagan, <i>Neural Network Design</i> , 2nd edition. 2. Tom M. Mitchell, <i>Machine Learning</i> , McGraw-Hill Education (India) Private Limited. 3. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, <i>Deep Learning</i> , MIT Press, 2016	4. Andries P., <i>Computational Intelligence: An Introduction</i> , Second Edition, Wiley, 2007 5. David Kriesel, <i>A Brief Introduction to Neural Networks</i> , 2009
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		2. Dr. Sharanya, SRMIST

Course Code	21CSE327T	Course Name	CLOUD COMPUTING FOR DATA ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:														
CLR-1:	Comprehend fundamentals of cloud application development	Engineering Knowledge	2 Problem Analysis	3 Design/development of solutions	4 Conduct investigations of complex problems	5 Modern Tool Usage	6 The engineer and society	7 Environment & Sustainability	8 Ethics	9 Individual & Team Work	10 Communication	11 Project Mgt. & Finance	12 Life Long Learning	PO-1	PO-2	PO-3
CLR-2:	Deployment of Cloud Applications using Cloud Native Services															
CLR-3:	Design various Cloud Applications															
CLR-4:	Understand the Cloud Security and Cloud pricing models															
CLR-5:	Learn the purpose of stream processing and its basic components															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Comprehend Cloud fundamental Concepts	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Understand virtualization foundations to cater the needs of elasticity, portability, and resilience by cloud service providers.	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Compare operation and economic models of various trending cloud platforms prevailing in IT industry	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-4:	Design a cloud framework with appropriate resource management techniques with its security.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Understand the concepts of Transfer Learning	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-

Course Outcomes (CO):		At the end of this course, learners will be able to:		1	2	3	4	5	6	7	8	9	10	11	12	PO-1	PO-2	PO-3
CO-1:	Comprehend Cloud fundamental Concepts	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Understand virtualization foundations to cater the needs of elasticity, portability, and resilience by cloud service providers.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Compare operation and economic models of various trending cloud platforms prevailing in IT industry	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Design a cloud framework with appropriate resource management techniques with its security.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Understand the concepts of Transfer Learning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-

Unit-1 - Introduction Cloud Computing	9 Hour
Introduction-- Cloud Introduction –NIST Definition: Cloud service Models - IaaS/ PaaS / SaaS, Deployment Models –Public, Private, Hybrid and Community, Cloud Characteristics, Cloud Challenges –user, Service Provider end, Applications of Cloud, Cloud federation, Cloud Enabling Technology, - Challenges and Issues-LAB1: Hosted Hypervisor and Bare Metal Hypervisor- LAB2: Install a Virtual box / VMware Workstation with different flavours of linux or windows.LAB3: Configure Kafka Streaming on cloud.	
Unit-2 - Cloud Resource Virtualization	9 Hour
Hypervisors – Type 1 Hypervisors – Type 2 Hypervisors –. Basics of Virtualization - Types of Virtualizations - Understanding Hypervisors - Implementation Levels of Virtualization -Virtualization Structures - Tools and Mechanisms – Resource sharing and Resource pooling -Desktop Virtualization – Server Virtualization.LAB3: Implementation of Virtual Machine(S) and create a Virtual Datacenter.LAB4: Kafka simple producer consumer message passing, topics and partitions on cloud.	
Unit-3 - Advances in Cloud Platforms	9 Hour
Comparing Amazon web services, Google AppEngine, Microsoft Azure from the perspective of architecture (Compute, Storage Communication) services and cost models. Working with EC2 API – Google App Engine API - Facebook API, Twitter API. Overview on Public Cloud Platforms-AWS, Amazon Web Services (AWS), Azure, Google Cloud Platform (GCP). Docker, Containers, Usage of containers, Terminology, Docker Run Static sites, Docker Images, Docker File, Docker on AWS, Devops.LAB5: Deployment of VMs in AWS. LAB6: Install a docker engine and docker client on windows. LAB7: Creation and removal of container, container images. Lab 8:: Building Kafka Streams application on cloud.	

Unit-4 – Cloud Security	9 Hour
Cloud Application Development – Cloud Application Execution, Applications using Containers - Testing the Cloud Application, Case study on Cloud Application – Cloud Security Concepts - Cloud Security Threats, Cloud Security Mechanisms: Encryption , Public Key Infrastructure, Identity and Access Management, Single Sign-On: Kerberos authentication , Mobile Cloud, Green Cloud.LAB9: Find a procedure to transfer the files from one virtual machine to another virtual machine Using VMWare. LAB10: Install Google App Engine. Create a hello world app and other simple web applications using python/java. Lab 11: Docker Containerization Lab 14:: Configure Apache Storm single node cluster on cloud.	

Unit-5 - Stream Processing	9 Hour
Introduction to Stream Processing - Batch vs Stream Processing, Examples of stream processing - Applications of stream processing - Stateful Stream Processing - Stream Processing Graph - Data Sources, Stream processing pipelines, Sinks - Transformations and Aggregation - Windowing - Stateless and stateful processing - Effect of time in stream processing - Complexity analysis. LAB15: : Build Apache Storm Word Count Topology on cloud.	

Learning Resources	1. Rajkumar Buyya, James Broberg, Andrzej, M. Goscinski, Cloud Computing: Principles and Paradigms, Wiley, 1st Edition, 2013.	5. Buyya, Rajkumar, Christian Vecchiola, and S. Thamarai Selvi. Mastering Cloud Computing: Foundations and Applications Programming, Tata Mcgraw Hill, 1 st Edition, 2017.
	2. Sosinsk, Barrie, Cloud Computing Bible, John Wiley & Sons, 1 st Edition, 2011.	6. Ellis B, Real-Time Analytics – Techniques to analyze and visualize streaming data, 1st ed., John Wiley & Sons Inc, 2014
	3. Docker: Up & Running: Shipping Reliable Containers in Production”, Sean P. Kane, Karl Matthias, O'Reilly Media Inc, 2015.	7. Mark Wilkins, “Learning Amazon Web Services (AWS): A Hands-On Guide to the Fundamentals of AWS Cloud”, 2019.
	4. Thomas Erl, Zaigham Mahmood, Richardo Puttini, "Cloud Computing: Concepts, Technology and Architecture", Fourth Printing, 2014, Prentice Hall/Pearson PTR, ISBN: 9780133387520.	8. https://cloudacademy.com/course/introduction-to-devops/intro-3/

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	10%	-	10%	-	10%	-
Level 4	Analyze	10%	-	10%	-	10%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Rajarajan Sundaramurthy, Senior Vice President - Devops		1. Dr.N.Manikandan, SRMIST

Course Code	21CSE373T	Course Name	STREAMING ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basic building blocks of stream processing	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Relate streaming data in real time															
CLR-3:	Explore the data ingestion options into stream processing engines															
CLR-4:	Extend stream processing results to end users															
CLR-5:	Explore NOSQL storage options to store real time data															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Illustrate the concepts and terminologies in stream processing	2	3	-	2	2	-	-	-	-	-	-	-	2	-	-
CO-2:	Interpret stream processing applications using Apache Spark Streaming	2	2	-	2	2	-	-	-	-	-	-	-	-	3	-
CO-3:	Summarize real-time streaming data pipelines and applications that adapt to the data streams using Kafka	2	2	-	2	2	-	-	-	-	-	-	-	-	3	-
CO-4:	Interpret stream processing applications using Apache Storm Streaming	2	2	-	2	2	-	-	-	-	-	-	-	-	3	-
CO-5:	Inquire real time data using NoSQL databases & MongoDB	2	2	-	2	2	-	-	-	-	-	-	-	-	-	3

Unit-1 - Fundamentals of Stream Processing	9 Hour
Introducing Stream Processing, Stream Processing, Examples of Stream Processing, Scaling Up Data Processing, Distributed Stream Processing, Stream-Processing Model, Sources and Sinks, Immutable Streams Defined from One Another, Transformations and Aggregations, Window Aggregations, Stateless and Stateful Processing, Stateful Streams, An Example: Local Stateful Computation in Scala, Stateless or Stateful Streaming, Streaming Architectures, Components of a Data Platform, Architectural Models, The Use of a Batch-Processing Component in a Streaming Application, Referential Streaming Architectures, Streaming Versus Batch Algorithms	
Unit-2 - Apache Spark & Structured Streaming	9 Hour
Apache Spark as a Stream-Processing Engine, Spark's Distributed Processing Model, Spark's Resilience Model, Introducing Structured Streaming, The Structured Streaming Programming Model	
Unit-3 - Kafka-A Realtime Data and Stream Processing	9 Hour
Getting Started with Kafka, Kafka, Publish Subscribe messaging model, Kafka Architecture, Messages and Batches, Schemas, Topics and Partitions, Producers and consumers, Brokers and Clusters, Multiple Clusters, Data Ecosystem, Kafka Producers: Writing messages to Kafka, Kafka Consumers - Reading data from Kafka, Stream Processing- Stream Processing Design Patterns-Kafka Streams by Examples- Kafka Streams: Architecture Overview	
Unit-4 - Apache Storm	9 Hour
Apache Storm – Introduction, Real-Time Processing and Storm Introduction, Storm Deployment, Topology Development, and Topology Options, Storm Parallelism and Data Partitioning, Integration of Storm, and Kafka	
Unit-5 - NoSQL Databases in Cloud and MongoDB	9 Hour
NoSQL Data Bases, AWS Cloud Dynamo Database: Amazon DynamoDB features, Serverless, Introduction to MongoDB, MongoDB Data Model, MongoDB Architecture - Core Processes, MongoDB Tools, Standalone Deployment, Replication, Sharding, MongoDB Use Cases- Performance Monitoring, and Social Networking.	

Learning Resources	7. Garillot F and Mass. G., <i>Stream Processing with Apache Spark</i> , 1st ed., O'Reilly Media, Inc., 2019.	10. https://docs.mongodb.com/manual/changeStreams/
	8. Narkhede N, Shapira. G, and Palino T., <i>Kafka: The Definitive Guide - Real-Time Data and Stream Processing at Scale</i> , 1st ed., O'Reilly Media, Inc., 2017	11. Shakuntala Gupta Edward Navin Sabharwal, "Practical MongoDB Architecting, Developing, and Administering MongoDB" Apress, 2016
	9. Ankit Jain, <i>Mastering Apache Storm</i> , 1st ed., Packt Publishing, 2017	12. https://aws.amazon.com/dynamodb/features/?pg=dynamodbt&sec=hs

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Gangeyan Ranganathan, Project Delivery Specialist II, Deloitte Consulting Llp, Sacramento, California	1. Dr Surendiran B, Associate Professor, National Institute of Technology, Puducherry	1. Dr. B Yamini, SRMIST
2. Mr. Shri Raghu Raaman, Solidity Developer, Pixelvault Inc., Toronto, Canada	2. Dr. Selvakumar K., B.E., M.E., Ph. D, Assistant Professor Grade-II, Department of Computer Applications, National Institute of Technology Trichy, Tiruchirappalli-620015, Tamil Nadu, India	2. Dr. G Suseela, SRMIST

Course Code	21CSE421T	Course Name	BUSINESS INTELLIGENCE AND ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Familiarize with Business Intelligence, Analytics and Decision Support	1	2	3	4	5	6	7	8	9	10	11	12					
CLR-2:	Understand the technologies for Decision making	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-3:	Familiarize with predictive modeling techniques																	
CLR-4:	Familiarize with sentiment analysis techniques																	
CLR-5:	Understand about Decision-making systems																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Gain knowledge on Business Intelligence, Analytics and Decision Support	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-		
CO-2:	Understand the technologies for Decision making	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-		
CO-3:	Apply predictive modeling techniques	-	-	-	-	-	-	-	3	-	3	-	-	2	-	-		
CO-4:	Apply sentiment analysis techniques	-	-	-	-	-	-	-	3	-	3	-	-	-	-	2		
CO-5:	Gain knowledge on Decision-making systems	-	-	-	-	-	-	-	3	-	3	-	-	-	1	-		

Unit-1 - Introduction: Business Intelligence, Analytics and Decision Support	9 Hour
Information Systems Support for Decision Making - An Early Framework for Computerized Decision Support - The Concept of Decision Support Systems - A Framework for Business Intelligence - Business Analytics Overview - Brief Introduction to Big Data Analytics - Clickstream Analysis – Metrics - Clickstream Analysis - Practical Solutions - Competitive Intelligence Analysis	
T1: Introduction to Power BI and SSMS	
T2: Installing Power BI and SSMS	
T3: Prepare data in Power BI Desktop	
Unit-2 - Decision Making	9 Hour
Decision Making - Introduction and Definitions - Phases of the Decision - Making Process - The Intelligence Phase - Design Phase - Choice Phase - Implementation Phase - Decision Support Systems Capabilities - Decision Support Systems Classification - Decision Support Systems Components	
T4: Load data in Power BI Desktop	
T5: Model data in Power BI Desktop part-1	
T6: Model data in Power BI Desktop part-2	
Unit-3 - Predictive modeling and Sentiment Analysis	9 Hour
Basic Concepts of Neural Networks - Developing Neural Network - -Based Systems - Illuminating the Black Box of ANN with Sensitivity - Support Vector Machines - A Process Based Approach to the Use of SVM - Nearest Neighbor Method for Prediction -Sentiment Analysis Overview - Sentiment Analysis Applications - Sentiment Analysis Process - Sentiment Analysis - Speech Analytics	
T7: Implement data model using SQL in Power BI	
T8: Create DAX calculations in Power BI Desktop part-1	
T9: Create DAX calculations in Power BI Desktop part-2	

Unit-4 - Multi-Criteria Decision-Making Systems	9 Hour
Decision Support Systems modeling - Structure of mathematical models for decision support - Decision making under certainty - Uncertainty and Risk - Decision modeling with spreadsheets - Mathematical programming optimization - Decision analysis introduction - Decision tables - Decision Trees - Multi-criteria decision making - Pairwise comparisons T10: Design a report in Power BI Desktop part-1 T11: Design a report in Power BI Desktop part-2 T12: Create a Power BI dashboard	
Unit-5 - Automated Decision Systems	9 Hour
Automated Decision Systems - The Artificial Intelligence field - Basic concepts of Expert Systems - Applications of Expert Systems - Structure of Expert Systems - Knowledge Engineering - Development of Expert Systems - Location based Analytics - Cloud Computing - Business Intelligence T13: Create a Power BI paginated report T14: Perform data analysis in Power BI Desktop T15: Enforce Row-level security	

Learning Resources	<p>7. Ramesh Sharda, Dursun Delen, Efraim Turban, J.E. Aronson, Ting-Peng Liang, David King, "Business Intelligence and Analytics: System for Decision Support", 10th Edition, Pearson Global Edition, 2013.</p> <p>8. Brett Powell, "Mastering Microsoft Power BI: Expert techniques for effective data analytics and business intelligence", 2018</p> <p>9. Alberto Ferrari Marco Russo, "Definitive Guide to DAX, The: Business intelligence for Microsoft Power BI, SQL Server Analysis Services, and Excel", Second Edition, By Pearson, 2020</p>
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. V. Selvakumar, Hexaware Technologies, selvakumarv@hexaware.com	1. Dr. T. Veerakumar, Professor, NIT Goa	1. Dr. T. Karthick, SRMIST

[illegible]

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing		Data Book / Codes / Standards	Nil	

[illegible]

Unit-1 - Introduction to AI & ML	9 Hour
Types of ML-Old versus new ML-Artificial neural networks-Activation functions The XOR problem-Training neural networks-Backpropagation and the chain rule-Batches Loss functions-The optimizer and its hyperparameters- Underfitting versus overfitting Feature Scaling-Fully connected layers T1: Implement Simple Programs like vector addition in TensorFlow. T2: Implement a simple problem like regression model in Keras. T3: Implement a perceptron in TensorFlow/Keras Environment.	
Unit-2 - Fundamental CNN Architecture	9 Hour
Convolution Input Padding-Calculating the number of parameters (weights)- Calculating the number of operations-Converting convolution layers into fully connected layers-The pooling layer-1x1 Convolution- Calculating the receptive field-Building a CNN model in TensorFlow. T1: Implement a CNN based classifier of handwritten digits: The Convolution Layer T2: Implement a CNN based classifier of handwritten digits: The Max Pooling Layer T3: Implement a CNN based classifier of handwritten digits: The Fully Connected Layer	
Unit-3 - Performance Optimization	9 Hour
Number of hidden layers -Number of neurons per hidden layer -Batch normalization -Advanced regularization and avoiding overfitting -Applying dropout operations with TensorFlow -Which optimizer to use? -Memory tuning - Appropriate layer placement -Building the second CNN by putting everything together - Dataset description and preprocessing -Creating the CNN model -Training and evaluating the network. T1: Implement a CNN with Adam optimizer T2: Implement a CNN and apply dropout operations with TensorFlow T3 Implement a CNN with a validation technique	

Unit-4 - Popular CNN Model Architectures	9 Hour
Introduction to ImageNet -LeNet -AlexNet architecture -VGGNet architecture -VGG16 image classification code example -GoogLeNet architecture -Architecture insights -Inception module -ResNet architecture. T1: Implement Image Net model for a Dataset T2: Traffic sign classifiers using AlexNet T3: Implement VGGNet model for a Dataset	
Unit-5 - Image Classification	9 Hour
CNN model architecture-Cross-entropy loss (log loss)-multi-class cross entropy loss-The train/test dataset split-Datasets-ImageNet-CIFAR-Loading CIFAR- -Building the CNN graph-Learning rate scheduling-Introduction to the tf.data API-Main training loop-Model Initialization-Do not initialize all weights with zeros-Initializing with a mean zero distribution-Xavier-Bengio and the Initializer-Improving generalization by regularizing-L2 and L1 regularization. T1: Implement Image classification with TensorFlow T2: Build TensorFlow input pipelines for image T3: Implement a CNN for Image processing L2 regularization	

Learning Resources	<ol style="list-style-type: none"> 1. Iffat Zafar, Giounona Tzanidou, Richard Burton, Nimesh Patel, Leonardo Araujo, "Hands-On Convolutional Neural Networks with TensorFlow", " , Packt Publishing, 2018. 2. Mohit Sewak, Pradeep Pujari, Md. Rezaul Karim, "Practical Convolutional Neural Networks: Implement Advanced Deep Learning Models Using Python, ", Packt Publishing , 2018 3. Charu C. Aggarwal. Neural Networks and Deep Learning: A Textbook. Springer. 2019. 4. Stanford University Course http://cs231n.stanford.edu/2018/syllabus.html
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Gowtham Kumar Jyayachandiran Assistant Vice President Nomura		1. Dr.K.Arthi, SRMIST

Course Code	21CSE423T	Course Name	BIG DATA VISUALIZATION	Course Category	E	PROFESSIONAL ELECTIVE				L	T	P	C
										2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Specific outcomes		
CLR-1:	Learn the basics of EDA analysis and exploring PyViz, HoloViz for data visualization	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions
CLR-2:	Know to perform D3 for data visualization	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-3:	Utilize the Matplotlib library to visualize data	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-4:	Explore the Tableau to visualize data	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CLR-5:	Explore the Apache Superset to visualize data	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Course Outcomes (CO):		At the end of this course, learners will be able to:												Conduct investigations of complex problems	Modern Tool Usage	The engineer and society
CO-1:	Use EDA techniques to identify insights of data and data visualization using PyViz and HoloViz	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Create effective visualization using D3 templates	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Implement the code to visualize data using Matplotlib	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Visualize different kinds of dataset using Tableau	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Visualize different kinds of dataset using Apache Superset	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Eda, PyViz and HoloViz	9 Hour
Fundamentals of EDA-EDA with Personal Email-Descriptive Statistics-EDA on Wine Quality Data Analysis-Exploratory data analysis using seaborn-Using PyViz / HoloViz (Geoviews, Dashader, HvPlot)-creating several types of Leaflet maps using folium. T1: A data-centric approach to visualization using plot, T2: Building interactivity in plots, T3: Building dashboards using Panel	
Unit-2 - Data Driven Documents-D3	9 Hour
Introduction to D3-Getting started with D3-D3 visualization sample templates-Displaying Results Using D3>Create a summary file for visualization-Visualization using HTML document-Data visualization showing the stacked view-Bar chart-Multiple Donuts-Stacked Area-Pie chart T4: Identifying appropriate template for the available dataset, T5: Displaying results using D3, T6: Creating visualization showing bar chart, donuts, pies using D3	
Unit-3 - Visualization with Matplotlib	9 Hour
Simple Line Plots-Simple Scatter Plots-Visualizing Errors-Density and Contour Plots-Histograms, Binnings, and Density-Customizing Plot Legends-Customizing Colorbars-Multiple Subplots-Text and Annotation-Customizing-Ticks-Customizing Matplotlib: Configurations and Stylesheets-Three-Dimensional Plotting in Matplotlib-Geographic Data with Basemap-Visualization with Seaborn T7: Implement simple plotting using Matplotlib, T8: Customizing colorbars, multiple subplots, text and annotation using Matplotlib, T9: Implement geographic data visualization using Seaborn	
Unit-4 - Tableau Your Data	9 Hour
Creating Visual Analytics with Tableau Desktop: shortcomings of traditional information analysis, Workspace-Connecting to Your Data :Connection, Generated values, Data Extract, Joining, Blending, Data Quality-Building Your First Visualization-creating calculations to enhance Your Data: Showme, Trendline, sorting, filters, sets, groups-Creating Calculations to Enhance Your Data: Aggregation, calculated values, Formulas, function reference-Bringing It All Together with Dashboards: understanding, right way, best practices	

T10: Exploring the workspaces of Tableau, T11: Building simple visualization using Tableau, T12 Building dashboards using Tableau	
Unit-5 - Apache Superset	9 Hour
Getting Started with Data Exploration: Installing, sharing, configuring, add database, uploading, customization -Configuring Superset and Using SQL Lab: setting wen server, creation, migration, securing, caching, mapbox-User Authentication and Permissions: security, google sign in, list users page, views/ menus, list permission, user statistics page-Visualizing Data in a Column-Comparing Feature Values-Drawing Connections between Entity Columns-Mapping Data That Has Location Information-Building Dashboards	
T13: Exploring the workspaces of Superset, T14: Building simple visualization using Superset, T15 Building dashboards using Superset	

Learning Resources	9. Jake VanderPlas (2017). Python Data Science Handbook: Essential Tools for Working with Data. First Edition O'Reilly Media, Inc. ISBN-10: 1491912057, ISBN-13:978-1491912058.	13. Big Data Visualization, James D. Miller, Copyright © 2017 Packt Publishing Ltd.
	10. Suresh Kumar Mukhiya, Usman Ahmed (2020). Hands-On Exploratory Data Analysis with Python: Perform EDA techniques to understand, summarize, and investigate your data, Copyright © Packt Publishing Ltd.	14. Tableau Your Data:Fast and Easy Visual Analysis with Tableau Software- Daniel G.Murray, with the InterWorks team, John Wiley & Sons, Inc. ISBN: 978-1-118-61204-0
	11. Shashank Shekhar (2018). Apache Superset Quick Start Guide-Develop interactive visualizations by creating user-friendly dashboards, -Copyright © Packt Publishing Ltd.	15. Shai Vaingast, "Beginning Python Visualization Crafting Visual Transformation Scripts", Apress, 2nd edition, 2014.
	12. Mike Dewar (2012). Getting Started with D3. O'Reilly Media, Inc., ISBN:9781449328795	16. Wes Mc Kinney, "Python for Data Analysis", O'Reilly Media, 2012.
		17. Wesley J.Chun, "Core Python Applications Programming, 3rd ed,Pearson, 2016
		18. https://pyviz.org/
		19. https://holoviz.org/

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Vishwa Prasath T S Technology Analyst Accenture Pvt Ltd	1. Mr.C.M.T.Karthikeyan, Asst. Professor, Government College of Engineering - Bargur	1. Dr. P.Rajasekar, SRMIST

Course Code	21CSE424T	Course Name	DEEP LEARNING FOR DATA ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the theoretical foundations, algorithms, and methodologies of convolutional neural networks	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Identify and apply appropriate recurrent neural networks for analyzing the data for variety of problems.															
CLR-3:	Understand the principles and applications of computer vision															
CLR-4:	Construct Generative Adversarial Networks to solve real - world problems.															
CLR-5:	Understand different methodologies to create application using deep nets.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Recognize the characteristics of convolutional neural networks and the use of optimizers.	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Analyze various recurrent neural networks models.	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Apply the Deep Learning models for Computer Vision.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-4:	Solve various real - world problems using Generative Adversarial Networks.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Build a Deep Reinforcement Learning models for solving various problems.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

Unit-1 - Convolutional Neural Networks	9 Hour
Introduction to Convolutional neural networks – Autoencoders: types, denoising, Convolutional autoencoder example, Uses and limitations – Variational autoencoders: Parameters to define a normal distribution, VAE loss function, Kullback-Leibler divergence, Training the VAE, The reparameterization trick – Applications of autoencoders – Optimizers: Gradient Descent, RMSProp, Adam Tutorial: T1. To build a convolutional autoencoder model for the MNIST dataset, T2. To build a convolutional variational autoencoders for the MNIST dataset Experiment with different learning rates and objective functions for gradient descent	
Unit-2 - Recurrent Neural Networks	9 Hour
Recurrent Neural Networks: Overview, Neural Networks with and without Hidden States, RNN-based Character-Level Language Models - Implementation: RNN Model, RNN-based Language Model, Gradient Clipping, Training, Decoding - Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU) Tutorial: T3. To implement the RNN model using the H. G. Wells' The Time Machine data set. T4. To implement the LSTM model using the H. G. Wells' The Time Machine data set. To implement the GRU model using the H. G. Wells' The Time Machine data set.	
Unit-3 - Deep Learning for Computer Vision	9 Hour
Image Augmentation - Object Detection and Bounding Boxes - Anchor Boxes - Multiscale Object Detection - Region-based CNNs: R-CNNs, Fast R-CNN, Faster R-CNN, Mask R-CNN Tutorial: T5. To demonstrate object detection model banana detection dataset. T6. To implement the classification model for CIFAR-10 dataset. To implement the classification model for Dog Breed Identification dataset	

Unit-4 - Generative Adversarial Networks	9 Hour
Generative Adversarial Networks: Generator, Discriminator, Loss function, Generator loss, Discriminator loss, Training - Deep Convolutional Generative Adversarial Networks: Wasserstein GAN, BEGAN, CycleGAN - Conditional GANs: Pix2Pix.	
Tutorial: T7. To build a model using GAN to resemble MNIST digits. , T8. To implement a Deep Convolutional GAN to generate complex color images. To implement a Deep Convolutional GAN on Fashion-MNIST data set using ReLU as activation function for generator, leaky ReLU as activation function for discriminator.	
Unit-5 - Deep Reinforcement Learning	9 Hour
Stateless Algorithms: Naïve Algorithm, ϵ -Greedy Algorithm, Upper Bounding Methods - The Basic Framework of Reinforcement Learning: Challenges, Simple Reinforcement Learning for Tic-Tac-Toe, Role of Deep Learning, and a Straw-Man Algorithm	
Tutorial: T9. Self-Learning Robots - Case Study, T10. Building Conversational Systems: Deep Learning for Chatbots - Case Study Self-Driving Cars - Case Study	

Learning Resources	<ol style="list-style-type: none"> 1. Iffat Zafar, Giounona Tzanidou, Richard Burton, Nimesh Patel, Leonardo Araujo, Hands-On Convolutional Neural Networks with TensorFlow, Packt Publishing, 2018. (Unit I) 2. Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola, Dive into Deep Learning, arXiv preprint, 2021 (http://d2l.ai/index.html) (Unit II, III & IV) 3. Charu C. Aggarwal, Neural Networks and Deep Learning - A Text Book, Springer Nature, 2018. (Unit V) 4. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, the MIT Press, 2017. 5. Umberto Michelucci, Applied Deep Learning – A Case-Based Approach to Understanding Deep Neural Networks, Apress, 2018. 6. François Chollet, Deep Learning with Python, Manning Publications, 2018.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Dr. M. Prakash, SRMIST
		2. Dr. G.Vadivu, SRMIST

Course Code	21CSE425T	Course Name	ADVANCED MACHINE LEARNING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the definition of a range of neural network models.	1	2	3	4	5	6	7	8	9	10	11	12															
CLR-2:	Understand neural implementations of attention mechanisms and sequence embedding models and how these modular components can be combined to build state of the art NLP systems.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3												
CLR-3:	Understand the mathematics necessary for constructing novel machine learning solutions.																											
CLR-4:	Focusing on recent advances in deep learning with neural networks, such as recurrent and Bayesian neural networks.																											
CLR-5:	Introduce the mathematical definitions of the relevant machine learning models and derive their associated optimization algorithms																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	derive and implement optimization algorithms for these models.	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-												
CO-2:	implement and evaluate common neural network models for language.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-												
CO-3:	choose a model to describe a particular type of data	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2												
CO-4:	design and implement various machine learning algorithms in a range of real world applications.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-												
CO-5:	Covers a range of applications of neural networks in natural language processing, including analyzing latent dimensions in text, translating between languages, and answering questions.	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-												

Unit-1 - Reinforcement Learning	9 Hour
Introduction to Reinforcement Learning, Basic concepts in RL, value iteration, policy iteration, Model-Based Reinforcement Learning (Dynamic Programming), value function approximator Model-Free Reinforcement Learning (SARSA, Monte Carlo, Q-Learning), Approximate and Deep Reinforcement Learning (Deep Q-Learning), Policy Gradient Reinforcement Learning, Advanced Topics on Exploration and Planning T1: Implementation of reinforcement learning using public dataset – chatbot, T2: Implementation of Deep Reinforcement learning, T3: Implementation of Policy Gradient reinforcement learning	
Unit-2 - Machine Learning with Graphs	9 Hour
Introduction; Machine Learning for Graphs, Traditional Methods for ML on Graphs, Node Embeddings, Link Analysis: PageRank, Label Propagation for Node Classification, Graph Neural Networks 1: GNN Model, Graph Neural Networks 2: Design Space, Applications of Graph Neural Networks, Knowledge Graph Embeddings, Reasoning over Knowledge Graphs, Frequent Subgraph Mining with GNNs T4: Building Graph Neural Networks using PYTHON, T5: Implementation of Knowledge Graphs, T6: Implementation of Frequent Subgraph Mining with GNNs	
Unit-3 - Ensemble Learning Models	9 Hour
Markov models - Hidden Markov models - Ensemble learning methods - Regularizations-pros and cons-Voting, Boosting, Adaboost - Gradient Boosting - Bagging with its impact on bias and variance - Random Forest - Fine Tuning Ensemble - Cascading - Application Face recognition - using Ensemble techniques - Examples - Learning - Conditional random fields (CRFs) - Structural SVMs T7: Implementation of Ada boosting and Gradient Boosting using public dataset, T8: Implementation of Bagging Classifiers using public dataset, T9: Implementation of Face recognition system using Ensemble Techniques.	

Unit-4 - Association Rule Mining	9 Hour
The applications of Association Rule Mining: Market Basket, Recommendation Engines, etc. A mathematical model for association analysis; Large item sets; Association Rules, Apriori: Constructs large item sets with mini sup by iterations; Interestingness of discovered association rules; Application examples; Association analysis vs. classification of FP-trees T10: Implementation of Association Rule Mining in Real-time applications., T11: Implementation of Apriori Algorithm, T12: Building Frequent Pattern Tree for Classification	
Unit-5 - Neural Networks	9 Hour
Neural Networks representations - McCulloch-Pitts units - Thresholding logic - Perceptron - Feed forward networks - multi-layer perceptron - Back propagation algorithms – Convergence and Hidden layer representation in back propagation - Optimization Algorithms - Gradient Decent - Stochastic gradient - Adam, Adagrad - RMSProp - Drop out - Batch Normalization – Application Face recognition using - Neural Networks T13: Implementation of optimization algorithm, T14: Implementation of Back-Propagation Algorithm, T15: Building Face recognition system using Neural Networks	

Learning Resources	1. Kevin P. Murphy. Machine Learning: A Probabilistic Perspective. MIT Press 2012 2. Ian Goodfellow, Yoshua Bengio and Aaron Courville. Deep Learning. MIT Press 2016 3. Ian Goodfellow, Yoshua Bengio and Aaron Courville. Deep Learning. MIT Press 2016 4. William L. Hamilton, Graph Representation Learning, McGill University, 2020 5. http://cs229.stanford.edu/ 6. Jason Brownlee, II Deep Learning with Python II, ebook, 2016. 7. Sebastian Raschka, Vahid Mirjalili, Python Machine Learning and deep learning, 2nd edition, kindle book, 2018
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. E Nagarajan, R&D Head, Solvedge Technology	1. Dr. Anandhakumar P Professor, Madras Institute of Technology, Chrompet	1. Dr.M.Lakshmi, SRMIST
		2. Dr.A.Shobanadevi, SRMIST

Course Code	21CSE426T	Course Name	FINANCIAL MACHINE LEARNING	Course Category	E	PROFESSIONAL ELECTIVE										L	T	P	C	
																2	1	0	3	
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil													
Course Offering Department		School of Computing		Data Book / Codes / Standards		Nil														
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Learn the machine learning for the finance domain				1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3			
CLR-2:	Know to the regression based supervised learning																			
CLR-3:	Explore the classification based supervised learning																			
CLR-4:	Explore the clustering based unsupervised learning																			
CLR-5:	Understand the NLP concepts to study various case studies																			
Course Outcomes (CO):		At the end of this course, learners will be able to:																		
CO-1:	Understand the machine learning approach to address finance domain				-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	
CO-2:	Implement regression based supervised learning in finance				-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
CO-3:	Implement classification based supervised learning in finance				-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO-4:	Implement clustering based unsupervised learning in finance				-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	
CO-5:	Understand various case studies with NLP concepts				-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
Unit-1 - Machine Learning in Finance																	9 Hour			
Machine Learning in Finance: Introduction to Machine Learning- Types of Machine Learning, NLP, Python packages for Machine Learning, Introduction and Installation, ANN models in Python-Keras-GPU and cloud services																				
T1: Identifying Python packages for Machine Learning																				
T2: Implementing ANN models in python																				
T3: Using Keras to build Machine Learning models																				
Unit-2 - Supervised Learning: Regression																	9 Hour			
Supervised Learning- Model Performance-Model Selection-Regression: Time series models, Case Studies-Stock price prediction-Derivative Pricing-Investor Risk Tolerance and Robo-Advisors-Yield Curve Prediction																				
T4: Using regression model to predict stock price																				
T5: Using regression model for derivative pricing																				
T6: Using regression model for yield curve prediction																				
Unit-3 - Supervised Learning: Classification																	9 Hour			
Supervised Learning: Classification-Case Studies- Fraud Detection-Loan Default Probability-Bitcoin Trading Strategy																				
T7: Using classification model for fraud detection																				
T8: Using classification model to identify loan default probability																				
T9: Using classification model for bitcoin trading strategy																				

Unit-4 - Unsupervised Learning: Clustering	9 Hour
Unsupervised Learning: Clustering – Clustering Techniques-Case Studies-Clustering for Pairs Trading-Portfolio Management: Clustering Investors-Hierarchical Risk Parity	
T10: Using clustering model for Pairs trading	
T11: Using clustering model for portfolio management	
T12 Using clustering model for hierarchical risk parity	
Unit-5 - Natural Language Processing	9 Hour
Natural Language Processing packages -Theory and concepts-Case Studies-NLP and Sentiment Analysis–Based Trading Strategies-Chatbot Digital Assistant- Document Summarization	
T13: Implement sentiment analysis-based trading strategies using NLP	
T14: Building simple chatbot digital assistant	
T15 Building document summarization using NLP	

Learning Resources	<ol style="list-style-type: none"> 1. Hariom Tatsat, Sahil Puri & Brad Lookabaugh (2021). Machine Learning & Data Science Blueprints for Finance-From Building Trading Strategies to Robo-Advisors Using Python, O'Reilly Media, ISBN: 9781492073055 2. Jannes Klaas (2019). Machine Learning for Finance. Publisher: Packt Publishing-ISBN: 9781789136364 3. Matthew F. Dixon, Igor Halperin and Paul Bilokon (2020). Machine Learning in Finance: From Theory to Practice. Springer Publication-ISBN: 9783030410674 4. Bob Mather (2018). Machine Learning in Finance: Use Machine Learning Techniques for Day Trading and Value Trading in the Stock Market. Abiproduct Pty Limited. 5. German G. Creamer, Gary Kazantsev, and Tomaso Aste (2021). Machine Learning and AI in Finance. Routledge, an imprint of the Taylor & Francis Group. 6. Wesley J.Chun, "Core Python Applications Programming,3rd ed,Pearson,2016
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers	Experts from Higher Technical Institutions	Internal Experts
Experts from Industry		
1. Vishwa Prasath T S Technology Analyst Accenture Pvt Ltd	1. Mr.C.M.T.Karthikeyan, Asst. Professor, Government College of Engineering - Bargur	1. Dr. P.Rajasekar, SRMIST

[illegible]

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	Data Science and Business Systems		Data Book / Codes / Standards	Nil	

Course Learning Rationale (CLR):		The purpose of learning this course is to:
CLR-1:	Learning various functions of Virtual Reality and Augmented Reality for 3D applications	
CLR-2:	Exploring the hardware and softwares for VR and AR for many applications	
CLR-3:	Knowing about the challenges for implementation especially in VR and AR	
CLR-4:	Utilities of hardware and software for closely real time usage for AR and VR	
CLR-5:	Explore the possibilities of brain computing interface with the applications of VR	
Course Outcomes (CO):		At the end of this course, learners will be able to:
CO-1:	Understand AR and VR applications in real time	
CO-2:	Learn the requirements of Hardwares and softwares	
CO-3:	Analyse the Challenges in AR and VR	
CO-4:	Create applications close to reality	
CO-5:	Create Brain Computer Interface with VR	

Unit-1 - Applications of VR and AR	9 Hour
Virtual reality in industry, Augmented reality and industrial applications, VR-AR for industrial renewal, augmented reality, Computer-assisted surgery, Virtual reality and simulation for learning, Augmented reality and intervention planning, Augmented reality in surgery, Current conditions and future prospects, Sustainable cities, Mobility aids in an urban environment, Building and architecture, Cities and urbanism, Towards sustainable urban systems, Innovative, integrative and adaptive societies, Education, Arts and cultural heritages. T1: VR and AR for Industrial applications , T2: Augmented Reality for building and architecture , T3: Sustainable solutions using AR and VR	
Unit-2 - Hardwares and Softwares	9 Hour
Positioning and orientation devices, Restitution devices, Technological challenges and perspectives, software, developing 3D applications, Managing peripheral devices, Dedicated VR-AR software solutions, sensory-motor actions for interaction, multisensory feedback, users and perception, Visual perception. T4: Sensors for AR and VR, T5: Hardwares for AR and VR, T6: Softwares for AR and VR	
Unit-3 - Challenges	9 Hour
Physical model and detecting collisions, Populating 3D environments: single virtual human to a surging crowd, the difficulty of making 3D interaction natural, the difficulty of synthesizing haptic feedback, the real-virtual relationship in augmented reality, Acquisition and restitution equipment, Pose computation, Realistic rendering, Complexity and scientific challenges of 3D interaction, Complexity and challenges surrounding the 3D interaction loop. T7: Collisions in digital reality, T8: Synthesizing in digital reality , T9: Complexity in digital reality	

Unit-4 – Close to Real World	9 Hour
Choosing a display device, Spatial localization, Topics in AR, Hybridization through a screen or HMD, Spatial augmented reality, Hybridization of the real world and the virtual world, Current evolutions, Presence in augmented reality, Mixed reality, From mixed reality to mixed presence, Augmented reality, 3D interaction on tactile surfaces T10: Head Mounted Display, T11: Hybridization of real world, T12: Tactile Stimulation	
Unit-5 – Immersive Medium with Brain	9 Hour
Polymorphic immersive medium, promised experiences, Brain-computer interfaces, Working principle of BCIs, Current applications of BCIs, The future of BCIs, Alternative perceptions in virtual reality, Pseudo-sensory feedback, Alternative perception of movement, Sensorimotor incoherences, Mitigation of the impact on visuo-vestibular incoherence T13: Brain Computer Interface, T14: Alternative Perceptions, T15: Sensorimotor Incoherences	

Learning Resources	<ol style="list-style-type: none"> 1. Bruno Arnaldi, Pascal Guitton, Guillaume Moreau, "Virtual Reality and Augmented Reality: Myths and Realities", ISBN: 978-1-786-30105-5 May 2018 Wiley-ISTE 2. Jesse Glover, Jonathan Linowes – Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications. Packt publishing, 17th April 2019. ISBN -13: 978-1838648183 3. Jonathan Linowes, Krystian Babilinski – Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt publishing, 9th October 2017. ISBN-13: 978-1787286436), "Retail Analytics: The Secret Weapon", Wiley, ISBN- 978-1-118-09984-1 4. Jesse Glover, Jonathan Linowes – Complete Virtual Reality and Augmented Reality Development with Unity: Leverage the power of Unity and become a pro at creating mixed reality applications. Packt publishing, 17th April 2019. ISBN -13 : 978-1838648183 5. Jonathan Linowes, Krystian Babilinski – Augmented Reality for Developers: Build practical augmented reality applications with Unity, ARCore, ARKit, and Vuforia. Packt publishing, 9th October 2017. ISBN-13: 978-1787286436
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Ravikumar, CEO at Hackwit Technologies Pvt Ltd, Chennai.	1. Prof. Indra kishor, Department of Computer Science and Engineering, Poomima Institute of Engineering & Technology, Jaipur, Rajasthan.	1. Dr. R. Rajkumar, SRMIST

Course Code	21CSE428T	Course Name	HEALTHCARE ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Familiarize with Healthcare Data Analytics, EHR	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the technologies for analyzing Biomedical Image															
CLR-3:	Familiarize with predictive modeling techniques for Clinical Data															
CLR-4:	Familiarize with predictive analysis techniques for genomic data															
CLR-5:	Understand about NLP and Data mining for clinical text															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Gain knowledge on Healthcare Data Analytics, EHR	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Understand the technologies for analyzing Biomedical Image	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Apply predictive modeling techniques for Clinical Data	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
CO-4:	Apply predictive analysis techniques for genomic data	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-5:	Gain knowledge on NLP and Data mining for clinical text	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-

Unit-1 - An Introduction to Healthcare Data Analytics	9 Hour
Healthcare Data Sources and Basic Analytics- Advanced Data Analytics for Healthcare- Applications and Practical Systems for Healthcare- Resources for Healthcare Data Analytics- Electronic Health Records- Components of HER- Coding Systems- Benefits of HER- Barriers to Adopting HER- Challenges of Using EHR Data T1: Understanding HER, T2: Preprocessing of HER – Standardization, Data Cleaning, T3: Preprocessing of HER – Redundant data removal, Missing data	
Unit-2 - Biomedical Image Analysis	9 Hour
Biomedical Imaging Modalities- Object Detection- Image Segmentation- Image Registration- Feature Extraction- Mining of Sensor Data in Healthcare- Mining Sensor Data in Medical Informatics- Challenges in Healthcare Data Analysis- Sensor Data Mining Applications T4: Biomedical Image Processing – enhancement, restoration, segmentation, Compression, T5: Biomedical Image Analysis Techniques – SIFT, RANSAC, CNN, T6: Biomedical Image - Visualization	
Unit-3 - Predictive Models for Integrating Clinical and Genomic Data	9 Hour
Introduction- Issues and Challenges- Different Types of Integration- Different Goals of Integrative Studies- Validation- Information Retrieval for Healthcare- Knowledge-Based Information in Healthcare and Biomedicine- Content of Knowledge-Based Information Resources- Indexing- Retrieval- Evaluation- Research Directions T7: Patient prediction for Improved staffing, T8: Using healthcare data for Informed Strategic Planning - Part 1, T9: Using healthcare data for Informed Strategic Planning – Part 2	
Unit-4 - Natural Language Processing and Data Mining for Clinical Text	9 Hour
Natural Language Processing- Mining Information from Clinical Text- Challenges of Processing Clinical Reports- Clinical Applications- Social Media Analytics for Healthcare- Social Media Analysis for Detection and Tracking of Infectious Disease Outbreaks- Social Media Analysis for Public Health Research- Analysis of Social Media Use in Healthcare T10: Classification and Clustering of Clinical Text Data, T11: Information Extraction and Entity Recognition of Clinical Text Data, T12: Ranking and word disambiguation of Clinical Text Data	

Unit-5 - Advanced Data Analytics for Healthcare	9 Hour
Automated Decision Systems - The Artificial Intelligence field - Basic concepts of Expert Systems - Applications of Expert Systems - Structure of Expert Systems - Knowledge Engineering - Development of Expert Systems – Location-based Analytics - Cloud Computing - Business Intelligence	
T13: Dimensionality reduction for exploratory data analysis in daily medical research, T14: Analyzing the complexity of behavioral factors influencing WEIGHTS IN ADULTS – Part 1	
T15: Analyzing the complexity of behavioral factors influencing WEIGHTS IN ADULTS – Part 2	

Learning Resources	1. Analytics in Healthcare-A Practical Introduction, Christo El Morr, Hossam Ali-Hassan, 2019 2. Healthcare Data Analytics, Charu C. Aggarwal
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. S. Santhosh, Manager of Team, Product Owner	1. Dr. M. Manikandan, Professor, MIT Campus, Anna University	1. Dr. T. Karthick, SRMIST

Course Code	21CSE429T	Course Name	DATA SCIENCE FOR INTERNET OF THINGS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn the basics of IoT analytics and the challenges involved in design of IoT															
CLR-2:	Understand the devices, protocols and standards involved in IoT systems															
CLR-3:	Learn various real-world systems involving IoT sensor															
CLR-4:	Explore the smart applications development using IoT sensors and systems															
CLR-5:	Identify the possible applications in healthcare using IoT sensors and the IoT data analytics in this domain															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Identify the challenges involved in the design of IoT Analytics systems	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Understand the internals of IoT devices and the sensor networks	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Design IoT Sensor networks for various real-world applications	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Develop smart applications using IoT sensors and analyse the data received from them	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-5:	Implement IoT healthcare systems and IoT Healthcare data analytical systems	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-

Unit-1 - Defining IoT Analytics and Challenges	9 Hour
The situation - Defining IoT analytics - Defining analytics - Defining the Internet of Things - The concept of constrained - IoT analytics challenges - The data volume - Problems with time - Problems with space - Data quality - Analytics challenges - Business value concerns	
Unit-2 - IoT Devices, Networking Protocols and Standards for Internet of Things	9 Hour
IoT Devices-Healthcare-Manufacturing-Transportation and logistics-Retail-Oil and gas- Home automation or monitoring - Wearables - Sensor types-IoT Data Link Protocols-Network Layer Routing Protocols - Network Layer-Encapsulation Protocols -Session Layer Protocols-IoT Management Protocols-Security in IoT Protocols-IoT Challenges	
Unit-3 - IoT Sensing, Mobile and Cognitive Systems	9 Hour
Sensing Technologies for Internet of Things - IoT Interactions with GPS, Clouds and Smart Machines - Radio Frequency Identification (RFID) - Sensors, Wireless Sensor Networks and GPS Systems - Cognitive Computing Technologies and Prototype Systems – Problems	
Unit-4 - Smart Applications IoT with Data Analytics	9 Hour
Defragmenting Intelligent Transportation: A Practical Case Study -Connected and Autonomous Vehicles-Transit Hub: A Smart Decision Support System for Public Transit Operations – Smart Home Services Using the Internet of Things	
Unit-5 - Case Studies in IoT Healthcare	9 Hour
Big Data Analytics for Healthcare and Cognitive Learning - Machine Learning for Big Data in Healthcare Applications - Healthcare Problems and Machine Learning Tools - IoT-based Healthcare Systems and Applications, Emotional Insights via Wearables- Structural Health Monitoring-Home Healthcare and Remote Patient Monitoring	

Learning Resources	1. <i>Analytics for the Internet of Things (IoT)</i> by Andrew Minter, Released July 2017, Publisher(s): Packt Publishing, ISBN: 9781787120730. 2. <i>Big-Data Analytics for Cloud, IoT and Cognitive Computing</i> , Kai Hwang, Min Chen, ISBN: 978-1-119-24729-6 March 2017. 3. <i>Internet of Things and Data Analytics Handbook</i> , Hwaiyu Geng (Editor) - ISBN: 978-1-119-17364-9 January 2017	4. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, <i>IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things</i> , Cisco Press, 2017 5. Arshdeep Bahga, Vijay Madisetti, <i>Internet of Things – A hands-on approach</i> , Universities Press, 2015
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
	1. Dr.I.Joe Louis Paul, Associate Professor, SSN College of Engineering	1. Dr.K.Shantha Kumari, SRMIST

Course Code	21CSE430T	Course Name	AUTOMATIC SPEECH RECOGNITION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Utilize Language models with regular expressions	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Understand the lexical analysis and neural networks in text processing	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Understand the machine translation process and deep learning architecture for speech recognition																
CLR-4:	Utilize information extraction and relation extraction applications																
CLR-5:	Construct Automatic speech recognitions applications using Chatbots																
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	Understand efficient text classification process	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	
CO-2:	Implement programs using the lexical analysis and neural networks in text processing	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO-3:	recognize the speech recognition models using deep learning architecture	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO-4:	model using information extraction	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
CO-5:	Implement ASR Applications with chatbots	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	

Unit-1 - Introduction to Speech and Language Processing	9 Hour
Knowledge in speech and language processing-ambiguity-models and algorithms: Regular expression-words, corpora-Text normalization-N Grams-Sampling sentences-smoothing techniques- Vector Semantics and Embeddings, Lexical Semantics, Vector Semantics, Words and Vectors, TF-IDF: Weighing terms in the vector, word to vec, Visualizing Embeddings	
T1. Regular expressions	
T2. Text preprocessing methods using TF-IDF	
T3. Implement Kneser-Ney Smoothing technique	
Unit-2 - Introduction to Neural Predictive Networks	9 Hour
Fundamentals of Neural networks- Linked Predictive Neural Networks - Extensions - Weaknesses of Predictive Networks - Frame Level Training- word level training- and Neural Language Models- Advantages of NN-HMM hybrids	
T4 speech recognition experiment using LPNN	
T5. Design and train a perceptron training for OR gate.	
Unit-3 - RNN in Speech Recognition	9 Hour
Part-of-Speech Tagging, HMM Part-of-Speech Tagging, Rule based POS Tagging- RNN for Sequence Processing, Managing Context in RNNs: LSTMs and GRUs, Self-Attention Networks: Transformers, Machine Translation and Encoder-Decoder Models, Language Divergences and Typology, The Encoder-Decoder Model	
T6. POS exercise	
T7. Exercise for RNN scenario for HMM	

Unit-4 - Computational Semantics and Semantic Parsing -Phonetics	9 Hour
Information Extraction, Relation Extraction, Relation Extraction Algorithms, Word Senses and WordNet, Word Senses, Relations Between Senses, Semantic Roles- Diathesis Alternations- FrameNet-Phonetics- Articulatory Phonetics- Phonological Categories and Pronunciation Variation- Acoustic Phonetics and Signals	
T8. Relation extraction process	
T9. Frame net generation	
T10. Simulation of original Lesk word overlap disambiguation algorithm	
Unit-5 - Text to Speech Conversion	9 Hour
Automatic Speech Recognition and Text-to-Speech, The Automatic Speech Recognition Task, Feature Extraction for ASR: Log Mel Spectrum, Speech Recognition Architecture, CTC, and ASR Evaluation: Word Error Rate, TTS.	
T11.Text to speech conversion	
T12.Log mel spectrum techniques	
T13.Chatbot creation	

Learning Resources	<ol style="list-style-type: none"> 1. Daniel Jurafsky and James H. Martin, "Speech and Language Processing", 3rd edition draft, 2019 [JM-2019] 2. Mark Gales and Steve Young, The application of hidden Markov models in speech recognition, Foundations and Trends in Signal Processing, 1(3):195-304, 2008. 3. Geoffrey Hinton, Li Deng, Dong Yu, George E. Dahl, Abdel-rahman Mohamed, Navdeep Jaitly, Andrew Senior, Vincent Vanhoucke, Patrick Nguyen, Tara N. Sainath, and Brian Kingsbury, Deep Neural Networks for Acoustic Modeling in Speech Recognition, IEEE Signal Processing Magazine, 29(6):82-97, 2012 4. Dong yu, Li Deng, Signals, and communications, "Automatic speech recognition" A Deep Learning approach, ISBN 978-1-4471-5779-3 (eBook) 5. Speech Recognition using Neural Networks, Joe Tebelskis, "Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition", Feb 2008
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Dr D Hemavathi SRMIST

Course Code	21CSE447T	Course Name	ROBOTICS: COMPUTATIONAL MOTION PLANNING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Acquire knowledge of Bug algorithms and configuration Space															
CLR-2:	Acquire knowledge of Potential functions and Navigations															
CLR-3:	Acquire knowledge of Sampling Algorithms															
CLR-4:	Gain knowledge of filtering techniques															
CLR-5:	Gain knowledge about Trajectory and Motion Planning and Design motion plan for Robot in the path specified															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply knowledge of Bug algorithms and configuration Space	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Apply knowledge of Potential functions and Navigations	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Apply knowledge of Sampling Algorithms	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO-4:	Gain knowledge of filtering techniques	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-5:	Gain knowledge about Trajectory and Motion Planning	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-

Unit-1 - Introduction to Motion Planning and Bug Algorithms	9 Hour
Overview of Motion Planning - Bug1 And Bug 2, Tangent Bug, Implementation: The Tangent Line, Distance On Gradient, Continuation Method, Robot Configuration Specification, Circular Mobile Robot, Two joint planer arm, Dimension Of The Configuration Space, Topology of configuration space: Homeomorphisms and Diffeomorphisms, Differentiable Manifolds, Examples. T1: Using Bug Algorithms implement Tangent Line, Distance and Gradient, Continuation Methods. T2: Implementation of Configuration space T3: Implementation of Matrix Representations of Rigid-Body Configuration	
Unit-2 - Potential Functions and Roadmaps	9 Hour
Potential Function: Addictive Attractive/Repulsive Potential, Gradient Descent, Computing Distance From Implementation In The Plane, Local Minima Problem, Wave-Front Planner, Navigation Potential Function: Sphere- Space Star-Space, Potential Functions for Rigid-Body Robots, Path Planning for Articulated Bodies, Visibility Graph, Deformation Retracts : Generalized Voronoi Diagram, Retract-Like Structure: Generalized Voronoi Graph, Piecewise Retracts: The Rod Hierarchical Generalized Voronoi Graph Silhouette Methods. T1: Using Potential Functions implementation of Mobile Robot T2: Using GVD for deformation retracts T3: Implementation using Silhouette Methods	

Unit-3 - Sampling Based Algorithms	9 Hour
Probabilistic Road Maps: Basic PRM, Implementation of basic PRM, PRM sampling Strategies, PRM connection Strategies, Single-Query Sampling Based Planners: Expensive Spaces Trees, Rapidly Exploring Random Trees, Connection Strategies and SBL Planner, Integration of Planners Sampling Based Roadmap, Analysis Of PRM, Control based Planning, Multiple Robots, Manipulation Planning, Assembly Planning. T1: Implementation of basic Probabilistic Road Maps T2: Analysis of Probabilistic Road Maps T3: Implementation of beyond Basic Path Planning	
Unit-4 - Filtering	9 Hour
Linear Kalman Filtering - Kalman Filter: Example - Bayesian Methods: Localization - Basic Idea Probabilistic Localization - Probabilistic Localization As Recursive Bayesian Filtering - Derivation Of Probabilistic Localization - Representation Of Posterior - Sensor Model - Mapping:: Mapping with known Locations - Bayesian Simultaneous Localization and Mapping T1: Implementation of Linear Kalman Filtering for Dead Reckoning T2: Implementation of Sensor Models T3: Study of Bayesian Simultaneous Localization and Mapping	
Unit-5 - Trajectory Planning	9 Hour
Trajectory Planning: Preliminaries - Decoupled Trajectory Planning - Direct Trajectory Planning: Optimal Control - Nonlinear Optimization - Grid-Based Search - Nonholonomic And Underactuated Systems: preliminaries - Control Systems – Controllability - Motion Planning: Optimal Control - Steering Chained -Form Systems Using Sinusoids - Nonlinear Optimization T1: Using Trajectory Planning Implement Grid Based Search algorithm T2: Using Nonholonomic and Underactuated Systems Implement Simple Mechanical Control Systems T3: Implementation of Motion Planning for Cars and Cars Pulling Trailers	

Learning Resources	1. HowieM.Choset, Seth Hutchinson, Kevin M.Lynch, George Kantor, Wolf ram Burgard, LydiaE. Kavraki, Sebastian Thrun, "Principles of Robot Motion: Theory, Algorithms, and Implementation". 2. Jean-Claude Latombe, "Robot Motion Planning", Springer Science & Business Media, 2012	3. http://robotics.stanford.edu/~latombe/cs326/2009/schedule.htm
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Dr.A.Shanthini, SRMIST

Course Code	21CSE448T	Course Name	BIO-INSPIRED COMPUTING AND FUZZY LOGIC	Course Category	E	PROFESSIONAL ELECTIVE										L	T	P	C	
																2	1	0	3	
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil													
Course Offering Department		School of Computing		Data Book / Codes / Standards		Nil														
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Learn the fundamentals of evolutionary theory				1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge Problem Analysis Design/development of solutions Conduct investigations of complex problems Modern Tool Usage The engineer and society Environment & Sustainability Ethics Individual & Team Work Communication Project Mgt. & Finance Life Long Learning PSO-1 PSO-2 PSO-3			
CLR-2:	Learn nature-inspired algorithms and the neural network systems																			
CLR-3:	Learn optimization algorithms for feature selection																			
CLR-4:	Learn the Genetic algorithm concepts																			
CLR-5:	Become familiar with fuzzy logic techniques																			
Course Outcomes (CO):		At the end of this course, learners will be able to:																		
CO-1:	understand basic concepts of evolutionary algorithm				-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO-2:	implement nature-inspired algorithms and the basics of neural network concepts				-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	
CO-3:	implement the biological background of optimization algorithms				-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	
CO-4:	code for genetic algorithms concepts				-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	
CO-5:	apply fuzzification and defuzzification concepts				-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	
Unit-1 - Introduction to Evolutionary Algorithms																9 Hour				
Introduction- Learning from Biology- Nature's Way for Optimizing: Algorithm Meets Evolution, The Flavors of Evolutionary Algorithms - Dissecting an Evolutionary Algorithm: The Fitness Function, Initialization, Selection, Recombination, Mutation, Replacement - Fields of Application of Evolutionary Algorithms																				
T1: Study of basic concepts of python programming																				
T2: Implementation of population concept																				
T3: Implementation of selection concept																				
Unit-2 - Nature-Inspired Algorithms																9 Hour				
Simulated Annealing, Genetic Algorithms, Differential evolution, Ant and Bee Algorithms, Firefly algorithms, Cuckoo algorithms, Bat algorithm, Harmony search, Flower algorithms, Overview of Neural Networks																				
Models: Single and Multi-Layer Perceptron																				
T4: Implementation of Firefly Algorithm																				
T5: Implementation of Bat algorithm																				
T6: Implementation of single and multi-layer perceptron																				
Unit-3 - Optimization algorithms																9 Hour				
Optimization- Classical Optimization- Taxonomy of optimization problem- continuous optimization - Algorithms for continuous optimization: Unconstrained optimization - constrained optimization. Ant colony optimization: Ant algorithms, ant system, Max min, Ant system. Particle Swarm Optimization- Properties of PSO, Discrete version, application.																				
T7: Implementation of Classical optimization																				
T8: Implementation of Ant colony optimization																				
T9: Implementation of particle swarm optimization																				

Unit-4 - Genetic algorithms	9 Hour
History of Genetic Algorithm, Basic concepts- Creation of offspring, working principles, encoding, fitness function, reproduction, Genetic modeling- Inheritance operator, crossover, inversion & deletion, mutation operator, Bitwise operator, Generational Cycle, Convergence of GA, Applications & advances in GA, Differences & similarities between GA & another traditional method, Hybrid systems, evolutionary computing, Genetic Algorithm based on Backpropagation networks- Implementation and comparison on the performance of traditional algorithms with Genetic Algorithm T10: Implementation of the fitness function T11: Implementation of mutation and cross over T12: Implementation of complete genetic algorithm	
Unit-5 - Fuzzy Logic	9 Hour
Introduction to Fuzzy Logic-Fuzzy sets and membership functions-Operations on Fuzzy sets-Fuzzy relations, rules, propositions, implications, and inferences-Defuzzification techniques-Fuzzy logic controller design-Some applications of Fuzzy logic. T13: Implementation of fuzzy set operations T14: Implementation of fuzzy logic functions (fuzzification and defuzzification) T15: Implementation of fuzzy inference	

Learning Resources	1. Stephan Olariu, Albert Y. Zomaya (2006), <i>Handbook of Bioinspired Algorithms and Applications</i> , Taylor & Francis Group, LLC. 2. Wahde, M. (2008). <i>Biologically Inspired Optimization Methods: An Introduction</i> . United Kingdom: WIT Press. 3. George J. Klir (2015), <i>Fuzzy Sets and Fuzzy Logic: Theory and Applications</i> , Prentice Hall. 4. Dennis Mou Ling Wong, Pan Zheng, Tao Song, Xun Wang (2019) <i>Bio-inspired Computing Models and Algorithms</i> . Japan: World Scientific Publishing Company.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.A Alkaff Ahamed, Software Developer Associate, Ceridian	1. Dr.L.Jayakumar, NIT Tripura	1. Dr.A.Shanthini, SRMIST

Course Code	21CSE449T	Course Name	RISK ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
CLR-1:	Learn risk assessment, management, and analytics	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
CLR-2:	Comprehend the functioning of Banking and apply analytic techniques to mitigate risks																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
CLR-3:	Explore the operations of Insurance sector																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
CLR-4:	Analyze the processes involved in healthcare industry and use data analysis to improve patient care and optimize cost																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
CLR-5:	Utilize human relationship management techniques for effective management of people																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
Course Outcomes (CO):		At the end of this course, learners will be able to:												-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Risk Introduction and Impacts	9 Hour
Risk Definition and Examples, Components and Factors, Understanding Risk Assessment, Risk Mitigation, Risk Management, Risk Analytics Introduction, Risk Analytics Definition and Objectives	
T1: Discussion with case studies on impacts with risks	
T2: Risk mitigation and management plan document	
T3: Explore Risk Analytics	
Unit-2 - Introduction to Banking Sector	9 Hour
Introduction to Banking Sector, National and International laws, Credit Risk Analytics, Internal capital Adequacy Assessment Process, Internal capital Adequacy Assessment Process Related Risk Analytics, Limit Management, Risk-Adjusted Performance Management, Fraud Risk	
T4: Compare national and international banking laws with case studies and papers	
T5: Internal capital Adequacy Assessment Process Related Risk Analytics	
T6: Risk-Adjusted Performance Management	
Unit-3 - Introduction to Insurance Sector	9 Hour
Property & Causality Insurance Companies, Life Insurance Companies, Using Analytics for Customer Acquisition and Retention, Detecting Fraud, Preventing Fraud, Managing Fraud, Detecting, Preventing and Managing Fraud using Analytics	
T7: A comprehensive study on Insurance sector App	
T8: Implementation of parsing RSS and HTML, pickling	
T9: Fraud Handling using analytics	

Unit-4 - Introduction to Healthcare Sector	9 Hour
HIPAA, Four Enterprise Disciplines of Health Analytics, Health Outcome Analysis, Customer Insights, Health Value and Cost, Actuary Services, Framework for Customer Analytics, T10: A survey on healthcare standards – national and international T11: Health Value, Cost and Outcome analysis T12: Explore available frameworks for customer analytics	
Unit-5 - Introduction to HR Analytics	9 Hour
Workforce Environment and Psychology, Talent Management, understanding retention, Predicting Retention, Boosting Employee Engagement, Sources of Hire, Quality of Hire, Profiling High Performers T13: Analyze workforce Psychology and Talent Management T14: Retention and employee engagement analytics T15: Analyze hiring processes and profiling performers	

Learning Resources	<ol style="list-style-type: none"> 1. Naeem Siddiqi, "Credit Risk Scorecards: Developing and Implementing Intelligent Credit Scoring", ISBN 978-0-471-75451 2. Patricial L. Saporito, "Applied Insurance Analytics", FT Press, 2015, ISBN-10:0-13-3760-36-7. 3. Laura B. Madsen, "Data-Driven Healthcare: How Analytics and BI are Transforming the Industry", M.S. ISBN 978-1-118-77221-8 4. Jason Burke, "Health Analytics: Gaining the Insights to Transform Health Care", John Wiley Sons Inc., 2013, ISBN: 978-1-118-38304-9 5. Jac Fitz-Enz, John R. Mattox II, "Predictive Analytics for Human Resources", ISBN-13: 978-8126552153. 6. James C. Sesil, "Applying Advanced Analytics to HR Management Decisions: Methods for Selection, Developing Incentives, and Improving Collaboration", ISBN-13: 978- 0133064605
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Dr.D.Rajeswari , SRMIST

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume - 11L

**(Syllabi for M.Tech (Integrated) Computer Science and
Engineering w/s in Cognitive Computing Programme
Courses)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC505T	Course Name	COMPUTER GRAPHICS AND VISION	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Introduce algorithms for line, circle, and ellipse	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Enumerate Two dimensional geometric transformations and clipping operations															
CLR-3:	Illustrate Three-dimensional object representations, transformation and viewing															
CLR-4:	Articulate Object recognition and feature detection															
CLR-5:	Discuss the applications of motion estimation															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Write algorithms for drawing line, circle, and ellipses.	3	3	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-2:	Perform two dimensional geometric transformations	3	2	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-3:	Practice three dimensional geometric transformations	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Determine the models for object recognition and feature detection	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Interpret the models for motion estimation	2	2	-	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction	12 Hour
Output primitives – points and lines, line drawing algorithms, loading the frame buffer, line function; circle and ellipse generating algorithms; Pixel addressing and object geometry, filled area primitives. Attributes of output primitives – Line attributes, curve attributes, Color and gray scale levels, Area fill attributes, Character attributes, and Bundled attributes, Inquiry functions, Antialiasing. Tutorials: T1: Find out the algorithm for circle generation or curve generation. T2: How does anti-aliasing help to improve graphics?, T3: Identify the different animation functions based on the types of output primitives.	
Unit-2 - Two Dimensional Geometric Transformations	12 Hour
Matrix representations and homogeneous coordinates, composite transformations; Two-dimensional viewing – viewing pipeline, viewing coordinate reference frame; window-to-viewport coordinate transformation, Two dimensional viewing functions; clipping operations – point, line, and polygon clipping algorithms. Tutorials: T1: Write a code to get one image as input and apply all 2d transformations on the given image. T2: What are the different types of polygons and various polygon clipping algorithms? T3: Write a program to make puzzle game.	
Unit-3 - Three Dimensional Concepts	12 Hour
Three-dimensional object representations – Polygon surfaces- Polygon tables- Plane equations – Polygon meshes; Curved Lines and surfaces, Quadratic surfaces; Blobby objects; Spline representations – Bezier curves and surfaces -B-Spline curves and surfaces. TRANSFORMATION AND VIEWING: Three dimensional geometric and modeling transformations – Translation, Rotation, Scaling, composite transformations; Three-dimensional viewing – viewing pipeline, viewing coordinates, Projections, Clipping; Visible surface detection methods. Tutorials: T1: Apply different 3d transformations on the given input image and show the result. T2: Given a bezier curve with 4 control points-B0 [1 0], B1 [3 3], B2 [6 3], B3 [8 1], Determine any 5 points lying on the curve. Also, draw a rough sketch of the curve. T3: Write a code to implement projections in an image.	

Unit-4 - Introduction to Computer Vision	12 Hour
Recognition - Instance Recognition – Image Classification – Object detection – Semantic segmentation - Feature detection and matching – Points and Patches – Edges and contour – Contour tracking – Lines and Vanishing points. Case study - Pose estimation and Hand written recognition Tutorials: T1: Write the different applications of computer vision. T2: Name the different feature detection and keypoints that can be used in person identification application. T3: How active contours are used in different real time applications.	
Unit-5 - Motion Estimation	12 Hour
Translational alignment – Parametric motion – Video stabilization – Spline based motion - medical image registration – Optical flow – Deep learning approaches – Rolling shutter wobble removal - Multi frame motion estimation – Video denoising – Layered motion – Frame interpolation – Transparent layers and reflections – Video object segmentation – Video object tracking. Case study - Road Traffic Analysis and Autonomous Vehicle. Tutorials: T1: State the suitable deep learning approach in motion estimation algorithm. T2: Explore the different available AI video denoising softwares, T3: Identify the suitable CV algorithm used in autonomous vehicle applications and list out its challenges.	

Learning Resources	1. Donald Hearn and M. Pauline Baker, "Computer Graphics C Version", second edition,	2. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2010
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	10%	-	20%	-
Level 2	Understand	20%	-	10%	-	20%	-
Level 3	Apply	30%	-	40%	-	30%	-
Level 4	Analyze	30%	-	40%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
Total		100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. shenbagavalli.pillai@axa.com.sg	1. Dr. Y.V.Lokeshwari - Associate Professor, SSN College of Engineering, Kalavakkam	1. Ms A L Amutha, SRMIST
2. shankarpillai@gudact.com	2. Gopinath.cse@sairam.edu.in	

Course Code	21CSC506J	Course Name	COMPUTATION AND COGNITION: THE PROBABILISTIC APPROACH	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing			Data Book / Codes / Standards	Nil

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the philosophical and psychological cognitive and generative approaches to modelling.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Analyze the basics of casual, conditional, and statistical dependence															
CLR-3:	Acquire the computational and Bayesian models for cognition															
CLR-4:	Implement the working pattern of cognitive architectures															
CLR-5:	Demonstrate the different cognitive architectures and cognitive robots															

Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Acquire the knowledge philosophical, and psychological approaches in cognitive models and generative models	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-2:	Illustrate casual, conditional, and statistical dependence	-	2	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-3:	Demonstrate cognitive and Bayesian models	-	-	3	-	-	-	-	-	-	-	-	-	-	-	1
CO-4:	Apply knowledge on computational psycholinguistics	-	2	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Design the cognitive robots and cognitive architectures	-	2	-	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Philosophical and Psychological	15 Hour
Introduction; Philosophical- Psychological - Cognitive approaches to modeling the mind, - Neuroscientific foundations - The Brain I - The Brain II - The Brain III - Brain Recording Techniques- Animal Cognition - The relevance of computation; types of computation – Building Generative Models - Prediction, Simulation and Probabilities	
Unit-2 - Casual, Conditional and Statistical Dependence	15 Hour
Causal and statistical dependence - Detecting Dependence Through Intervention - Graphical Notations for Dependence - Priori Dependence to Conditional Dependence - Non-monotonic Reasoning	
Unit-3 - Cognitive and Bayesian Models	15 Hour
Symbolic representations and models of cognition - Debates about thinking, AI, and representation- Cognitive models and Bayesian inferencing - Bayesian models of cognition - Computational models of attention - Visual Attention; Audio and Multimodal Attention	
Unit-4 - Cognitive Science	15 Hour
Computational psycholinguistics-. Language and Cognitive Science - Language and Cognition - Word Processing - Cognitive architectures- cognitive system organization - Social Cognition – Communication and Language	
Unit-5 - Cognitive Robotics and Applications	15 Hour
Cognitive architectures; Cognitive robotics and embodied cognition - Applications: Audio quality assessment - compression & indexing - Applications: Image quality assessment, compression, Haptic interfaces- Memorability of images; Haptic/tactile displays - Audio Engineering: Quality Assessment; Audio Engineering: Spatial Audio; Audio Engineering: Perceptual.	

Lab Experiments	
Lab 1: Study the Retina Process Lab 2: Implement the Retina Computation Process Lab 3: Demonstrate the Scene Statistics and Perception Lab 4: Simulate the Intuitive Physics using Generative Model Lab 5: Analyse the process of texture synthesis to artistic style transfer Lab 6: Demonstrate the Image Compression method Lab 7: Implement and analyse the Tokenization/Lexicons/n-grams	Lab 8: Implement the Morphology Technique Lab 9: Demonstrate the Part-of-Speech tagging Lab 10: Implement the Parsing Technique. Lab 11: Demonstrate the Stochastic Parsing Lab 12: Demonstrate the Audio Synthesis Lab 13: Implement the Audio Processing

Learning Resources	1. Jay Friedenberg and Gordon Silverman. Cognitive Science: An Introduction to the Study of Mind. SAGE Publications, 2006.	6. N. D. Goodman and A. Stuhlmüller (electronic). The Design and Implementation of Probabilistic Programming Languages. Retrieved 2022-8-16 from http://dippl.org .
	2. E. Bruce Goldstein. Sensation and Perception. Wadsworth, 8th Edition, 2010.	7. Searle, John R. Minds, Brains, and Programs. Behavioral and Brain Sciences 3: 417–424 (1980) [doi: 10.1017/S0140525X00005756] [pdf].
	3. José Luis Bermúdez. Cognitive Science: An Introduction to the Science of the Mind. Cambridge, 4th Edition, 2022.	8. Pinker, Steven. How the Mind Works. Penguin, 1999.
	4. Matthew J. Traxler. Introduction to Psycholinguistics: Understanding Language Science. Wiley- Blackwell, 2011.	9. Fodor, Jerry. The Mind Doesn't Work That Way: The Scope and Limits of Computational Psychology. MIT, 2000.
	5. N. D. Goodman, J. B. Tenenbaum, and the ProbMods Contributors (2016). Probabilistic Models of Cognition (2nd ed.). Retrieved 2022-8-16 from https://probmods.org/	10. Thomas L. Griffiths, Charles Kemp, and Joshua B. Tenenbaum. Bayesian models of cognition. In Ron Sun (ed.), The Cambridge handbook of computational cognitive modeling (2008) [pdf]

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	25%	-	-	10%	25%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	20%	-	-	30%	20%	-
Level 4	Analyze	20%	-	-	30%	20%	-
Level 5	Evaluate	10%	-	-	10%	10%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr Vijay Daniel, Software Engineering Manager, MasterCard, Dublin, Ireland	1. Dr D Sumathi, Professor, VIT-AP, Amaravathi	1. Dr S Prithi, SRMIST

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSE541T	Course Name	PROBABILISTIC GRAPHICAL MODELS: PRINCIPLES AND TECHNIQUES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Outline the ideas of probabilistic model used in probability theory, statistics, and machine learning	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Illustrate directed and undirected graphical models															
CLR-3:	Gain knowledge on Inference in exact, approximate inferences with algorithms															
CLR-4:	Relate inference in MAP and temporal inference algorithms															
CLR-5:	Learn about different learning algorithms															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the fundamentals of probability theory	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Learn the directed and undirected graphical models with example algorithms	2	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Understand the Inference in exact, approximate Inference with algorithms	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Analyze the Inference in MAP and Temporal Inference with algorithms	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Design different learning algorithms in graphical models	-	-	-	3	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Fundamentals	9 Hour
Fundamentals of Probability Theory - Views of Probability, Random Variables and Joint Distributions, Conditional Probability, Conditional Independence, Expectation and Variance, Probability Distributions - Conjugate Priors, Introduction to Exponential Family; Fundamentals of Graph Theory - Paths, Cliques, Subgraphs, Cycles and Loops.	
Unit-2 - Graphical Models	9 Hour
Introduction - Directed Models -Bayesian Network, Undirected Models -Markov Random Fields, Dynamic Models -Hidden Markov Model & Kalman Filters and Factor Graph; Conditional Independence -Bayes Ball Theorem and D-separation, Markov Blanket, Factorization-Hammersley-Clifford Theorem, Equivalence: I-Maps & Perfect Maps; Factor Graphs - Representation, Relation to Bayesian Network and Markov Random Field.	
Unit-3 - Inference in Graphical Models	9 Hour
Exact Inference - Variable Elimination, Elimination Orderings, Relation to Dynamic Programming, Dealing with Evidence, Forward-Backward Algorithm, Viterbi Algorithm; Clique Tree Algorithm; Belief Propagation (Sum Product); Approximate Inference - Variation Methods-Kikuchi & Bethe Approximation, Expectation Propagation, Gaussian Belief Propagation;	
Unit-4 - Inference in MAP and Temporal	9 Hour
Max-Product, Graph Cuts, Linear Programming Relaxations to MAP: Tree-Reweighted Belief Propagation, MPLP; Sampling - Markov Chain Monte Carlo, Metropolis Hastings, Gibbs - Collapsing & Blocking, Case study: Particle filtering applications.	
Unit-5 - Learning in Graphical Models	9 Hour
Parameter Estimation - Expectation Maximization, Maximum Likelihood Estimation, Maximum Entropy, Pseudo likelihood, Bayesian Estimation, Conditional Likelihood, Structured Prediction; Learning with Approximate Inference; Learning with Latent Variables; Structure Learning, Case Study-Structure Search.	

Learning Resources	1. Koller, D. and Friedman, N. (2009). <i>Probabilistic Graphical Models: Principles and Techniques</i> . MIT Press.	4. Barber, D. (2011). <i>Bayesian Reasoning and Machine Learning</i> . Cambridge University Press, 1st edition.
	2. Jensen, F. V. and Nielsen, T. D. (2002). <i>Bayesian Networks and Decision Graphs</i> . Information Science and Statistics. Springer, 2nd edition.	5. Wainwright, M. and Jordan, M. (2008). <i>Graphical Models, Exponential Families, and Variational Inference</i> . Foundations and Trends in Machine Learning, 1:1–305.
	3. Kevin P. Murphy (2013) <i>Machine Learning: A Probabilistic Perspective</i> . 4th Printing. MIT Press.	6. David Bellot (2016) <i>Learning Probabilistic Graphical Models in R</i> 7. Kiran R Karkera, (2014) <i>Building Probabilistic Graphical Models with Python</i>

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	40%	-	40%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	-	-	-	-	10%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mrs.Savitha Boomiperumal, Technical Lead, Accenture Technology Solutions, Portugal, Europe	1. Dr.Anusha K, Associate Professor, School of Computing, VIT Chennai.	1. Dr.Sumathy G, SRMIST

Course Code	21CSE542T	Course Name	DEEP GENERATIVE MODELS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basics of generative models and deep learning architectures	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the significance of autoregressive and flow-based models															
CLR-3:	Apply latent variable models for non-linear variables and to improve the performance															
CLR-4:	understand various basic generative adversarial networks for different applications															
CLR-5:	Explore deep GAN models for various multimedia applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	gain the knowledge on basic units of generative models and their types	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	implement autoregressive models and flow-based models with continuous and discrete random variables	-	2	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Learn the latent variable models and variational encoders	-	3	-	3	-	-	-	-	-	-	-	-	-	-	2
CO-4:	develop the hybrid model and energy-based models for different applications	-	3	-	3	-	-	-	-	-	-	-	-	-	-	2
CO-5:	Apply various case studies that adapt deep GAN models	-	2	-	3	-	-	-	-	3	-	-	-	-	-	3

Unit-1 - Generative Modeling	9 Hour
Introduction - Generative Versus Discriminative Modeling - Advances in Machine Learning - The Rise of Generative Modeling - The Generative Modeling Framework – Probabilistic Generative Models - The Challenges of Generative Modeling - Representation Learning -Setting Up Your Environment – Deep Learning – Structural and unstructural data – Deep Neural Network – Example – Improving model.	
Unit-2 - Deep generative modelling	9 Hour
Types – Autoregressive models - Autoregressive Models Parameterized by Neural Networks - Deep Generative Autoregressive Model: an example Flow based models - Flows for Continuous Random Variables - Change of Variables for Deep Generative Modeling - Building Blocks of RealNVP – example - Flows for Discrete Random Variables - Flows in R or Maybe Rather in Z - Integer Discrete Flows. Case study using Deep generative modeling	
Unit-3 - Latent Variable Models	9 Hour
probabilistic principal component analysis - Variational Auto-Encoders: Variational Inference for Non-linear Latent Variable Models - Improving Variational Auto-Encoders - Hierarchical Latent Variable Models.	
Unit-4 - Hybrid Modeling and GAN	9 Hour
Naive approach – shared parameterization approach – example – Energy based models – model formation – training – example – restricted Boltzmann machines Generative adversarial networks – GAN architecture – GAN challenges – Wasserstein GAN – WGAN – GP. Case study using Hybrid approach with GAN	
Unit-5 - Future of Generative Modelling	9 Hour
the transformer – advances in image generation – applications of generative modelling	
Case studies – BERT – GPT-2- MuseNet – ProGAN – SAGAN – BigGAN – StyleGAN – AI Art – AI Music	

Learning Resources	<ol style="list-style-type: none"> 1. David Foster, <i>Generative Deep Learning, Teaching Machines to Paint, Write, Compose, and Play</i>, O'Reilly Media, Inc., 2019, ISBN: 9781492041948 2. Jakub M. Tomczak, <i>Deep Generative Modeling</i>, Springer nature, Edition 1, 2022, ISBN - 978-3-030-93157-5 3. Kailash Ahirwar, <i>Generative Adversarial Networks Projects, build next-generation generative models using TensorFlow and Keras</i>, pakt publisher, 2019. ISBN: 978-1789136678 	<ol style="list-style-type: none"> 4. Roozbeh Razavi-Far, Ariel Ruiz-Garcia, Vasile Palade, Juergen Schmidhuber, <i>Generative Adversarial Learning: Architectures and Applications</i>, (2022), Springer Cham 5. Jakub M. Tomczak, <i>Deep Generative Modeling</i>, Springer, 2022, 978-3-030-93158-2
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	10%	-	10%	-	10%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100%		100%		100%	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Kavita Ganeshan Artificial Intelligence Principal - AI Products and Solutions, Accenture, Mumbai, India	1. Dr. S. Chandrakala, Professor, School of Computing, Sastra Deemed to be University, Thanjavur	1. Dr. A. Robert Singh, SRMIST

Course Code	21CSE543T	Course Name	BRAIN MACHINE INTERFACE: SCIENCE, TECHNOLOGY AND APPLICATION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:		Program Outcomes (PO)												Program Specific outcomes		
CLR-1:		CLR-2:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the basic concepts of brain computer/machine interface	CLR-2:	Study the various signal acquisition methods of Brain Machine/Computer Interface	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	Interpret signal processing methods used in Brain Machine/Computer Interface	CLR-4:	Understand the various machine learning methods of Brain Machine/Computer Interface															
CLR-5:	Learn the various applications of Brain Machine/Computer Interface																	
Course Outcomes (CO):		At the end of this course, learners will be able to:																
CO-1:	Summarize the Brain Machine /Computer Interface	CO-2:	Assess concept of BCI	2	1	-	2	-	-	-	-	-	-	-	-	1	-	-
CO-3:	Assign functions appropriately to the human and to the machine	CO-4:	Choose appropriate feature extraction methods	3	1	-	2	-	-	-	-	-	-	-	-	1	-	-
CO-5:	Apply machine learning algorithms for translation			2	1	-	3	-	-	-	-	-	-	-	-	1	-	-
				3	2	-	3	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to BCI	9 Hour
Introduction - Brain structure and function, Brain Computer Interface Types - Synchronous and Asynchronous -Invasive BCI -Partially Invasive BCI - Non Invasive BCI, Structure of BCI System- BCI Monitoring Hardware, EEG, ECoG, MEG, fMRI-10-20 electrode positions.	
Unit-2 - Brain Activation	9 Hour
Brain activation patterns - Spikes, Oscillatory potential and ERD, Slow cortical potentials, Movement related potentials-Mu rhythms, motor imagery, Stimulus related potentials - Visual Evoked Potentials – P300 and Auditory Evoked Potentials, Potentials related to cognitive tasks.	
Unit-3 - Feature Extraction Methods	9 Hour
Data Processing – Spike sorting, Frequency domain analysis, Wavelet analysis, Time domain analysis, Spatial filtering -Principal Component Analysis (PCA), Independent Component Analysis (ICA), Artefacts reduction, Feature Extraction - Phase synchronization and coherence. Case study : Application of Feature extraction methods	
Unit-4 - Machine Learning Methods for BCI	9 Hour
Classification techniques –Binary classification, Ensemble classification, Multiclass Classification, Evaluation of classification performance, Regression - Linear, Polynomial, RBF's, Perceptron's, Multilayer neural networks, Support vector machine, Graph theoretical functional connectivity analysis. Case study: Machine learning methods in BCI applications.	
Unit-5 - Applications of BCI	9 Hour
Invasive BCIs: decoding and tracking arm (hand) position, controlling prosthetic devices such as orthotic hands, Cursor and robotic control using multi electrode array implant, Cortical control of muscles via functional electrical stimulation. Non-invasive BCIs: P300 Mind Speller, Visual cognitive BCI, Emotion detection. Ethics of Brain Computer Interfacing.	

Learning Resources	1. Rajesh.P.N.Rao, "Brain-Computer Interfacing: An Introduction", Cambridge University Press, First edition, 2019.	5. Ali Bashashati, MehrdadFatourehchi, Rabab K Ward, Gary E Birch," A survey of signal Processing algorithms in brain-computer interfaces based on electrical brain signals" Journal of Neural Engineering, Vol.4, 2007, PP.32-57.
	2. Jonathan Wolpaw, Elizabeth Winter Wolpaw, "Brain Computer Interfaces: Principles and practice", Oxford University Press, USA, Edition 1, January 2012.	6. Arnon Kohen, "Biomedical Signal Processing", Vol I and II, CRC Press Inc, Boca Rato, Florida.Bishop C.M., "Neural networks for Pattern Recognition", Oxford, Clarendon Press, 1995.
	3. Ella Hassianien, A &Azar.A.T (Editors), "Brain-Computer Interfaces Current Trends and Applications", Springer, 2015.	7. Andrew Webb, "Statistical Pattern Recognition", Wiley International, Second Edition, 2002.
	4. Bernhard Graimann, Brendan Allison, GertPfurtscheller, "Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction", Springer, 2010	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.M.Prakash Team Lead(Associate Consultant) ,Virtusa ,Chennai	1. Dr.V Hariabaabu Associate Faculty in Entrepreneurship Development Institute of India Gandhi Nagar, Gujarat.	1. Dr.M.UMA, SRMIST

Course Code	21CSE544T	Course Name	DATA ANALYSIS AND VISUALIZATION	Course Category	C	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):	The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand the basics of data analytics and essential tools	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-2:	Apply the preprocessing methods to prepare the data for data analytics	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-3:	Utilize various data visualization tools for understanding the insights of data															
CLR-4:	Analyze time-series data and its structure for making prediction															
CLR-5:	Apply advanced data analytic tools for real time applications															

Course Outcomes (CO):	At the end of this course, learners will be able to:	1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CO-1:	Use data analysis tools in the panda's library	1	-	-	3	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Load, clean, transform, merge, and reshape data.	-	-	-	3	-	-	-	-	-	-	-	-	3	-	-
CO-3:	Handle various data visualization tools.	-	-	-	3	-	-	-	-	-	-	-	-	-	1	-
CO-4:	Analyze and manipulate time series data.	-	-	-	3	2	-	-	-	-	-	-	-	-	-	2
CO-5:	Solve real world data analysis problems.	-	-	-	3	2	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction	9 Hour
Introduction to Data Science, Exploratory Data Analysis and Data Science Process. Motivation for using Python for Data Analysis, Introduction of Python shell iPython and Jupyter Notebook.	
Unit-2 - Started with Pandas	9 Hour
Arrays and vectorized computation, Introduction to pandas Data Structures, Essential Functionality, Summarizing and Computing Descriptive Statistics. Data Loading, Storage and File Formats. Reading and writing Data in Text Format, Web Scraping, Binary Data Formats, Interacting with Web APIs, Interacting with Databases Data Cleaning and Preparation. Handling Missing Data, Data Transformation, String Manipulation Case study: Understanding the data thoroughly using APIs	
Unit-3 - Data Wrangling	9 Hour
Hierarchical Indexing, Combining and Merging Data Sets Reshaping and Pivoting. Data Visualization matplotlib: Basics of matplotlib, plotting with pandas and seaborn, other python visualization tools - Plotnine, geoplotlib	
Unit-4 - Data Aggregation and Group operations	9 Hour
Group by Mechanics, Data aggregation, General split-apply-combine, Pivot tables and cross tabulation Time Series Data Analysis: Date and Time Data Types and Tools, Time series Basics, date Ranges, Frequencies and Shifting, Time Zone Handling, Periods and Periods Arithmetic, Resampling and Frequency conversion, Moving Window Functions.	
Unit-5 - Advanced Pandas:	9 Hour
Categorical Data, Advanced GroupBy Use, Techniques for Method Chaining, Case studies: mining text data, analyze image dataset, analyze social network data set	

Learning Resources	<ol style="list-style-type: none"> McKinney, W. (2017). <i>Python for Data Analysis: Data Wrangling with Pandas, NumPy and IPython</i>. 2nd edition. O'Reilly Media O'Neil, C., & Schutt, R. (2013). <i>Doing Data Science: Straight Talk from the Frontline</i> O'Reilly Media Anil Maheshwari, <i>Data Analytics</i>, 1st Edition (2017), TataMcGraw Hill 	<ol style="list-style-type: none"> Dr. Ossama Embarak, <i>Data Analysis and Visualization Using Python</i>, Springer (2018). Avinash Navlani, Armando Fandango, Ivan Idris, <i>Python Data Analysis</i>, Packt publisher, 2021, 9781789955248
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	30%	-	30%	-
Level 2	Understand	30%	-	30%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	20%	-	20%	-	20%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100%		100%		100%	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. R. Praveen Kumar, Technical lead, Allianz Technology, Thiruvananthapuram, Kerala.	1. Dr. N. Sudha, Professor, School of Computing, Sastra Deemed to be University, Thanjavur	1. Dr. A. Robert Singh, SRMIST

Course Code	21CSE545T	Course Name	COMPUTATIONAL PERCEPTION AND COGNITION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Introduce the computational models, and perception of cognition	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Illustrate the basic parameter estimation techniques															
CLR-3:	Introduce the bayesian parameter estimation techniques and Hierarchical modeling															
CLR-4:	Relate the different computational models															
CLR-5:	Analyze the models in psychology															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the computational models, and Cognition	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Apply the basic parameter estimation techniques	-	-	3	2	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Interpret the bayesian parameter estimation techniques and Hierarchical modeling	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Compare the different computational models	-	-	3	3	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Analyze the models in psychology	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Modeling	9 Hour
Introduction to Modeling: Models and Theories in Science - Quantitative Modeling in Cognition - Potential Problems: Scope and Falsifiability from Words to Models: Response Times in Speeded-Choice Tasks - Building a Simulation - The Basic Toolkit	
Unit-2 - Basics Parameter Estimation	9 Hour
Basic Parameter Estimation Techniques- Discrepancy Function- Fitting Models to Data: Parameter Estimation Techniques- Least-Squares Estimation in a Familiar Context- Inside the Box: Parameter Estimation Techniques- Variability in Parameter Estimates - Maximum Likelihood Parameter Estimation- Basics of Probabilities- Defining a Probability Distribution- Finding the Maximum Likelihood Combining Information from Multiple Participants	
Unit-3 - Parameter Estimation	9 Hour
Bayesian Parameter Estimation- Bayesian Inference- Analytic Methods for Obtaining Posteriors- Determining the Prior Distributions of Parameters- Markov Chain Monte Carlo Methods- Problems Associated with MCMC Sampling- Gibbs Sampling - Multilevel or Hierarchical Modeling- Conceptualizing Hierarchical Modeling- Bayesian Hierarchical Modeling- Hierarchical Maximum Likelihood Modeling.	
Unit-4 - Model Comparison	9 Hour
Psychological Data and the Very Bad Good Fit- Model Comparison- The Likelihood Ratio Test- Akaike's Information Criterion- Other Methods for Calculating Complexity and Comparing Models- Parameter Identifiability and Model Testability Bayesian Model Comparison using Bayes Factors: Marginal Likelihoods and Bayes Factors- Methods for Obtaining the Marginal Likelihood- Bayes Factors for Hierarchical Models- The Importance of Priors. Case study on Model comparison.	

Unit-5 - Models in Psychology	9 Hour
<i>Models in Psychology: Broad Overview of the Steps in Modeling- Drawing Conclusions from Models- Good Practices to Enhance Understanding and Reproducibility Neural Network Models- Hebbian Models- Backpropagation Models in Neuroscience- Methods for Relating Neural and Behavioral Data- Reinforcement Learning Models- Neural Correlates of Decision-Making. Case study: Applications of Cognition towards model building.</i>	

Learning Resources	<ol style="list-style-type: none"> 1. <i>Computational Modeling of Cognition and Behavior</i>, Simon Farrell and Stephan Lewandowsky, Cambridge University Press, 2018 2. Jerome R. Busemeyer, Zheng Wang, James T. Townsend, Ami Eidels (ed.), <i>The Oxford Handbook of Computational and Mathematical Psychology</i>, Oxford University Press, 2015 3. Jerome R. Busemeyer, Peter D. Bruza, <i>Quantum Models of Cognition and Decision</i>, Cambridge University Press, 2014 4. Emmanuel M. Pothos, Andy J. Wills, <i>Formal Approaches in Categorization</i>, Cambridge University Press, 2011 5. Ron Sun (ed.), <i>The Cambridge Handbook of Computational Psychology</i>, Cambridge University Press, 2008 6. Nils J. Nilsson, <i>The Quest for Artificial Intelligence</i>, Cambridge University Press, 2009 7. Bernard J. Bears, Nicole M. Gage, <i>Cognition, Brain and Consciousness: Introduction to Cognitive Neuroscience (2010)</i>, Academic Press, 2010
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	30%	-	20%	-	20%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	30%	-	40%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Guruprasad Lakshmanan, Chief Technology Officer, Twice Group & Blocksrus, Chennai	1. Dr. B.Sathish Babu, Professor, Department of AI & ML, RV College of Engineering, Bengaluru, Karnataka	1. Dr. M. Uma, SRMIST

Course Code	21CSE546T	Course Name	MEDICAL SIGNAL PROCESSING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes						
CLR-1:	Understand the basic concepts of signals and frequency-based transforms	CLR-2:	understand the basics of digital filters	CLR-3:	Investigate the events in the signal and interpret the basic architecture of the processor	CLR-4:	Study of spectral and cross-spectral features of electrocardiographic signals	CLR-5:	Interpret the basic architecture of the DSP processor and its applications	1	2	3	4	5				6	7	8	9
			Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3				
Course Outcomes (CO):			At the end of this course, learners will be able to:																		
CO-1:	Comprehend and analyse the signals in different statistical methods		1	-	-	-	-	-	-	-	-	-	-	-	1	-	-				
CO-2:	Gain the transforms enactments on bio-signal		-	-	2	-	-	-	-	-	-	-	-	-	-	-	2				
CO-3:	Comprehend the implementations of filters in biosignals		-	-	2	-	-	-	-	-	-	-	-	-	-	-	2				
CO-4:	ECG signal analysis and modelling		-	-	2	-	-	-	-	-	-	-	-	-	-	-	2				
CO-5:	Familiarize the digital signal processors and its application in medical fields		-	-	3	-	-	-	-	-	-	-	-	-	-	-	3				

Unit-1 - Introduction to Signal Processing	9 Hour
Z transform introduction, definition, convergence. Inverse Z transforms, Analysis of discrete-time systems using Z transforms. Solutions of differential equations. Transfer functions and stability.	
Unit-2 - Time-Frequency Domain Analysis	9 Hour
Fourier transforms for continuous signals. Energy spectrum, Properties (without proof), Gibbs phenomena, Auto and cross-correlation. Discrete Fourier transforms. Properties (without proof), Inverse DFT, introduction to FFT.	
Unit-3 - Digital Filters	9 Hour
Types of artefacts and noise - Time domain filters, frequency domain filters, notch and comb filters, optimal filtering, adaptive filters - Signal decomposition-based filtering.	
Unit-4 - Event Detection and Feature Extraction Techniques	9 Hour
Signal segmentation - Envelop extraction and analysis, temporal, spectral, statistical, information theoretic and cross spectral features - Waveform complexity. Case Studies: Estimating fractal connectivity with an application to neurophysiological signals, Cross spectral analysis of electrocardiographic signals.	
Unit-5 - Digital Signal Processors	9 Hour
Introduction, General purpose DSP processors, architecture, hardware configuration, software development tools - Implementation considerations. TMS 320 Family of DSP Processors-Architecture - Functional units - Pipelining-Registers - Linear and Circular addressing - Types of instructions - Sample Programs - Real Time Implementation on DSP processors. Case Studies: - Linear Discrimination-Detection of motor activity from EMG, Harmonic analysis - Estimation of heart rate in ECG - Auto-regressive model - Estimation of spectrum of thoughts in EEG	

Learning Resources	<ol style="list-style-type: none"> 1. Digital signal processing, Proakis (PHI) 2. Rangaraj M. Rangayyan, "Biomedical Signal Analysis", 2015, 2nd Edition, WileyIEEE Press, New 3. Signal Analysis by R. P. Singh, Second edition Tata McGraw – Hill 4. Engineering Electronics by Mauro R Prentice – Hall 	<ol style="list-style-type: none"> 5. Malmivuo, J. and Plonsey, R. Bioelectromagnetism: Principles and Applications of Bioelectric and Biomagnetic Fields, Oxford University Press, New York, 1995. 6. D C Reddy, McGraw Hill, Biomedical Signal Processing. 7. Rulph Chassaing, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", 2012, 1st Edition, Wiley, New York. 8. Nasser Kehtarnavaz, "Real Time Signal Processing Based on TMS320C6000", 2011, 2nd Edition, Elsevier, Netherlands.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. K. Selvaraj, Caterpillar, Bangalore	1. Dr. S.Shoba, VIT, Chennai	1. Dr.R.Athilakshmi, SRMIST
	2. Dr.R.Rajavel,ECE,SSN College of Engineering, Chennai	

Course Code	21CSE547T	Course Name	DEEP MULTITASK AND META LEARNING	Course Category	C	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Acquire knowledge in Multitask learning and Meta learning	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Gain knowledge in Optimization algorithms and dimensionality reduction															
CLR-3:	Acquire knowledge in neural network approach to pattern recognition															
CLR-4:	Acquire knowledge in Transfer learning and Sequential Models															
CLR-5:	Understand the principles of unconstrained optimization															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Explore Multitask learning and Meta learning	3	3	-	-	-	-	-	-	-	-	-	-	1	-	2
CO-2:	Compare the optimization algorithms and high dimensional data using reduction techniques	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Explore various approaches to identify the patterns.	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Apply RNN and transfer learning to real world scenarios	3	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Acquire the principles of unconstrained optimization	2	2	-	-	-	-	-	-	-	-	-	-	-	-	1

Unit-1 - 1 Introduction and Start of multi-task learning	9 Hour
Multi-task learning- Single task learning, Multi task classification, Image Net classification with deep convolution neural networks, Task conditioning, Alternative view on Multi task Architecture- concatenation based conditioning, Additive conditioning, Multi head architecture, Multiplicative Conditioning, Multi label learning T1: Multi – Task learning, T2: Multi -Transfer learning, T3: Fine tuning.	
Unit-2 - Meta-Learning Structure	9 Hour
Meta learning Advantages, Bayesian meta-learning approaches: black-box approaches, optimization-based meta-learning, metric learning), Non-Parametric Few-Shot Learning: Siamese networks, matching networks, prototypical networks Embed, nearest neighbours. T4: Properties of Meta-Learning Algorithms, T5: Meta-features for meta-learning, T6: Federated and Meta learning over Non-Wireless and Wireless Networks	
Unit-3 - Advanced Meta-Learning Topics	9 Hour
Stacking Generalization, Meta learning approaches and its applications, meta-overfitting, unsupervised meta-learning, Bayesian models, Multi-task RL, goal-conditioned RL, Meta-reinforcement learning, hierarchical RL. T7: Example of Meta-Learning Applications - Imitation learning, T8: Example of Meta-Learning Applications-Drug discovery, motion prediction, T9: Example of Meta-Learning Applications- language generation.	
Unit-4 - Optimization-Based Meta-Learning	9 Hour
Unconstrained Optimization and Neural Networks, Single-Neuron Training, Backpropagation Algorithm, Genetic Algorithms, Chromosomes and Representation Schemes, Selection and Evolution. T10: Hessian in Meta Learning, T11: The Rank One Correction Formula, T12: Analysis of Genetic Algorithms	
Unit-5 - Dynamic Meta Learning	9 Hour
Prototypical clustering Networks for Dermatological Image Classification, selecting models for forecasting stationary time series. T13: Real-Number Genetic Algorithms, T14: Dynamic meta-learning for failure prediction in large-scale systems, T15:Dynamic Alignment via Meta-filter for Few-shot Learning	

Learning Resources	1. Eugene Charniak, <i>Introduction to Deep Learning</i> , MIT Press, 2018.	4. Edwin K.P. Chong, Stanislaw H. Zak, <i>An Introduction to Optimization</i> , Wiley-Interscience, Second edition
	2. Robert J. Schalkoff, and <i>Pattern Recognition: Statistical, Structural and Neural Approaches</i> , John Wiley & Sons Inc., New York, Reprint 2014.	5. Dimitri P. Bertsekas, <i>Nonlinear Programming</i> , MIT, Second Edition
	3. Fukunaga, <i>Introduction to Statistical Pattern Recognition</i> , second edition, Academic press, 2013.	6. https://cs330.stanford.edu/lecture_slides/cs330_nonparametric_2022.pdf .

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	30%	-	30%	-
Level 2	Understand	40%	-	40%	-	30%	-
Level 3	Apply	20%	-	30%	-	40%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.M.Vivekanandan,Nokia	1. Karthikeyan.C.M.T, Govt College of Engg,Bargur	1. Dr.N.Meenakshi, SRMIST
2. Mr.SanthoshKumar,CTS	2. Syedthouheed,Reva University, Bangalore	

Course Code	21CSE548T	Course Name	SPATIAL AND TEMPORAL COMPUTING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Outline the ideas of traditional relational data and spatial data.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Illustrate the basics of spatial databases.															
CLR-3:	Gain knowledge on spatial data models.															
CLR-4:	Gain knowledge on Spatio-Temporal computing Techniques.															
CLR-5:	Learn about different Application programming Interfaces.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Illustrate the concepts of traditional relational data and spatial data.	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Learn the spatial databases.	-	2	2	-	-	-	-	-	-	-	-	-	-	1	-
CO-3:	Understand the spatial data models.	-	2	-	-	-	-	-	-	-	-	-	-	-	1	-
CO-4:	Analyze Spatio-Temporal computing Techniques.	-	-	2	-	2	-	-	-	-	-	-	-	-	2	-
CO-5:	Analyze various Application programming Interfaces.	-	2	-	-	2	-	-	-	-	-	-	-	-	-	2

Unit-1 - Introduction to Spatio Temporal Data	9 Hour
Representation of Spatio temporal data, Visualization of Spatio-Temporal Data – Spatial plots – Time series plots - Hovmoller plot – Interactive plots, Visualizing large spatial temporal datasets –Visualizing Uncertainty- Exploratory Analysis of Spatio-Temporal Data - Empirical Spatial Means and Covariances - Spatio-Temporal Covariograms and Semivariograms - Empirical Orthogonal Functions (EOFs) - Spatio-Temporal Canonical Correlation Analysis	
Unit-2 - Introduction to Spatial Databases	9 Hour
Requirements, Principles, and Concepts for Spatial Database Management Systems (SDBMS) – Spatial Databases and Geographic Information Systems SDBMS and GIS Applications. Spatial networks: conceptual, logical and physical level design issues, Spatial networks Query: shortest path from a start-point to a destination, shortest route to deliver packages to a set of homes, Query processing in spatial network databases.	
Unit-3 - Models for Spatial Data: Geographic Space Modelling	9 Hour
Representation Models – Geometry of Collection of Objects – Vector Data – Raster Data. Modelling Spatial Data. Spatial Access Methods (SAM): Issues in SAM Design – Space Driven Structures versus Data Driven Structures – The Grid File – Quadtree and Variants – R-Tree and Variants – k-d-B Tree. Case study- SAM Cost Models	
Unit-4 - Spatio-Temporal Computing	9 Hour
Techniques of spatial and temporal analysis, point patterns, spatio - temporal database applications. geostatistics, spectral analysis, wavelet analysis, interpolation, and mapping. Spatial information services: virtual globes, location-based services, Case study-Enterprise consulting service.	
Unit-5 - Application Programming Interfaces	9 Hour
HTML5 Geolocation API, Google Maps API, Bing Maps API, Maps SDK, Flickr location API, Twitter location API, OSHDB: a framework for spatio-temporal analysis of OpenStreetMap history data.	

Learning Resources	<ol style="list-style-type: none"> 1. Christopher K. Wikle, Andrew Zammit-Mangion, Noel Cressie, <i>Spatio Temporal Statistics with R</i>, CRC Press, 2019. 2. Philippe Rigaux, Michel Scholl, Agnes Voisard, "Spatial Databases with Applications to GIS", Morgan Kaufman, 2002. 3. Shashi Shekhar, Pamela Vold, <i>Spatial Computing</i>, The MIT Press, 2020. 4. Noel Cressie, Christopher K. Wikle, <i>Statistics for Spatio-Temporal data</i>, Wiley, 2015. 	<ol style="list-style-type: none"> 5. Narayan Panigrahi, <i>Computing in Geographic Information Systems</i>, CRC press, 2014. 6. Shashi Shekhar and Sanjay Chawla "Spatial Databases: A Tour "Pearson. 7. Evangelos Petroutsos, <i>Google Maps: Power Tools for maximizing the API</i>, McGraw-Hill, 2014.
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	40%	-	40%	-	30%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	-	-	-	-	10%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mrs.Savitha Boomiperumal, Technical Lead, Accenture Technology Solutions, Portugal, Europe	1. Dr.Anusha K, Associate Professor, School of Computing, VIT Chennai.	1. Dr.Sumathy G, SRMIST

Course Code	21CSE549T	Course Name	DECISION MAKING UNDER UNCERTAINTY	Course Category	C	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1: learn and identify the opportunities for creating value using these models		Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2: Develop models that can be used to improve decision making under uncertainty within an organization																
CLR-3: Sharpen their ability to structure problems and to perform logical analyses																
CLR-4: Know how to assess the significance of model outputs for managerial insights and action																
CLR-5: Develop the skills to identify, define, scope, model, and analyze complex decision problems																
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1: Gain a broad fundamental understanding of the mathematical models and solution methods for decision making		-	3	1	-	-	-	-	-	-	-	-	-	1	-	-
CO-2: Implement and extend key algorithms for learning and decision making		-	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO-3: Identify an application of the theory and formulate it mathematically		-	3	-	2	-	-	-	-	-	-	-	-	-	-	2
CO-4: Gain a deep understanding of an area of particular interest and apply it to a problem		-	3	-	2	-	-	-	-	-	-	-	-	-	-	3
CO-5: Make inferences about a management problem based on the solution of a model		-	3	-	2	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Probabilistic Reasoning	9 Hour
Introduction-Degrees of Belief and Probability-Probability Distributions-Bayesian Networks-Inference in Bayesian Networks- Inference in naïve Bayes Models-Direct Sampling-Gibbs Sampling-Inference in Gaussian Models-Bayesian Parameter Learning-Nonparametric Learning-Learning with Missing Data-Bayesian Network Scoring-Directed Graph Search-Markov Equivalence Classes-Partially Directed Graph Search-Simple Decisions-Constraints on Rational Preferences-Utility Functions-Utility Elicitation-Maximum Expected Utility Principle-Decision Networks.	
Unit-2 - Sequential Problems	9 Hour
Markov Decision Processes-Policy Evaluation-Value Function Policies-Policy Iteration-Value Iteration-Asynchronous Value Iteration-Linear Program Formulation-Linear Systems with Quadratic Reward-Parametric Representations-Nearest Neighbor-Kernel Smoothing-Linear Interpolation-Simplex Interpolation-Linear Regression-Neural Network regression-Forward Search-Branch and Bound-Sparse Sampling-Monte Carlo Tree Search-Heuristic Search-Labeled Heuristic Search-Open-Loop Planning-Local Search-Genetic Algorithms-Cross Entropy Method-Evolution Strategies.	
Unit-3 - Model Uncertainty	9 Hour
Bandit Problems-Bayesian Model Estimation-Undirected Exploration Strategies-Directed Exploration Strategies –Optimal Exploration Strategies-Maximum Likelihood Models-Bayesian Methods-Bayes-Adaptive Markov decision Processes-Incremental Estimation of the Mean- Q-Learning- Sarsa-Eligibility Trace-Action Value Function Approximation-Behavioural Cloning-Data Set Aggregation-Stochastic Mixing Iterative Learning-Maximum Margin Inverse Reinforcement Learning-Maximum Entropy Inverse Reinforcement Learning.	

Unit-4 - State Uncertainty	9 Hour
Belief Initialization-Discrete State Filter-Kalman Filter-Extended Kalman Filter-Unscented Kalman Filter-Belief-State Markov Decision Processes-Conditional Plans-Alpha Vectors-Pruning-Value Iteration-Linear Policies-Fully Observable Value Approximation-Fast Informed Bound-Fast Lower Bounds-Point-Based Value Iteration-Randomized Point-Based Value Iteration-Sawtooth Heuristic Search-Triangulated Value Functions-Online Belief State Planning- Forward Search-Branch and Bound-Sparse Sampling-Monte Carlo Tree Search-Determinized Sparse Tree Search	
Unit-5 - Multiagent Systems	9 Hour
Multiagent Reasoning-Simple Games-response Models-Dominant Strategy Equilibrium-Nash Equilibrium-Correlated Equilibrium-Hierarchical Softmax-Sequential Problems- Markov Games-Response Models- Nash Equilibrium-Fictitious Play-Gradient Ascent-Nash Q-Learning-State Uncertainty-Partially Observable Markov Games-Policy Evaluation-Nash Equilibrium-Dynamic Programming-Decentralized Partially Observable Markov Decision Processes-Subclasses-Dynamic Programming-Iterative Best Response-Heuristic Search-Nonlinear Programming.	

Learning Resources	<ol style="list-style-type: none"> 1. Mykel J. Kochenderfer, Tim A. Wheeler, Kyle H. Wray Algorithms for Decision Making, MIT Press, 2022 2. https://github.com/JuliaAcademy/Decision-Making-Under-Uncertainty 3. Laura Graesser, Wah Loon Keng, Foundations of Deep Reinforcement Learning: Theory and Practice in Python. Pearson Education, 2020. 4. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, 2nd Ed. MIT Press, 2018. Dimitri P. Bertsekas, Dynamic Programming and Optimal Control, Athena Scientific, 2012 (4th Ed.). 5. D.V.Lindley, Making Decisions, 2nd Edition, John Wiley & Sons.
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers			
Experts from Industry		Experts from Higher Technical Institutions	
1. S Sai Manjunath Software engineer – I Cisco Systems		1. Dr. P Vetrivelan Professor, VIT-Chennai	
		Internal Experts	
		1. Dr. Kanipriya M, SRMIST	

Course Code	21CSE553T	Course Name	NEURAL NETWORK MODELS OF COGNITION	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Specific outcomes		
		Program Outcomes (PO)												1	2	3
		1	2	3	4	5	6	7	8	9	10	11	12			
CLR-1:	Describe the various neural processes	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Illustrate computational neuroscience (Neural Network Models)															
CLR-3:	Analyze simulating cognitive, perceptual, emotional, and motivational processes using neural network models.															
CLR-4:	Formalize behavioral and biological levels of analysis															
CLR-5:	Observe a range of phenomena within this framework, including attention, memory, language, higher-level cognition, motivation, emotion, and personality.															
Course Outcomes (CO):		At the end of this course, learners will be able to:												1	2	3
		1	2	3	4	5	6	7	8	9	10	11	12			
CO-1:	Acquire the knowledge on the various neural processes	1	2	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-2:	Implementation computational neuroscience (Neural Network Models)	1	2	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-3:	Simulating cognitive, perceptual, emotional, and motivational processes using neural network models.	1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Analysis behavioral and biological levels	1	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Examine a range of phenomena within this framework, including attention, memory, language, higher-level cognition, motivation, emotion, and personality.	3	2	-	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction to Neural Networks	9 Hour
The Necessity of Neural Networks- Toward A Natural-Science Account of Human Behavior -Interpreting Complex behavior Using Neural Networks - Network Architecture -A Statistical Framework -Evolving Artificial Neural Networks -A Computational Approach -Ontogeny -Phylogeny - The Baldwin Effect - Simulations -Genetic Algorithms - Network Architectures -Evolution Simulations - Effects on Learning.	
Unit-2 - Neurotransmission	9 Hour
Principles Of Neurotransmission-Neurotransmitter and Neuropeptide Systems-Synaptic Structure and Sites of Neurotransmitter Action- Neurotransmitters and Gene Regulation in The Nervous System-Cellular Mechanisms-Mechanisms Of LTP-Phases Of LTP-Late Phase of LTP (L-LTP)-Protein Synthesis and LTI -Temporal Information Processing: -Spatial and Temporal Information -Time-Dependent Neuronal Properties-A Model of Temporal Information Processing-Simulations of Temporal Processing-Plasticity	
Unit-3 - Neocortical Processing	9 Hour
Perceiving-Development and Plasticity-Of Neocortical Processing Architectures-Two Strategies, Two Classes of Connections-Strategies for Response Selection -assembly-Forming Connections-Plasticity, Orientation, and Size-Columnar Organization in TE-Organization of Afferents to TE-Optical Imaging of The Columnar Organization-Changeability of Selectivity in The Adult-Functions of the Columns:- Case Studies: Sparse Coding of Faces in A Neuronal Model, Face Recognition and Categorization	
Unit-4 - Object Perception	9 Hour
Structure And Binding in Object Perception- Constancy and Structure in Object Perception-A Neural-Network Approach- -A Bottom-Up Model of Redundancy Compression in Entorhinal Cortex-Evaluating the Entorhinal Model. -Incorporating Models of Sept Hippocampal Cholinergic Modulation-Behaving-Motor Cortex:, Network Modelling of Motor-Cortical Directional Operations-Selectionist Constraints on Neural Networks.	

Unit-5 - Reinforcement Learning	9 Hour
Reinforcement Learning of Complex Behavior-Adaptive Dopaminergic Neurons Report-Adaptive Properties of Dopaminergic Neurons-Relations to Associative Learning Theories-Neuronal-Network Simulation of the Selection of Behavior-Simulation of the Selection of Stimulus Configurations-Implications for Complex Behavior-Reinforcement Learning in Artificial Intelligence- -Value Functions-The Optimality Equation Case Studies: Models Using Dopamine-Through Reinforcement Learning-The Credit-Assignment Problem-The Reinforcement-Learning Problem	

Learning Resources	1. J.W. Donahoe, V.P. Dorsel, "Neural-Network Models of Cognition Biobehavioral Foundations" (Volume 121) (Advances in Psychology, Volume 121) 1st Edition. 2. Michael I. Jordan and Terrence J. Sejnowski. "Graphical Models: Foundations of Neural Computation" 2011	3. Hagan, Martin T., Howard B. Demuth, and Mark Beale. "Neural network design" PWS Publishing Co., 1997.
---------------------------	---	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	40%	-	40%	-
Level 2	Understand	40%	-	40%	-	40%	-
Level 3	Apply	20%	-	20%	-	20%	-
Level 4	Analyze	-	-	-	-	-	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. P S Saravanan, Associate Consultant, CTS, USA	1. Dr.A Balaji , Senior Assistant Professor at VIT Bhopal University,	1. Dr. K Suresh
	2. Prof.K Somasundram, Department of Computer Science and Engineering, Saveetha School of Engineering, Saveetha Institute of Medical and Technical Sciences,	2. Dr. B.Hariharan

Course Code	21CSE552T	Course Name	COMPUTATIONAL LINGUISTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Introduce the Basic Concepts of Computational Linguistics in NLP.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Illustrate the knowledge on language Interpretation															
CLR-3:	Analyze the classification of computer in accomplishing linguistics tasks.															
CLR-4:	Illustrate the uniqueness of text meaning with linguistics multistage transformation.															
CLR-5:	Illustrate the various modelling techniques based on linguistics															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Summarize the concepts in Computational Linguistics.	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Construct the various applications of computers in linguistics and language studies.	3	2	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Design the various Tools for Linguistic analysis	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Apply the text transformation of linguistic and strengthen NLP systems	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply the different model techniques based on linguistics	3	2	-	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Introduction	9 Hour
The Role of Natural Language Processing – Linguistics and Its Structure - What We Mean by Computational Linguistics - The Important Role of The Fundamental Science - Current State of Applied Research on Spanish.	
Unit-2 - Overview of Grammar	9 Hour
A Historical Outline - The Structural list Approach - Initial Contribution of Chomsky - A Simple Context-Free Grammar - Transformational Grammars - The Linguistic Research After Chomsky: Valencies and Interpretation – free grammar allows for a lot of different types of ungrammatical sentences. - Linguistic Research After Chomsky: Constraints - Head-Driven Phrase Structure Grammar - The Idea of Unification - Multistage Transformer and Government Patterns - Dependency Trees - Semantic Links	
Unit-3 - Products of Computational Linguistics	9 Hour
Present And Prospective - Classification of Applied Linguistic Systems - Automatic Hyphenation - Spell Checking - Grammar Checking - Style Checking - References To Words And Word Combinations - Information Retrieval - Topical Summarization - Automatic Translation - Natural Language Interface - Extraction Of Factual Data From Texts - Text Generation - Systems Of Language Understanding - Related Systems.	
Unit-4 - Language as A Meaning	9 Hour
Text Transformer - Possible Points Of View On Natural Language - Language As A Bi-Directional Transformer Text – Two Ways To Represent Meaning - Decomposition And Atomization Of Meaning - Not-Uniqueness Of Meaning —Text Mapping: Synonymy - Not-Uniqueness Of Text - Meaning Mapping: Homonymy - More On Homonymy - Multistage Character Of The Meaning - Text Transformer - Translation As A Multistage Transformation - Two Sides Of A Sign - Linguistic Sign - Linguistic Sign In The MMT - Linguistic Sign In HPSG - Generative, MTT, And Constraint Ideas In Comparison - Case Study writing simple parsers in groups for regional languages.	

Unit-5 - Linguistic Models	9 Hour
What Is Modeling In General - Neurolinguistic Models - Psycholinguistic Models - Functional Models Of Language - Research Linguistic Models - Common Features Of Modern Models Of Language - Specific Features Of The Meaning - Text Model - Reduced Models - Analogy In Natural Languages - Empirical Versus Rationalist Approaches - Limited Scope of The Modern Linguistic Theories – Case Study applications involving language models, Demonstration of simple application specific modules using tools.	

Learning Resources	1. Igor Bolshakov & Alexander Gelbukh, "Computational Linguistics Models, Resources and applications ", Ciencia De La Computación. 2004. 1. Alexander Clark, Chris Fox, & Shalom Lappin, "The Handbook of Computational Linguistics and Natural Language Processing", A John Wiley & Sons. 2010	2. Ralph Fasold & Jeff Connor-Linton, "An Introduction to Language and Linguistics", Cambridge University Press. 2018 3. Roland Hausser, "Man-Machine Communication in natural language ". 4. Stabler, "Notes on computational linguistics", UCLA, Winter 2003
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	25%	-	25%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr.A.Mohanraj, Data Scientist, Standarad chartered	1. Dr.P.Visu, Professor, Velammal College of Engineering	1. Dr.P.G. Om Prakash, SRMIST
2. Mr.N. Nagendran, Senior Software Engineer, Cognizant	2. Dr.K.Sathishkumar, Associate Professor, KLEF- AP.	2. Dr.R.Siva, SRMIST

Course Code	21AIE536T	Course Name	ARTIFICIAL INTELLIGENCE ENGINES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn the fundamentals of Artificial Neural Networks and Linear Associative Networks	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Gain Knowledge on Hopfield Network, Boltzmann Machines.															
CLR-3:	Gain Knowledge on Hopfield Network, Boltzmann Machines.															
CLR-4:	Illustrate the Variational Auto encoders and Deep Back propagation Networks.															
CLR-5:	Learn Reinforcement Learning function.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Describe the features of Artificial Neural network and Linear Associative Networks.	3	2	1	-	-	-	-	-	-	-	-	-	1	1	1
CO-2:	Understand the Perceptrons and Back propagation algorithms.	3	2	2	-	-	-	-	-	-	-	-	-	-	1	-
CO-3:	Apply AI techniques in Hopfield Networks and Boltzmann Machines.	3	1	1	-	-	-	-	-	-	-	-	-	1	2	1
CO-4:	Articulate AI systems that are used in Convolutional Neural Networks and Autoencoder networks.	3	1	2	-	-	-	-	-	-	-	-	-	-	1	-
CO-5:	Understand the Reinforcement Learning function and Applications.	3	2	1	-	-	-	-	-	-	-	-	-	1	1	1

Unit-1 - Introduction	9 Hour
Artificial Neural Networks- Origins of Neural Networks, From Backprop to Deep Learning, Linear Associative Networks- Setting One Connection Weight, Learning One Association, Gradient Descent, Learning Two Associations, Learning Many Associations, Learning Photographs	
Unit-2 - Perceptrons and Backpropagation	9 Hour
Perceptron Learning Algorithm- Exclusive OR Problem, Exclusive OR Matters, Backpropagation Algorithm- Sigmoidal Hidden Units, Generalisation and Overfitting, Vanishing Gradients, Speeding Up Backprop, Local and Global Mimima, Temporal Backprop, Early Backprop Achievements	
Unit-3 - Hopfield Nets and Boltzmann Machines	9 Hour
Hopfield Network- Content Addressable Memory, Tolerance to Damage, Energy Function, Boltzmann Machines- Generative Models, Energy Function, Simulated Annealing, Learning by Sculpting Distributions, learning in Boltzmann Machines, Learning by Maximising Likelihood, Restricted Boltzmann Machines, Autoencoder and Deep Autoencoder Networks, Deep RBMs - Restricted Boltzmann Machines, Training Restricted Boltzmann Machines, Deep Autoencoder Networks	
Unit-4 - Variational Autoencoder and Deep Backprop Networks	9 Hour
Variational Autoencoders- Overview of Variational Autoencoders, Latent Variables and Manifolds, Key Quantities, VA Work, Evidence Lower Bound, Alternative Derivation, Maximising the Lower Bound, Conditional Variational Autoencoders Applications, Convolutional Neural Networks- LeNet1, LeNet5, AlexNet, GoogLeNet and ResNet, Ladder Autoencoder Networks- Denoising Autoencoders- Fooling Neural Networks- Generative Adversarial Networks- Temporal Deep Neural Networks- Capsule Networks, Case Studies: Backpropagation neural network for Landslide monitoring,	

Unit-5 - Reinforcement Learning	9 Hour
Reinforcement Learning- Markov Decision Processes- Formalising the Problem- Bellman Equation- Learning State-Value Functions- Eligibility Traces- Learning Action-Value Functions- Balancing a Pole- Applications, Case Studies: Adaptive Traffic Signal Control, Pommerman.	

Learning Resources	<ol style="list-style-type: none"> 1. Artificial Intelligence Engines: A Tutorial Introduction to the Mathematics of Deep Learning, James V Stone, Sebtel Press 2019. 2. Deep learning: Ian Goodfellow and Yoshua Bengio and Aaron Courville, MIT press 2016. 3. Dive into Deep Learning: Aston Zhang, Zachary C. Lipton, Mu Li, And Alexander J. 2018. 4. MATLAB Deep Learning-with Machine Learning, Neural Networks and Artificial Intelligence: Phil Kim, Springer, Apress 2017. 5. Machine learning with neural networks: Bernhard Mehlig, Cambridge University Press 2021. 6. https://www.elsevier.com/books/artificial-intelligence-and-data-driven-optimization-of-internal-combustion-engines/badra/978-0-323-88457-0 7. https://www.deeplearningbook.org/lecture_slides.html 8. https://d2l.ai/d2l-en-mxnet.pdf
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. Kodainathan, Data Scientist Elpis IT solutions pvt Ltd	1. Dr. A. Menaka Pushpa, Assistant Professor (SG) SCOPE, VIT, Chennai Campus	1. Dr.AR. Arunarani,, SRMIST,

Course Code	21AIE538T	Course Name	ARTIFICIAL INTELLIGENCE FOR INDUSTRIAL APPLICATIONS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Analyze the various characteristics of Intelligent agents	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Understand the growth of AI Technology in Industry.															
CLR-3:	Learn the technical elements and algorithm for solving problems using Artificial Intelligence.															
CLR-4:	Apply knowledge to establish Industrial AI Technology and its assessment.															
CLR-5:	Apply the concepts of AI to attain industrial automation and its application															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Use appropriate search algorithms for any AI problem	-	-	-	3	3	-	-	-	-	1	-	2	1	2	-
CO-2:	Identify appropriate AI methods and new opportunity spaces AI for industrial application.	-	-	-	2	2	-	-	-	-	1	-	1	1	2	-
CO-3:	Understand the categories of Algorithm in Industrial AI.	-	-	-	2	2	-	-	-	-	1	-	1	1	3	2
CO-4:	Understanding the assessment and capability to establish industrial AI.	-	-	-	2	2	-	-	-	-	1	-	2	1	2	2
CO-5:	Understand the levels of automation and its application	-	-	-	2	2	-	-	-	-	-	-	2	1	2	-

Unit-1 - Introduction to AI and Production Systems	9 Hour
Introduction to AI - Problem formulation, Problem Definition - Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics - Specialized production systems - Problem solving methods -Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing, Depth first and Breath first, Constraints satisfaction, Knowledge Representation and Reasoning.	
Unit-2 - The Development and Application of AI Technology.	9 Hour
Why do we need Industrial AI – New Perspective in industrial systems for AI, Basic problem in Industry, Basic method of problem solving with AI, what kind of AI Technology is most suitable for industry, Machine Intelligence meets industry, Difference between industry AI and AI, Challenge of AI in Industry, New opportunity spaces for industry AI to realize industrial value transformation. Definition and Meaning of Industrial AI – The Beginning of Industrial AI, Purpose and value of Industrial AI, GE prefix success and failure.	
Unit-3 - Technical Elements and Algorithm of Industrial AI	9 Hour
Technical Element – Data, Analytics, Platform, Operation and Human Machine Technology, CPS, Industrial AI: Categories of Algorithm, Industrial AI Algorithm: Selection and Application. Application Scenario Types of Industrial AI, Enabling Industrial AI system – Intelligence monitoring and maintenance platform for CNC machine, Intelligence operation, intelligence rail transit predictive maintenance system.	
Unit-4 - How to Establish Industry AI Technology and Capability	9 Hour
Assessment of Basic capability Maturity during industrial intelligence transformation – Assessment Tools for global industrial AI enterprise transformation achievement – Foxconn Lighthouse factory – How to construct organizational intelligence transformation ability in industrial enterprises – Open-source industrial big data competitions.	
Unit-5 - Industrial AI applications and Case studies	9 Hour
Applications of Industrial AI in Monitoring, optimization and control.AI applications in Industry Automation using -Natural Language Processing-Speech Recognition-Computer vision. Machine Learning Models for Industrial Applications, AI & Digital Platforms case study. A Framework for Learning System for Complex Industrial Processes.	

Learning Resources	1. Elaine Rich, "Artificial Intelligence", 2nd Edition, McGraw Hill, 2005	4. Anuradha Srinivasaraghavan, Vincy Joseph "Machine Learning", Wiley, 2019
	2. AI and Learning Systems - Industrial Applications and Future Directions, Konstantinos Kyprianidis and Erik Dahlquist, published in London, United Kingdom, 2021.	5. Wolfgang Ertel, "Introduction to Artificial Intelligence", Second Edition, Springer, 2017.
	3. Industrial AI – Application with sustainable performance, Jay Lee, Springer Publication, 2020.	6. Rajiv Chopra, "Deep Learning", 1st edition, Khanna Publishing House, 2018.

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	10%	-	20%	-
Level 2	Understand	15%	-	10%	-	20%	-
Level 3	Apply	30%	-	35%	-	20%	-
Level 4	Analyze	30%	-	25%	-	20%	-
Level 5	Evaluate	10%	-	20%	-	20%	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Naveen Baskaran, ADP Solution Chennai	1. Dr.P.SivaKumar, VIT Chennai	1. Dr.S.Nagendra Prabhu, SRMIST
	2. Dr.Senthil, NHCE Bangalore	

Course Code	21AIE539T	Course Name	ARTIFICIAL INTELLIGENCE IN MEDICAL IMAGING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Discuss the fundamentals of Medical Imaging	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Introduce the concepts of Diagnostic Radiology															
CLR-3:	Impart knowledge on Nuclear Medicine.															
CLR-4:	Become familiar in applying AI techniques in medical imaging.															
CLR-5:	Explore various future perspectives of medical imaging Technology.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the fundamentals of Medical Imaging	3	2	1	-	-	-	-	-	-	-	-	-	1	2	2
CO-2:	Summarizes the concepts of Diagnostic Radiology	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Utilize the features and characteristics of Nuclear Medicine	3	1	1	-	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Articulate AI systems that are used in medical imaging.	3	1	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply various AI techniques in medical imaging	3	3	3	-	-	-	-	-	-	-	-	-	-	-	2

Unit-1 - Introduction	9 Hour
Introduction to medical imaging – The modalities – Digital imaging basics – Image properties – Radiation and the atom – Interaction of radiation with matter – Image Quality – Spatial resolution – contrast resolution – Medical imaging informatics – Ontologies, standards and profiles – Algorithms for image and non-image analytics – Security and privacy.	
Unit-2 - Diagnostic Radiology	9 Hour
X-Ray Production tubes and generators – Production of X-Rays – X-Ray tubes – X-Ray generators – Factors affecting X-Ray emission – Radiography – Geometry of projection radiography – scattered radiation in projection radiographic imaging – Computed Radiography – Artifacts in digital radiography – Dual energy subtraction radiography- Fluoroscopy – Computed Tomography – X-Ray Dosimetry – Magnetic Resonance Basics – Ultrasound.	
Unit-3 - Nuclear Medicine	9 Hour
Radioactivity and nuclear Transformation – Radiation detection and measurement – Nuclear Imaging – The Gamma camera – Planar Nuclear Imaging – Computers in Nuclear Imaging – Nuclear Tomographic Imaging – Single Photon and Positron Emission Tomography (SPECT and PET) – Dual modality Imaging – Advances in PET Imaging.	
Unit-4 - Applying AI in Medical Imaging	9 Hour
Historical perspective – Quantitative image analysis – Computer aided detection and diagnosis – Triage – image registration – Radiomics: Radiology meets Big Data – Applications beyond image interpretation – Applications beyond radiology – Case Studies: CAD in CT Colonography – CAD in Mammography – Diabetic Retinopathy	
Unit-5 - Future Perspectives	9 Hour
Progress in established imaging modalities: X-Ray and CT – Magnetic Resonance Imaging – Ultra sound Imaging – PET and Multimodality Imaging – Molecular Imaging – Optical Tomography – Advanced Image processing.	

Learning Resources	1. Jerrold T. Bushberg, J. Anthony Seibert PhD (Author), Edwin M. Leidholdt The Essential Physics of Medical Imaging, 2021 (1,2,3) 2. Mark A.Haidekker, Medical Imaging Technology, Springer Briefs in Physics, 2013.(5) 3. Artificial Intelligence in Medical Imaging from theory to clinical practise, Lia Morra, Silvia Delsanto, Loredana Correale, CRC Press 2019 (4)	4. Artificial Intelligence in Medical Imaging, Opportunities, Applications and Risks, Erik R. Ranschaert, Sergey Morozov, Paul R. Algra, Springer, 2019. 5. Haidekker, M. A., "Medical Imaging Technology", Springer, 2013.
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	10%	-	20%	-
Level 2	Understand	20%	-	10%	-	20%	-
Level 3	Apply	30%	-	40%	-	30%	-
Level 4	Analyze	30%	-	40%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.R. Durairaj, Clayfin Technologies Private Limited, Chennai	1. Dr.M.S. Bhuvaneswari, Asso. Professor, Mepco Schlenk Engineering College, Sivakasi	1. Dr.R. Beaulah Jeyavathana, SRMIST

Course Code	21AIE541T	Course Name	MULTIMODAL MACHINE LEARNING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							3	0	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
The purpose of learning this course is to:		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Provide the basic understanding of multimodal data and its importance in various fields.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Various representations used in multimodal machine learning using different models															
CLR-3:	Understand the details about the translation and mapping algorithms of multimodal data															
CLR-4:	Create interest to develop a project using various applications of multimodal machine learning framework															
CLR-5:	Importance of multimodal deep learning and behavior generations functions															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Outline the critical elements of multimodal data and models	3	3	3	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Illustrate different kinds of unimodal and multimodal representations	3	2	2	-	-	-	-	-	-	-	-	-	2	-	-
CO-3:	Demonstrate multimodal translation and mapping	3	2	2	-	-	-	-	-	-	-	-	-	1	-	-
CO-4:	Classify machine learning techniques and frameworks of multimodal applications in real time scenario	3	2	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Analyze various multimodal fusion and behavior generation for multimodal applications	3	2	2	-	-	-	-	-	-	-	-	-	1	-	2

Unit-1 - Introduction	9 Hour
Introduction – Multimodal, Basic Concepts - Linear models - Score and loss functions – regularization, Neural networks - Activation functions - multi-layer perceptron, Optimization - Stochastic gradient descent – backpropagation	
Unit-2 - Unimodal and Multimodal Representations	9 Hour
Language representations - Distributional hypothesis and word embedding, Visual representations - Convolutional neural networks, Acoustic representations - Spectrograms – Autoencoders, Multimodal representations - Joint representations - Visual semantic spaces - multimodal autoencoder, Orthogonal joint representations - Component analysis, Parallel multimodal representations - Similarity metrics, canonical correlation analysis	
Unit-3 - Multimodal Translation and Mapping	9 Hour
Language models – Unigrams – bigrams - skip-grams - skip-thought, Unimodal sequence modelling - Recurrent neural networks, LSTMs, Optimization - Backpropagation through time, Multimodal translation and mapping - Encoder-decoder models - Machine translation - Image captioning, Generative vs retrieval approaches - Viseme generation - visual puppetry, Modality alignment - Latent alignment approaches - Attention models - multi-instance learning, Explicit alignment - Dynamic time warping	
Unit-4 - Multimodal Applications	9 Hour
Multimodal fusion and co-learning - Model free approaches - Early and late fusion - hybrid models, Kernel-based fusion - Multiple kernel learning, Multimodal graphical models - Factorial HMM, Multi-view Hidden CRF, Case studies - Automatic Face Recognition - Video Segmentation and Keyframe Extraction - Gesture Recognition - Biometric-based System	

Unit-5 - Deep Learning for Multimodal **9 Hour**

Deep Learning for multimodal data fusion – Basics of multimodal deep learning – Multimodal image-to-image translation networks – Multimodal encoder decoder networks, Multimodal applications - Image captioning - Video description - AVSR, Core technical challenges - Representation learning – translation – alignment - fusion and co-learning

Learning Resources	1. Multimodal Scene Understanding: Algorithms, Applications and Deep Learning, Michael Ying Yang, Bodo Rosenhahn, Vittorio Murino, Academic Press, Elsevier, 2019, ISBN:978-0-12-817358-9 (Unit V)	4. Unifying Visual-Semantic Embeddings with Multimodal Neural Language Models. Ryan Kiros, Ruslan Salakhutdinov, and Richard S. Zemel; TACL 2015
	2. Representation Learning: A Review and New Perspectives. Yoshua Bengio, Aaron Courville, and Pascal Vincent	5. Multi-View Latent Variable Discriminative Models for Action Recognition. Yale Song, Louis-Philippe Morency, Randall Davis, CVPR 2012
	3. Visualizing and understanding recurrent networks. Andrej Karpathy, Justin Johnson, Li Fei-Fei, 2015	6. M. Gori, "Machine Learning: A Constraint-Based Approach", 2017, Morgan Kauffman, ISBN: 978-0081006597
		7. F. Camastra, A. Vinciarelli, "Machine Learning for Audio, Image and Video Analysis: Theory and Applications", 2nd Edition, 2016, Springer Verlag, ISBN: 978-1447168409

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	20%	-	20%	-	20%	-
Level 2	Understand	20%	-	20%	-	20%	-
Level 3	Apply	30%	-	30%	-	30%	-
Level 4	Analyze	30%	-	30%	-	30%	-
Level 5	Evaluate	-	-	-	-	-	-
Level 6	Create	-	-	-	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr.Sanjay Hotwani, Senior Manager – Data Science, Products & Technology, PwC US	1. Dr. Tulasi Prasad Sariki, Associate Professor, VIT, Chennai, tulasiprasad.sariki@vit.ac.in	1. Dr.T.Subha, SRMIST

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 11M

**(Syllabi for M.Tech (Integrated) Computer Science and
Engineering w/s in Cyber Security & Digital Forensics
Programme Courses)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC503T	Course Name	SECURITY SERVICE MANAGEMENT	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	1	0	4

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:												Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Understand risk management security principles and concepts, and threat modelling concepts and methodologies.	1	2	3	4	5	6	7	8	9	10	11	12	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Explain concepts of security models, vulnerabilities of security architectures and methods of cryptanalytic attacks.																											
CLR-3:	Study secure design principles in network architectures and Manage identification and authentication of people, devices, and services.																											
CLR-4:	Demonstrate the knowledge and skills for Security Assessment and Testing and security audits.																											
CLR-5:	Manage Security Operations concepts and logging and monitoring activities with various recovery plans.																											
Course Outcomes (CO):		At the end of this course, learners will be able to:																										
CO-1:	Students can able to identify security principles and concepts, and threat modelling concepts and methodologies.	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
CO-2:	Students can obtain knowledge from vulnerabilities of security architectures and methods of cryptanalytic attacks.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
CO-3:	Students can gain information from secure design principles in network architectures.	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
CO-4:	Students are able to gain knowledge for Security Assessment and Testing and security audits.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	
CO-5:	Students can enhance their knowledge of obtaining logging and monitoring activities with various recovery plans.	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Unit-1 - Security and Risk Management	12 Hour
security concepts, security governance principles, requirements for investigation types, security policy, standards, procedures, and guidelines, Business Continuity (BC) requirements, risk management concepts, threat modelling concepts and methodologies.	
Unit-2 - Security Architecture and Engineering	12 Hour
fundamental concepts of security models (e.g., Biba, Star Model, Bell-LaPadula), security capabilities of Information Systems (IS) (e.g., memory protection, Trusted Platform Module (TPM), encryption/decryption), vulnerabilities of security architectures, designs, and solution elements, cryptographic solutions, methods of cryptanalytic attacks, security principles to site and facility design.	
Unit-3 - Communication and Network Security	12 Hour
secure design principles in network architectures, Secure network components, secure communication channels according to design, Identity and Access Management (IAM)- Physical and logical access to assets, identification and authentication of people, devices, and services, identity with a third-party service, authorization mechanisms.	
Unit-4 - Security Assessment and Testing	12 Hour
Design and validate assessment, test, and audit strategies, conduct security control testing, collect security process data (e.g., technical, and administrative), Analyze test output and generate report, Conduct, or facilitate security audits.	

Unit-5 - Security Operations		12 Hour
Understand and comply with investigations, conduct logging and monitoring activities, Perform Configuration Management (CM) (e.g., provisioning, baselining, automation), Apply foundational security operations concepts, apply resource protection, conduct incident management, Implement Disaster Recovery (DR) processes, Test Disaster Recovery Plans (DRP).		
Learning Resources	1. https://www.koenig-solutions.com/security-management-training-certification-courses . 2. https://www.koenig-solutions.com/cissp-certification-training-course#benefitsc 3. https://www.linkedin.com/learning/topics/security-management-and-policy	4. https://www.linkedin.com/learning/certified-information-security-manager-cism-cert-prep-2022-3-information-security-program?trk=learning-topics_learning-search-card_search-card&upsellOrderOrigin=default_guest_learning .

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. T Ravichandran, Product Manager, Servis2 IT Team, Chennai.		1. Dr. P. Balamurugan, SRMIST
2. Mr. Dhanvanth Kesavan, NTT Data Cyber security analyst, Chennai.		

Course Code	21CSC504J	Course Name	ANDROID MALWARE ANALYSIS	Course Category	C	PROFESSIONAL CORE	L	T	P	C
							3	0	2	4

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:		Understand the various Android malware threats.														
CLR-2:		Gain knowledge about Sandboxing and Memory Analysis.														
CLR-3:		Gain knowledge about traffic analysis of Android application														
CLR-4:		analyze different malware families and perform static and dynamic mechanisms.														
CLR-5:		Explore popular security vulnerabilities in Android Application.														
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:		Gain knowledge about the different forms of malware.														
CO-2:		Set up a safe virtual environment to analyze malware.														
CO-3:		Navigate, comment, and modify android malware samples.														
CO-4:		Use tools and perform static and dynamic analysis.														
CO-5:		Use web view and explore Android vulnerabilities.														

Unit-1 - Introduction	15 Hour
Basics- Android development tools- Risky Apps- Malware Threats- Open-Source Tools- Vulnerability research for Android OS- Antivirus Scans. Lab: Static Analysis of Android Application	
Unit-2 – Advanced Static Analysis	15 Hour
Sandbox Analysis- Emulation Analysis- Native Analysis- Reverse Engineering- Memory Analysis- Traffic Analysis of Android Devices-Passive and Active Analysis- HTTPs proxy interception- extracting sensitive files Malware Collections- Lab: Reversing of Android malware applications.	
Unit-3 – Behavioral Analysis	15 Hour
Process Emulation- Configuring device with Genymotion- Using the ADB Tool- Capabilities and Limitations of the Emulators- Network Architecture for Sniffing in a Physical Environment- Device View- Logcat View- Application Tracing- Analysis of Results- Imaging the Device. Lab: Case study on Usbcleaver.	
Unit-4 - Android Vulnerabilities	15 Hour
SQLite in depth- Web view vulnerability - Infecting legitimate APKs- Vulnerabilities in ad libraries- Cross-Application Scripting in Android- Lab- Exploring security vulnerabilities using Drozer and Andriller.	
Unit-5 - Exploitation	15 Hour
ARM architecture- Execution modes- Simple stack-based buffer overflow- Return-oriented programming- Android root exploits- Lab: Writing the pentest report for Android malwares.	

Learning Resources	1. Ken Dunham, <i>Android Malware and Analysis</i> , Kindle Edition, Auerbach Publications. International Standard Book Number-13:978-1-4822-5220-0. 2. Aditya Gupta, <i>Learning Pentesting for Android Devices Illustrated Edition</i> , Kindle Edition, ISBN-13- 978-1783288984.	3. Pratiyush Guleria, <i>Android for Beginners: Step by Step guide to develop Android App: Learn Step-by-Step 1st Edition</i> , Kindle Edition, and ISBN- 13 978-9388176231.
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Karthik Expert Member from k7 Computing	1. Dr Bhawana Rudra Assistant Professor (Grade II) National Institute of Technology, Warangal	1. Mr. V. Joseph Raymond, SRMIST

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSE531T	Course Name	CYBER SECURITY OPERATIONS	Course Category	E	PROFESSIONAL ELECTIVE										L	T	P	C				
																2	1	0	3				
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil																
Course Offering Department		School of Computing			Data Book / Codes / Standards			Nil															
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes					
CLR-1:	Understand the basic security operations					Engineering Knowledge	2	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3		
CLR-2:	Acquire knowledge in assessing security operation capabilities																						
CLR-3:	Understand the SOC Infrastructure and security Events Generation																						
CLR-4:	Understand the security technology and preparation to operate																						
CLR-5:	Understand the types of events and Incidents																						
Course Outcomes (CO):		At the end of this course, learners will be able to:				-	2	-	-	-	-	2	-	-	-	-	-	-	-	-			
CO-1:	Apply the knowledge of security technologies					-	2	-	-	-	-	-	-	-	-	3	-	3	-	-	-		
CO-2:	Analyze the security operation capabilities					-	-	-	-	-	-	-	-	-	-	3	-	3	-	-	-		
CO-3:	Evaluate the security Events Generation					-	2	-	-	-	-	-	-	-	-	-	3	-	-	3			
CO-4:	Analyze the preparing to operate					-	-	-	-	-	-	2	-	-	3	-	-	-	-	3			
CO-5:	Evaluate the Events and Incidents					-	2	-	-	-	-	-	-	-	-	-	3	-	-	-			
Unit-1 - Introduction to Security Operations and the SOC Technologies																					9 Hour		
Cyber security Challenges- Introduction to Information Assurance- Introduction to Risk Management- Information Security Incident Response- SOC Generations- Characteristics of an Effective SOC-Introduction to Maturity Models - Applying Maturity Models to SOC- Phases of Building a SOC- Challenges and Obstacles-Data Collection and Analysis-Vulnerability Management-Threat Intelligence-Compliance- Ticketing and Case Management- Collaboration- SOC Conceptual Architecture																							
Unit-2 - Assessing Security Operations Capabilities																					9 Hour		
Assessment Methodology-Organization's Threat Landscape-SOC Sponsorship- Allocated Budget- Presenting Data Strategy Elements-SOC Model of Operation-SOC Services-SOC Capabilities Roadmap																							
Unit-3 - SOC Infrastructure and Security Events Generation, Collection , Vulnerability Management																					9 Hour		
Design Considerations- Model of operation-Facilities-Active Infrastructure-Data Collection- Cloud Security- Intrusion Detection and Prevention System- Network Telemetry with Network Flow - Handling Vulnerabilities-Automating Vulnerability Management- Threat Intelligence																							
Unit-4 - Technology and Preparing to Operate																					9 Hour		
Network- Security- Systems- Storage- Collaboration- Technologies to consider during SOC design- Breach Detection- Final SOC Architecture- Preparing to Operate-Key Challenges- Managing Challenges through a Well Managed Transition																							
Unit-5 - Reacting to Events and Incidents																					9 Hour		
Event Intake, Enrichment, Monitoring and Handling- Closing and Reporting on the case- Review and Assessing the SOC- Maintaining and Improving SOC																							

Learning Resources	1. Joseph Muniz, Gary McIntyre, Security Operations Center, Cisco press 2015	3. Russel C Hibler, Engineering Mechanics: Statics, Dynamics, Pearson, 14th ed., 2015
	2. John Rittinghouse PhD CISM Captain, William M. Hancock PhD CISSP CISM, Digital Press, 2003	4. Robert H. Deatherage, Jr., Security Operations an Introduction to planning and Conductive Private Security Details for High-Risk Areas

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sankaranarayanan, Security Analyst, Philips	1. Karthikeyan.C.M.T, Govt College of Engg, Bargur	1. Dr. J. Godwin Ponsam, SRMIST

Course Code	21CSE532T	Course Name	NETWORK MANAGEMENT AND PROTOCOLS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Determine the various type of Networks and the Network Management basics	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Exploring the Network Management Standards															
CLR-3:	Analyze the working of Simple Network Management Protocol and its various versions															
CLR-4:	Exploring the working of Remote Monitoring															
CLR-5:	Analyze the Network Management Applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Produce knowledge on networks and network management	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Gain knowledge on various standards	-	-	-	-	3	-	-	-	-	-	-	-	-	-	3
CO-3:	Analyze the working of SNMP protocol and its various applications	-	-	-	-	-	-	-	-	-	-	3	-	-	-	3
CO-4:	Apply the network management tools and gather information from the network	-	3	-	-	3	-	-	-	-	-	-	-	-	-	-
CO-5:	Apply the knowledge to create an efficient network	-	-	-	-	3	-	-	-	-	-	3	-	-	-	-

Unit-1 - Network Management Overview	9 Hour
Telephone Network Management, Distributed Computing Environment ,TCP/IP Based Networks, Communication Protocols and Standards, Protocol Layer and Services, Challenges of IT Managers, Network Management, Network and System Management, Network Management System Platform, Current status and future of Network, Management Network Management Standards, Network Management Model - Organizational model, Information Model, Management Information Trees, Communication Model, ASN.1, Terminology, Symbols and Conventions, Functional Model	
Unit-2 - SNMP and Network Management	9 Hour
Introduction to SNMP, SNMP v1 model, Organization Model, System overview, SNMP v1 Information model, Structure of Management Information, Managed Objects MIB-Object Group, System Group, Interfaces Group, Address Translation group, IP Group, ICMP Group, TCP Group, UDP Group, SNMP v1Communication model, Functional model, SNMPv2, System Architecture, MIB, Protocol, SNMPv3, MIB, User Based Security Model, Access Control	
Unit-3 - Remote Monitoring System	9 Hour
Remote Monitoring, RMON SMI and MIB, RMON1, RMON2, System Utilities for Management, Tools, Network Statistics Measurement Systems, Traffic Load, Protocol Statistics, Data and Error Statistics, Network Management System, Components, Requirements, System Management, Network Management Applications, Configuration Management, Inventory Management, Performance Management, Tools	
Unit-4 - Fault Management	9 Hour
Fault Management -Architecture, Fault location, Fault isolation, Algorithm, Self-healing, avoiding failures, Configuration setting, Configuration discovery and Change Control, Configuration Management Applications, Patch Management, Approaches for Performance Management, Performance Monitoring and Reporting, Performance trouble shooting, Capacity Planning, Account Management, Report Management-System and User Reports, Policy Management, Service Level Management	

Unit-5 - Network Design and Planning	9 Hour
Network Design and Planning, Network Design for Enterprise Network, Network Design Process, Data Collection, Data Generation, Traffic Generators, Cost Generators, Topology, Architecture, Graph, Link, Algorithms, Network Design Techniques, Performance Analysis, Queuing Essentials, Loss and Delay, Reliability, Network Cost	

Learning Resources	1. Mani Subramanian — <i>Network Management Principles and Practicell</i> , Second Edition, Pearson Publication, 2012. 2. Dinesh Chandra Verma— <i>Principles of Computer Systems and Network Management</i> , Springer, 2009	3. Greg Tomsho, Ed Tittel, David Johnson, — <i>Guide to Network Essentials</i> , Fifth Edition, Cengage Learning, 2010 4. Teresa C. Piliouras, <i>Network Design Management and Technical Perspectives</i> , Second Edition, 2004
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Srinivasan Varadarajan, Manhattan Associates, Atlanta	1. Dr. I. Joe Louis Paul, Associate Professor, SSN College of Engineering, TamilNadu	1. Dr S. Metilda Florence, SRMIST
2. Mr. Shiva Praveen, American Express, USA	2. Dr. B. Vinayaga Sundaram, Associate Professor, Madras Institute of Technology, Chennai	

Course Code	21CSE533T	Course Name	FIREWALLS AND ACCESS CONTROLS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understanding why port-based firewalls have become obsolete & addressing the data leakage problem, device sprawl.	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Recognizing the security and business benefits of next-generation firewalls															
CLR-3:	Configure and troubleshoot remote connectivity through direct access and the cloud															
CLR-4:	Learn to interpret the SELinux log events that describe to us what activities SELinux has prevented															
CLR-5:	Examining the Challenges in a Global Access Controls Strategy															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understanding accessibility tactics and examining the shortcomings of intrusion prevention	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
CO-2:	Comparing performance between next-generation and legacy firewall architectures and knowing what features to look for in a next-generation firewall.	-	-	-	-	-	-	-	-	-	3	-	-	-	-	3
CO-3:	Configuring Advanced Global Protect Features, Centralizing logs, and setting up site-to-site VPNs and Large-Scale VPNs.	-	-	-	-	-	-	2	-	-	-	-	-	-	-	3
CO-4:	Understanding SELinux Decisions and Logging and Defining users that have sufficient rights to do their jobs, ranging from unprivileged users to fully privileged users, running almost without SELinux protection.	-	-	-	-	-	-	2	-	-	3	-	-	-	-	-
CO-5:	Understanding the Security Matrix and Developing a Directory-Based Access Control Strategy.	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Firewalls	9 Hour
Why Legacy Firewalls Are No Longer Effective - Data Leakage Is a Problem - Compliance Is Not Optional - Applications Are Not All Good or All Bad - Applications Are Evasive - Threats Are Coming Along for the Ride - Whatever Happened to the Firewall? - Traditional IPS Is a Poor Match for Today's Threats - UTM Only Makes What Is Broken Cheaper - It's Time to Fix the Firewall	
Unit-2 - Solving the Problem with Next-Generation Firewalls	9 Hour
The Next-Generation Firewall - What a Next-Generation Firewall Isn't - Benefits of Next-Generation - Safe Enablement through Smart Policies Firewalls - Defining Your Requirements and Developing an RFP - Deployment Flexibility Matters - Addressing Mobile and Remote Users - Ten Evaluation Criteria for Next-Generation Firewalls-Identify Applications, Not Ports - Identify Users, Not IP Addresses - Identify Content, Not Packets – Control	
Unit-3 - Securing Remote Access in Palo Alto Networks	9 Hour
Understanding log forwarding profiles and best practices - Learning about Panorama and log collectors - Forwarding logs to syslog, SMTP, and other options - Exploring log forwarding profiles - Troubleshooting logs and log forwarding - Learning about advanced configuration features - Leveraging quarantine to isolate agents - Configuring a site-to-site VPN connection - Anti Phishing with User Credential Detection - Practical troubleshooting and Best Practice Tools.	
Unit-4 - SELinux access controls	9 Hour
SELinux users and roles - Jumping from one role to another - Context switching during authentication - Application-based contexts - Reading and changing file contexts - The context of a process - Dealing with types, permissions, and constraints - Integrating with Linux netfilter - Introducing labeled networking - Example – labeled IPSec	

Unit-5 - Security Controls	9 Hour
Simplifying the Security Matrix - Understanding Identification - Understanding Authentication - Understanding Authorization - Understanding Access Control - Examining Directory Services - Understanding LDAPv3 - Understanding the Meta-Directory - Revisiting Security Policy Domains- Examining the Challenges in a Global Access - Exploring a Future with Global Access Controls-Understanding Standard Data-Related Access Rights.	

Learning Resources	1. Lawrence C. Miller - Next-Generation Firewalls for Dummies Wiley Publishing, ISBN 978-0-470-93955-0 2. Tom Piens - Securing Remote Access in Palo Alto Networks_ Practical techniques to enable and protect remote users, improve your security posture, and troubleshoot next-generation firewalls-Packt Publication	3. Sven Vermeulen - SELinux System Administration _ A Comprehensive Guide to Walk You Through SELinux Access Controls-Packt Publishing (2013) 4. Dennis C Brewer - Security controls for Sarbanes-Oxley section 404 IT compliance _ authorization, authentication, and access-Wiley Pub (2006)
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. S. Sajiv, Technical Leader, CISCO	1. Dr. A. Balaji, School of Computing Science and Engineering (SCSE), VIT Bhopal University	1. Dr. S. Prabakeran, SRMIST
2. Mr. Varun Subramanian, QA Automation Tester, Likewize		

Course Code	21CSE534T	Course Name	NETWORK PROGRAMMING AND MANAGEMENT	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Explore different socket function and implement client server applications using sockets	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Analyze various application program like TELNET, DNS, DHCP															
CLR-3:	Create Thread and Raw Socket															
CLR-4:	Create Macros for including Objects In MIB Structure															
CLR-5:	Explore SNMPv1, v2 and v3 protocols and practical issues															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Define elementary socket functions	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Implement client –server applications using Sockets	-	-	-	-	-	-	-	-	-	-	-	2	-	-	3
CO-3:	Create Thread and Raw Socket	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Implement Macros for including Objects In MIB Structure	-	3	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Determine SNMPv1, v2 and v3 protocols and practical issues	-	-	-	-	-	-	-	-	-	-	-	2	-	-	3

Unit-1 – Sockets and Application Development	9 Hour
Introduction to Socket Programming – System Calls – Address conversion functions – POSIX Signal Handling – Server with multiple clients – Boundary conditions – Server process Crashes, Server host Crashes, Server Crashes and reboots, Server Shutdown – I/O Multiplexing – I/O Models -TCP echo client/server with I/O Multiplexing	
Unit-2 – Socket Options	9 Hour
Socket options – getsockopt and setsockopt functions – Generic socket options – IP socket options – ICMP socket options – TCP socket options – Multiplexing TCP and UDP sockets – SCTP Sockets – SCTP Client/server – Streaming Example – Domain name system – gethostbyname, gethostbyaddr, getservbyname and getservbyport functions – Protocol Independent functions in TCP Client/Server Scenario	
Unit-3 – Advanced Sockets	9 Hour
Ipv4 and Ipv6 interoperability – Threaded servers – Thread creation and termination – TCP echo server using threads – Mutex – Condition variables – Raw sockets – Raw socket creation – Raw socket output – Raw socket input – ping program – traceroute program	
Unit-4 – Simple Network Management	9 Hour
SNMP network management concepts – SNMPv1 – Management information – MIB Structure – Object syntax – Standard MIB's – MIB-II Groups – SNMPv1 protocol and Practical issues.	
Unit-5 – SNMP V2, V3 and RMON	9 Hour
Introduction to SNMPv2 – SMI for SNMPv2 – Protocol – SNMPv3 – Architecture and applications – Security and access control model – Overview of RMON	

Learning Resources	1. W. Richard Stevens, "UNIX Network Programming Vol-I", Third Edition, PHI Pearson Education, 2003.	3. D... E. Comer, "Internetworking with TCP/IP Vol- III: Client-Server Programming and Application BSD Sockets Version", Second Edition, Pearson Edition, 2003.
	2. William Stallings, "SNMP, SNMPv2, SNMPv3 and RMON 1 and 2", Third Edition, Pearson Edition, 2009.	4. Behrouz A.Forouzan , – TCP/IP protocol suite, 4 th edition, Mc Graw Hill education private limited,2010

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. Srinivasan Varadarajan, Manhattan Associates, Atlanta	1. Dr. I.Joe Louis Paul, Associate Professor, SSN College of Engineering, TamilNadu	1. Dr.S. Metilda Florence, SRMIST
2. Mr. Shiva Praveen, American Express, USA	2. Dr. B. Vinayaga Sundaram, Associate Professor, Madras Institute of Technology, Chennai	

Course Code	21CSE535T	Course Name	NETWORK INTRUSIONS AND COMPUTER FORENSICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12			
CLR-1:	Understand the basic of forensic investigation and its procedure	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3
CLR-2:	Understand the packet capturing and Analysis															
CLR-3:	Acquire knowledge in location awareness and Logs															
CLR-4:	Understand the network Intrusions and Alerting															
CLR-5:	Understand the types of scanning															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the knowledge forensic investigation	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Implement packet capturing and analysis	-	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Evaluate the different types of logs	2	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Analyze the intrusion detection system	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Test using scanning technique	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Network Forensics	9 Hour
Handling Evidence-Cryptographic Hashes-Incident Response-Need for Forensic practitioners. Networking basics-Host side Artifacts-Services- Connections- Tools-netstat, nbstat- ifconfig-ntop- Task Manager- Resource Monitor-ARP.	
Unit-2 - Packet Capture and Analysis	9 Hour
Capture Packets- Packet Analysis with wireshark- Network Miner-Attack Types –SYN Floods- Malformed Packets- UDP floods- Amplification Attacks- Distributed Attacks- Backscatter-Vulnerability Exploits-Insider Threats- Evasion- Application Attacks	
Unit-3 - Location Awareness	9 Hour
Time zones- Using Whois- Traceroute-Geo Location- Location based services- Wifi Positioning- Preparing for Attacks-Netflow- Logging- Syslog- Windows Event Logs- Firewall Logs- Router and Switch Logs- Log Servers and Monitors- Antivirus- Incident Response Preparation- Security Information and Event Management	
Unit-4 - Intrusion Detection System	9 Hour
Detection Styles- Signature Based-Heuristic- Host based versus Network based- Snort- Suricata and Sagan- Bro- Tripwire-OSSEC- Architecture- Alerting	
Unit-5 - Correlating Attacks	9 Hour
Packet Capture Times- Log Aggregation and Management- Timelines- Network Scanning- Port Scanning- Vulnerability Scanning- Port Knocking- Tunnelling- Passive Data Gathering	

Learning Resources	1. <i>Network Forensics</i> , Ric Messier, Wiley, ISBN: 978-1-119-32828-5, August 2017	3. <i>Computer Forensics: Investigating Network Intrusions and Cyber Crime</i> , EC-Council.
	2. <i>Network Attacks and Exploitation: A Framework</i> , Matthew Monte, Wiley, 2015	4. <i>Network Forensics: Tracking Hackers through Cyberspace</i> , Sherri Davidoff and Jonathan Ham, Prentice Hall, 2015

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sankaranarayanan, Security Analyst, Philips	1. Karthikeyan.C.M.T, Govt College of Engg, Bargur	1. Dr. J. Godwin Ponsam, SRMIST

Course Code	21CSE536T	Course Name	MOBILE FORENSICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the challenges of mobile forensics and the process model on mobile device forensics	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Acquire in-depth knowledge about smartphone acquisition and acquisition methods															
CLR-3:	Gain a solid understanding of iOS devices and guides to prepare the desktop machine for forensic work.															
CLR-4:	Explore the topics of Android model, file system, and its security features.															
CLR-5:	Explore the types of evidence available on iOS, Android, Windows, and BlackBerry mobile devices															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the mobile forensics process model on mobile device forensics	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Plan and prepare the knowledge about smartphone acquisition and acquisition methods	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO-3:	Acquire the knowledge on handling iOS devices	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Utilize the concepts of Android model, file system, and its security features.	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Demonstrate the ability to accurately document using Android Forensics, Windows Phone Forensics and BlackBerry Forensics	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-

Unit-1 – Introduction	9 Hour
Introduction to Mobile Forensics -Mobile forensics – Mobile forensic challenges – Mobile phone evidence extraction process – Other sources of potential evidence -Lab:1 Study of Mobile Forensics and different tools used for forensic investigation – Practical mobile forensic approaches – Mobile operating systems overview – Mobile forensic tool levelling system- Lab 2. Implement how to Recover Deleted Files using Forensics Tools - - Data acquisition methods – Potential evidence stored on mobile phones – Good forensic practices- Lab 3: Forensics environment setup (Install Linux VM and intro to Linux command)	
Unit-2 – iOS	9 Hour
Internals of iOS Devices and Data Acquisition from iOS Devices-iPhone models-iPhone operating system – The iOS architecture – iOS security -Address Space Layout Randomization – Lab 4: Using Android SDK Tools (AVD to create simulator, ADB to explore the data, etc.)-Data Acquisition from iOS Devices – Physical acquisition – The forensic environment setup – Downloading iPhone Data Protection Tools – Building the IMG3FS tool – Creating and loading the forensic toolkit – Establishing communication with the device – Lab 5: Android acquisition & analysis – Data Acquisition from iOS Backups -iTunes backup – Understanding the backup structure – Unencrypted backup – Encrypted backup – iCloud backup -Extracting iCloud backups- Lab 6: Case study on iphone	
Unit-3 – iOS Forensic Tools	9 Hour
iDevices from a Forensic Point of View – The iOS architecture – The iOS filesystem – iOS platform and hardware security – Identifying stored data – iOS acquisition and forensic approaches Lab 7: iOS forensics setup – iOS Data Analysis and Recovery – Timestamps – SQLite databases – Important database files -Property lists – Important plist files- Cookies Lab 8:- iphone acquisition & analysis – iOS Forensic Tools – Elcomsoft iOS Forensic Toolkit – Oxygen Forensic Suite 2014 – Cellebrite UFED Physical Analyzer – Paraben iRecovery Stick – Lab 9: Case study on Oxygen Forensic Suite	

Unit-4 – Android Model	9 Hour
Android Forensic Setup and Pre Data Extraction Techniques – The Android model – Android security – Android file system -Extended File System – Android Software Development Kit – Android Debug Bridge -Lab 10: How to View Last Activity of Your PC- Accessing the device using adb – Handling an Android device – Screen lock bypassing techniques – Smudge attack – Lab 11: Comparison of two Files for forensics investigation by Compare IT software – Gaining root access – Rooting an Android device – Imaging an Android Phone – Data extraction techniques – Lab 12: Live Forensics Case Investigation using Autopsy-Android Data Recovery Techniques	
Unit-5 – BlackBerry OS	9 Hour
Analysis and Overview of Forensic Tools on Android App, Windows Phone & Blackberry – Reverse engineering Android apps – Forensic tools overview – Windows Phone OS – Lab 13: windows phone acquisition & analysis – Windows chambers – Windows Phone file system – Extracting the data – Lab 14 : BlackBerry Investigation – BlackBerry OS – Security features -Data acquisition – Creating a BlackBerry backup – BlackBerry analysis – BlackBerry forensic image analysis – Forensic tools for BlackBerry analysis – Lab 15: Acquiring and Analyzing a BlackBerry device	

Learning Resources	1. Satish Bommisetty, Rohit Tamma, Heather Mahalik, Practical Mobile Forensics – 2014 Packt Publishing. 2. Soufiane Tahiri, Mastering Mobile Forensics, Packt Publishing.	3. Mobile Forensics: Advanced Investigative Strategies, Oleg Afonin, Vladimir Katalov, Packt Publishing. 4. Lee Reiber, Mobile Forensic Investigations: A Guide to Evidence Collection, Analysis, and Presentation, Second Edition, 2 nd Edition, McGraw-Hill
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sankaranarayanan, Security Analyst, Philips	1. Karthikeyan.C.M.T, Govt College of Engg, Bargur	1. Dr.M.Jeyaselvi, SRMIST
	2. Dr. Raju Abraham, NIOT, Chennai	2. Mr. Joseph Raymond V, SRMIST

Course Code	21CSE537T	Course Name	DIGITAL FORENSICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the history and purpose of digital forensics	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Acquire in-depth knowledge about workings of computer hardware and the operating systems															
CLR-3:	Gain knowledge about disruptive technology that is challenging in digital forensic															
CLR-4:	Understand the Windows Registry as a resource of digital evidence															
CLR-5:	Explore the knowledge in rich resources of digital evidence															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Apply the digital forensics process model	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
CO-2:	Plan and prepare the knowledge about Hardware and Software Environments	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
CO-3:	Acquire the knowledge on digital Forensic Tools	-	-	-	-	2	-	2	-	-	-	-	-	-	-	3
CO-4:	Apply the Digital Evidence in Windows OS	-	-	-	-	2	-	-	-	-	-	-	-	-	-	3
CO-5:	Demonstrate the ability to accurately document using rich resources of digital evidence	-	-	-	-	2	-	2	-	-	-	-	-	-	-	-

Unit-1 - The Role of Digital Forensics and Its Environment	9 Hour
Understanding the history and purpose of forensics -Defining digital forensics and its role-Looking at the history of digital forensics-Studying criminal investigations and cybercrime-Outlining civil investigations and the nature of e-discovery-The role of digital forensic practitioners and the challenges they face- Special Properties of Digital Evidence-The special characteristics and technical complexities of digital evidence.	
Unit-2 - Hardware and Software Environments	9 Hour
Computers and the nature of digital information – Operating systems – Filesystems that contain evidence – Locating evidence in filesystems – Explaining password security, encryption, and hidden files -Case study : linking the evidence to the user – Recovering and Preserving Digital Evidence – Understanding the chain of custody.	
Unit-3 - Physical acquisition and safekeeping of digital evidence	9 Hour
Recovering digital evidence through forensic imaging processes -Acquiring digital evidence through live recovery processes -Outlining the efficacy of existing forensic tools and the emergence of enhanced processes and tools -The Need for Enhanced Forensic Tools -Digital forensics laboratories -Emerging problems with datasets -Case study : Illustrating the challenges of interrogating large datasets	
Unit-4 - Selecting and Analysing Digital Evidence	9 Hour
Structured processes to locate and select digital evidence – Locating digital evidence – Selecting digital evidence – Case study : Illustrating the recovery of deleted evidence held in volume shadows – Windows and Other Operating Systems as Sources of Evidence – The Windows Registry and system files and logs as resources of digital evidence – Apple and other operating system structures – Remote access and malware threats	

Unit-5 - Examining Browsers	9 Hour
E-mails, Messaging Systems, and Mobile Phones – Locating evidence from Internet browsing – Messaging systems – E-mail analysis and the processing of large e-mail databases – The growing challenge of evidence recovery from mobile phones and handheld devices -Case study : mobile phone evidence in a bomb hoax – Validating the Evidence – The nature and problem of unsound digital evidence ,Impartiality in selecting evidence -The structured and balanced analysis of digital evidence ,Ethical issues confronting digital forensics practitioners	

Learning Resources	1. Practical Digital Forensics – Richard Boddington [PACKT] Publication, Open-source community 2. Warren G. Kruse II and Jay G. Heiser, “Computer Forensics: Incident Response Essentials”, Addison Wesley, 2002.	3. Nelson, B, Phillips, a, Enfinger, F, Stuart, C., “Guide to Computer Forensics and Investigations, 2 nd ed., Thomson Course Technology, 2006, ISBN: 0-619-21706-5. 4. Vacca, J, Computer Forensics, Computer Crime Scene Investigation, 2 nd Ed, Charles River Media, 2005, ISBN: 1-58450-389.
---------------------------	--	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sankaranarayanan, Security Analyst, Philips	1. Karthikeyan.C.M.T, Govt College of Engg,Bargur	1. Dr.M.Jeyaselvi, SRMIST
	2. Dr. Raju Abraham, NIOT, Chennai	2. Mr. Joseph Raymond V, SRMIST

Course Code	21CSE538T	Course Name	SECURITY SCRIPTING AND ANALYSIS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Gain mastery in scripting application	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Practice computer network security scripting and packet analysis automation															
CLR-3:	Apply the secure web app scripting development															
CLR-4:	Analyze and practice exploit scripting and vulnerability analysis techniques															
CLR-5:	Analyze and expertise over the tool wireshark scripting															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Experience on scripting programming for network security	-	-	2	-	-	-	-	2	-	-	-	-	-	-	-
CO-2:	Acquire knowledge on developing web servers and clients	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3
CO-3:	Develop their own packet capturing and analyzing tools	-	-	2	-	-	-	-	2	-	-	-	-	-	-	3
CO-4:	Develop source code vulnerability detecting scripts	-	-	2	-	-	-	-	2	-	-	-	-	-	-	-
CO-5:	Perform exploit analysis tools and network security analysis using packet capturing tools	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 – Scripting Techniques	9 Hour
Introduction to Interpreted Language, Coding standards and data types, Mutable and immutable datatypes comparison in memory level, Variables, operators and Expressions, Program Structure and Control statements, Loops - different types of for, while, Functions and lambda expression, Examples for different types functions, Classes, Objects and Other OOPS Concepts, Scope of variables-class level, instance level and local, Inheritance and Overloading-types and examples, Exception handling, Introduction to IO streams and programming in file concepts, Directory Access and file traversing, Creation of Threads and its need, Multithreading and Concurrency using locks and synchronization, Inter Process Communication (IPC, Permissions and Controls.	
Unit-2 – Computer Network Security Scripting Techniques	9 Hour
Raw Socket programming, Packet injection using raw socket programming, Socket Libraries and its functionalities, Programming server clients using TCP, Asynchronous socket channels, Programming Servers and Clients using UDP, Multithreaded server-TCP and UDP, Example programs applying multithreaded server concepts, Scapy Introduction, Packet crafting using scapy, Programming Wired Sniffers-scapy, Packet injection –scapy wired, Programming Wireless Sniffers-scapy, Wireless sniffers examples, Programming arbitrary packet Injectors- wireless, Packet injection examples, Read and write to pcap file –scapy, Attack automation using scapy	
Unit-3 – Web App Security Scripting	9 Hour
Web Servers, Client side scripting, HTML basics, CGI scripts, Web Application Fuzzers, Types of fuzzing techniques, Types of fuzzing techniques, Scraping Web Applications- introduction, Remote file access - Urlopen, urlretrieve, BeautifulSoup-urllib, HTML parsing, XML file analysis, Examples for XML file analysis, Web Browser Emulation- introduction, Mechanize- examples, Application Proxy, Own proxy creation, Attacking Web Services, Examples for attacking web services.	

Unit-4 – Computer Network Exploit Scripting and Vulnerability Analysis	9 Hour
Exploit Development techniques-introduction, Types of exploit development techniques, Immunity Debuggers and Libs, Attaching and detaching process, Writing plugins for Immunity debugger, Malware sample analysis, Advanced exploitation techniques, Writing payloads for exploitation, Buffer overflow attack, Example with immunity debugger, Pyhook introduction, Examples for pyhook key loggers, Source code vulnerability –introduction, Source code vulnerability analysis, Static source code vulnerability detection –scripting, Example scripts for static detection, dynamic source code vulnerability detection-scripting, Example methods for dynamic detection.	
Unit-5 – Computer Network Packet Analysis Scripting	9 Hour
Wireshark- introduction, Capturing methodologies, Capture filters, Display filters, Searching for packets using the Find dialog, Create new Wireshark profiles, Usage of Graphs, IO, TCP, Flow Graphs, Inspection of Application Layer protocols, DNS, FTP, HTTP, SMTP, Colourcoding, Creation of colouring rules, Analyzing Transport Layer Protocol, TCP-UDP, Analyzing packets for security tasks, Security analysis methodology, Scans and sweeps, ARP ICMP TCP UDP	

Learning Resources	1. Mike Dawson, More Python programming for Absolute Beginner, Cengage Learning PTR; 3 rd edition, ISBN-10: 1435455002, ISBN-13: 978-14354550092, 2010. 2. The Web Application Hacker's Handbook, 2 nd Edition, Wiley 3. Publication, Dafydd Stuttard, Marcus Pinto 4. Mastering Wireshark, PACKT Publishing, By Charit Mishra, March 2016 5. James H. Baxter, Wireshark essentials, 2014 6. T.J. O'Connor, Violent Python A Cookbook for Hackers, Forensic Analysts, Penetration Testers, and Security Engineers (2013), Elsevier
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Sankaranarayanan, Security Analyst, Philips	1. Karthikeyan.C.M.T, Govt College of Engg, Bargur	1. Dr.P.Savaridassan, SRMIST
	2. Dr. Raju Abraham, NIOT, Chennai	

Course Code	21CSE539T	Course Name	PRINCIPLES OF SECURE CODING PRINCIPLES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Discover the need for secure coding and proactive development process	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Demonstrate secure coding practices															
CLR-3:	Implement automated tools to analyze and test the code for vulnerabilities															
CLR-4:	Analyze input issues related to database and web															
CLR-5:	Incorporate fundamental principles of software security engineering															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Acquire the knowledge on secured software development and life cycle process	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Design secure software by incorporating security principles and mitigation strategies	-	-	2	-	2	-	-	-	-	-	-	-	-	-	-
CO-3:	Analyze vulnerable code in implemented software and describe attack consequences	-	-	2	-	2	-	-	-	-	-	-	-	-	-	3
CO-4:	Apply mitigation and implementation practices to construct attack resistant web applications	-	-	2	-	2	-	-	-	-	-	-	-	-	-	3
CO-5:	Apply secure design principles for developing attack resistant software applications	-	-	2	-	-	-	-	-	-	-	-	-	-	-	3

Unit-1 - Secure Development Techniques	9 Hour
Introduction to secure coding principles, Need for secure systems - ideas for instilling Security culture and deploying Information Security culture frameworks, Attackers advantage and defenders dilemma, Proactive security, Design phase considerations, Development and test phase considerations, Security principles to live by – SD3, Security principles, Secure design through threat modeling, Security Techniques, Threat Modeling Tools, Security Into DevOps Processes.	
Unit-2 - Secure Coding In C	9 Hour
Character strings- Common string manipulation errors – String Vulnerabilities and exploits –Mitigation strategies for strings, Obsolete functions, and secure functions by standards – Pointers, C Dynamic Memory Management, Common errors in memory management, Instruction pointer modification, Targets for instruction pointer modification, Referencing Freed Memory, Mitigation strategies in pointer-based vulnerabilities – Buffer Overflow based vulnerabilities.	
Unit-3 - Secure Coding in C++ and Java	9 Hour
Dynamic memory management- Common errors in dynamic memory management- Memory managers, Double-free vulnerabilities, Integer Security-Mitigation strategies, Tools to check code for common programming errors - Static code checkers, Runtime code checkers.	
Unit-4 - Database and Web Specific Input Issues	9 Hour
Quoting the Input – Use of stored procedures- SQL injection – Anatomy of the vulnerability, Building SQL statements securely-XSS related attacks and remedies, Web Server and Database Attacks and Countermeasures.	
Unit-5 - Software Security Engineering	9 Hour
Requirements engineering for secure software: Misuse and abuse cases-SQUARE process model- Software security practices and knowledge for architecture and design.	

Learning Resources	<ol style="list-style-type: none"> 1. Michael Howard, David LeBlanc, "Writing Secure Code", Microsoft Press, 2nd Edition, 2003. 2. Robert C. Seacord, "Secure Coding in C and C++", Pearson Education, 2nd edition, 2013. 3. Julia H. Allen, Sean J. Barnum, Robert J. Ellison, Gary McGraw, Nancy R. Mead, "Software Security Engineering: A guide for Project Managers", Addison-Wesley Professional, 2008. 	<ol style="list-style-type: none"> 4. David A. Wheeler, "Secure Programming for Linux and Unix HOWTO" 5. Bryan Sullivan, Vincent Liu, "Web Application Security – A Beginner's Guide" 6. Ron Ben Natan, "Implementing Database Security and Auditing: A guide for DBAs, Information security administrators and auditors", Published by Elsevier Inc., 2005
---------------------------	--	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Praveen Kumar, Team Lead, Cognizant Technology Solutions.	1. Karthikeyan.C.M.T, Govt College of Engg, Bargur	1. Dr. Savaridassan.P, SRM IST
	2. Dr. Raju Abraham, NIOT, Chennai	2. Mr. Joseph Raymond V, SRM IST

Course Code	21CSE540T	Course Name	ANDROID SECURITY AND DESIGN INTERNALS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co-requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the Android Security Model	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Develop the android security design and architecture															
CLR-3:	Identify various Android attacks and hacking methods															
CLR-4:	Understand the User Space Software and Return Oriented Programming															
CLR-5:	Demonstrate Network Security and PKI, Enterprise Security and Device Security															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Understand the Android Security Model	2	2	-	2	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Develop the android security design and architecture	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Explore Android attacks and hacking methods	-	2	-	2	-	-	-	-	-	-	-	-	-	-	3
CO-4:	Understand the User Space Software and Return Oriented Programming	-	2	-	2	-	-	-	-	-	-	-	-	-	-	3
CO-5:	Demonstrate Network Security and PKI, Enterprise Security and Device Security	2	-	-	2	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Android's Security Model	9 Hour
Android's Security Model – Android Architecture, Android's Security Model. Permissions – The Nature of Permission, Requesting Permission, Permission Management, Permission Protection Levels, Permission Assignment, Permission Enforcement, System Permission, Shared user ID, Custom Permission, Public and Private components, Activity and Service Permission, Broadcast Permission, Content Provider Permission. Package Management – Android Application package format, Code signing, APK Install Process, Package verification. User Management – Multiuser support overview, Type of users, user management, user metadata, Per User Application Management, External Storage, Other Multiuser features	
Unit-2 - Android Security Design and Architecture	9 Hour
Android Security Design and Architecture - Understanding Android System Architecture, Understanding Security Boundaries and Enforcement, Complex Security, Complex Exploits. Rooting Your Device - Understanding the Partition Layout, Understanding the Boot Process, Locked and Unlocked Boot Loaders, Rooting with an Unlocked Boot Loader, Rooting with a Locked Boot Loader, History of Known Attacks. Reviewing Application Security - Common Issues, Case Study: Mobile Security App, Case Study: SIP Client.	
Unit-3 - Android Attacks and Hacking	9 Hour
Understanding Android's Attack Surface - An Attack Terminology Primer, Classifying Attack Surfaces, Remote Attack Surfaces, Physical Adjacency, Local Attack Surfaces, Physical Attack Surfaces, and Third-Party Modifications. Finding Vulnerabilities with Fuzz Testing -Fuzzing Background, Fuzzing on Android, Fuzzing Broadcast Receivers, Fuzzing Chrome for Android, Fuzzing the USB Attack Surface. Debugging and Analyzing Vulnerabilities – Choosing a Tool Chain, Debugging with Crash Dumps, Remote Debugging, Debugging Dalvik Code, Debugging Native Code, Debugging Mixed Code, Alternative Debugging Techniques, Vulnerability Analysis.	

Unit-4 - User Space Software	9 Hour
Exploiting User Space Software - Memory Corruption Basics, A History of Public Exploits, Exploiting the Android Browser. Return Oriented Programming - History and Motivation, Basics of ROP on ARM, Case Study: Android 4.0.1 Linker. Hacking and Attacking the Kernel - Android's Linux Kernel, Extracting Kernels, Running Custom Kernel Code, Debugging the Kernel, Exploiting the Kernel.	
Unit-5 - Network Security and PKI	9 Hour
Cryptographic Providers - JCA Provider Architecture, JCA Engine Classes, Android JCA Providers, Using a Custom Provider. Network Security and PKI - PKI and SSL Overview, JSSE Introduction, Android JSSE Implementation. Credential Storage - VPN and Wi-Fi EAP Credentials, Credential Storage Implementation, Public APIs. Online Account Management - Android Account Management Overview, Account Management Implementation, Google Accounts Support. Enterprise Security – Device Administration, VPN Support, Wi-Fi EAP. Device Security - Controlling OS Boot-Up and Installation, Verified Boot, Disk Encryption, Screen Security, Secure USB Debugging, Android Backup.	

Learning Resources	1. Android Security Internals – An In-depth Guide To Android's Security Architecture, by Nikolay Elenkov, No Starch Press 2. Android™ Hacker's Handbook, Joshua J. Drake, Pau Oliva Fora, Zach Lanier, Collin Mulline, Stephen A. Ridley, Georg Wicherski, Welly, ISBN: 978-1-118-60864-7 3. Android Security (and Not) Internals, Yury Zhauniarovich, June 2014 4. Android Security: Attacks and Defenses, Anmol Misra, Abhishek Dubey, CRC Press, ISBN: 9780367380182 5. Android Security Cookbook, Keith Makan, Scott Alexander-Bown, December 2013, ISBN: 9781782167167 6. Android Application Security Essentials, Pragati Ogal Rai, Packt Publishing (21 August 2013), ISBN: 978-1849515603
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Dr. N. Arun, Senior Software Engineer, Quick Heal		1. Dr. Vigneshwaran P, SRMIST

ACADEMIC CURRICULA

UNDERGRADUATE/ INTEGRATED POST GRADUATE DEGREE PROGRAMMES

(With exit option of Diploma)

(Choice Based Flexible Credit System)

Regulations 2021

Volume – 11N

**(Syllabi for M.Tech (Integrated) Computer Science and
Engineering w/s in Data Science Programme Courses)**



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**

ACADEMIC CURRICULA

Professional Core Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSC501T	Course Name	NATURAL LANGUAGE PROCESSING TECHNIQUES	Course Category	C	PROFESSIONAL CORE										L	T	P	C				
																3	1	0	4				
Pre-requisite Courses	Nil		Co- requisite Courses	Nil		Progressive Courses	Nil																
Course Offering Department		School of Computing			Data Book / Codes / Standards			Nil															
Course Learning Rationale (CLR):		The purpose of learning this course is to:				Program Outcomes (PO)												Program Specific outcomes					
CLR-1:	familiarize the basic concepts of NLP					1	2	3	4	5	6	7	8	9	10	11	12						
CLR-2:	inculcate the knowledge of preprocessing techniques of NLP					Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3			
CLR-3:	build probabilistic language models																						
CLR-4:	Brief about syntax and semantic techniques																						
CLR-5:	design the application models of NLP																						
Course Outcomes (CO):		At the end of this course, learners will be able to:																					
CO-1:	Understand Ambiguity of NLP, Challenges, and applications of NLP.					-	-	-	-	-	-	-	-	-	-	-	-	1	-	-			
CO-2:	Illustrate NLP Techniques such as POS, Morphology, text Preprocessing					-	-	-	-	-	-	-	-	-	-	-	-	-	2	-			
CO-3:	Develop applications of probabilistic models					-	-	-	-	-	-	-	-	-	-	-	-	-	-	3			
CO-4:	Analyze the concepts of syntax and semantics in NLP					-	-	-	-	-	-	-	-	-	-	-	-	-	2	-			
CO-5:	Implement the applications of NLP using Machine Learning and Deep Learning model					-	-	-	-	-	-	-	-	-	-	-	-	-	-	3			
Unit-1 - NLP Overview																				12 Hour			
History of NLP, Applications of NLP, Information Retrieval, Information Extraction, Question Answering, Sentiment Analysis, Optical Character Recognitions Summarization Spell and Grammar Checking. Text Categorization word prediction speech recognition Machine Translation, Classification of NLP, Ambiguity Lexical Ambiguity, Syntactic Ambiguity, Semantic Ambiguity, Pragmatic Ambiguity, NLP Terminology, Components of NLP																							
T1: NLP Packages																							
T2: Preprocessing of Text																							
T3: Language Model																							
Unit-2 - NLP Technique																				12 Hour			
NLP Technique, Parts of speech, Rule based POS, HMM POS, Formatting Hidden, Markov Model Taggers, Phonology, Veterbi Algorithm for HMM Tagging, Probabilistic Speech Recognition, Morphology, Finite state Morphological Parsing, Text Preprocessing, Tokenization, Stemming, Lemmatization, Regular expressions, Finite State Automata, Deterministic Automata, Non-Deterministic Automata.																							
T4: Implementation of POS Tagging																							
T5: Tools of Morphology																							
T6: Implementation of Regular Expression																							

Unit-3 - Probabilistic Language Model	12 Hour
Potter Stemmer, Detection and Correction of Spelling Errors, Minimum Edit Distance, Application of Probabilistic of Model, Bag of words with N-Gram, The Chain Rule, Language model with N-Gram, N-Gram, Language Model applications, Unigram model, Bigram Model, Unsmoothed N-Grams, Evaluating N-Grams perplexity, Smoothing: Laplace Smoothing, Interpolation, Likelihood computation, Context free grammar, Top Down parsing. T7: Spelling Correction T8: N-Gram Model T9: Probabilistic Language Model	
Unit-4 - Natural Language and Neural Networks	12 Hour
Introduction to Neural Networks, Network Architecture, Recurrent Neural Networks in NLP, WordSense, WordNet, Learning Representation, Back propagation errors, Vectorization, Information extraction, Backdrop, Dependency Parsing, Fast and Accurate Dependency Parser using Neural Networks, Globally Normalized Transition Based Neural Networks. T10: NN Architecture T11: Distributed Representation T12: Word embedding	
Unit-5 - NLP and Deep learning	12 Hour
Introduction to NLP and Deep Learning, Word Vectors, Distributed Representations of Words and Phases, Word representations in vector space Word vector, Glove vectors for word representation, improving distributional similarity, Evaluation methods for Unsupervised word embedding. T13: Pretrained Language model T14: Transfer Learning T15: Long Short-Term Memory	

Learning Resources	1. Daniel Jurafsky and James H Martin. Speech and Language Processing, 2e, Pearson Education, 2009 2. James A... Natural language Understanding 2e, Pearson Education, 1994 3. Bharati A., Sangal R., Chaitanya V... Natural language processing: a Paninian perspective, PHI, 2000 4. Siddiqui T., Tiwary U. S... Natural language processing and Information retrieval, OUP, 2008.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1.		1. Dr. R. Rajkumar, SRMIST

Course Code	21CSC502J	Course Name	APPLIED DEEP LEARNING	Course Category	C	PROFESSIONAL CORE				L	T	P	C
										2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the theoretical foundations, algorithms, and methodologies of convolutional neural networks	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Identify and apply appropriate recurrent neural networks for analyzing the data for variety of problems.															
CLR-3:	Understand the principles and applications of computer vision															
CLR-4:	Construct Generative Adversarial Networks to solve real - world problems.															
CLR-5:	Understand different methodologies to create application using deep nets.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Recognize the characteristics of convolutional neural networks and the use of optimizers.	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Analyze various recurrent neural networks models.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Apply the Deep Learning models for Computer Vision.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-4:	Solve various real - world problems using Generative Adversarial Networks.	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-5:	Build a Deep Reinforcement Learning models for solving various problems.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

Unit-1 - Convolutional Neural Networks	9 Hour
Introduction to Convolutional neural networks – Autoencoders: types, denoising, Convolutional autoencoder example, Uses and limitations – Variational autoencoders: Parameters to define a normal distribution, VAE loss function, Kullback-Leibler divergence, Training the VAE, The reparameterization trick – Applications of autoencoders – Optimizers: Gradient Descent, RMSProp, Adam	
Tutorial:	
T1. To build a convolutional autoencoder model for the MNIST dataset, T2. To build a convolutional variational autoencoders for the MNIST dataset, T3. Experiment with different learning rates and objective functions for gradient descent	
Unit-2 - Recurrent Neural Networks	9 Hour
Recurrent Neural Networks: Overview, Neural Networks with and without Hidden States, RNN-based Character-Level Language Models - Implementation: RNN Model, RNN-based Language Model, Gradient Clipping, Training, Decoding - Long Short-Term Memory (LSTM), Gated Recurrent Units (GRU)	
Tutorial:	
T1. To implement the RNN model using the H. G. Wells' The Time Machine data set. T2. To implement the LSTM model using the H. G. Wells' The Time Machine data set. T3. To implement the GRU model using the H. G. Wells' The Time Machine data set	
Unit-3 - Deep Learning for Computer Vision	9 Hour
Image Augmentation - Object Detection and Bounding Boxes - Anchor Boxes - Multiscale Object Detection - Region-based CNNs: R-CNNs, Fast R-CNN, Faster R-CNN, Mask R-CNN	
Tutorial:	
T1. To demonstrate object detection model banana detection dataset. T2. To implement the classification model for CIFAR-10 dataset. T3. To implement the classification model for Dog Breed Identification dataset	

Unit-4 - Generative Adversarial Networks	9 Hour
Generative Adversarial Networks: Generator, Discriminator, Loss function, Generator loss, Discriminator loss, Training - Deep Convolutional Generative Adversarial Networks: Wasserstein GAN, BEGAN, Cycle GAN - Conditional GANs: Pix2Pix	
Tutorial: T1. To build a model using GAN to resemble MNIST digits. T2. To implement a Deep Convolutional GAN to generate complex color images. T3. To implement a Deep Convolutional GAN on Fashion-MNIST data set using ReLU as activation function for generator, leaky ReLU as activation function for discriminator.	
Unit-5 - Deep Reinforcement Learning	9 Hour
Stateless Algorithms: Naïve Algorithm, ϵ -Greedy Algorithm, Upper Bounding Methods - The Basic Framework of Reinforcement Learning: Challenges, Simple Reinforcement Learning for Tic-Tac-Toe, Role of Deep Learning, and a Straw-Man Algorithm	
Tutorial: T1. Self-Learning Robots - Case Study , T2. Building Conversational Systems: Deep Learning for Chatbots - Case Study, T3. Self-Driving Cars - Case Study	

Learning Resources	<ol style="list-style-type: none"> 1. Iffat Zafar, Giounona Tzanidou, Richard Burton, Nimesh Patel, Leonardo Araujo, Hands-On Convolutional Neural Networks with TensorFlow, Packt Publishing, 2018. (Unit I) 2. Aston Zhang, Zack C. Lipton, Mu Li, Alex J. Smola, Dive into Deep Learning, arXiv preprint, 2021 (http://d2l.ai/index.html) (Unit II, III & IV) 3. Charu C. Aggarwal, Neural Networks and Deep Learning - A Text Book, Springer Nature, 2018. (Unit 4. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, the MIT Press, 2017. 5. Umberto Michelucci, Applied Deep Learning – A Case-Based Approach to Understanding Deep Neural Networks, Apress, 2018. 6. François Chollet, Deep Learning with Python, Manning Publications, 2018.
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (45%)		Life-Long Learning CLA-2 (15%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	-	15%	15%	-
Level 2	Understand	25%	-	-	20%	25%	-
Level 3	Apply	30%	-	-	25%	30%	-
Level 4	Analyze	30%	-	-	25%	30%	-
Level 5	Evaluate	-	-	-	10%	-	-
Level 6	Create	-	-	-	5%	-	-
	Total	100 %		100 %		100 %	
Course Designers							
Experts from Industry		Experts from Higher Technical Institutions				Internal Experts	
1. Mr. N. Mohanraj, Software Engineer 2, PayPal Inc.,		1. Dr. M. Vinoth Kumar, Associate Professor, Department of Information Science and Engineering, Dayananda Sagar Academy of Technology & Management				1. Dr. M. Prakash, SRMIST	
						2. Dr.G.Vadivu, SRMIST	

ACADEMIC CURRICULA

Professional Elective Courses

Regulations 2021

SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India

Course Code	21CSE521T	Course Name	ADVANCED ALGORITHMS ANALYSIS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the fundamentals of algorithms and its complexity	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Analyse algorithm design strategies															
CLR-3:	Implement graph and network algorithms															
CLR-4:	Design the Parallel and Distributed algorithms															
CLR-5:	Utilize the search algorithms															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Develop algorithms and analyze its complexity	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-2:	Utilize appropriate design strategies	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO-3:	Implement the graph and network algorithms	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-4:	Design and analysis of paradigms for sequential and parallel models	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
CO-5:	Implement search algorithms	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-

Unit-1 - Introduction to Algorithms	9 Hour
Introduction to Preliminaries - Design and Analysis Fundamentals - Mathematical Tools for Algorithm Analysis - Trees and Applications to Algorithms - More on Sorting Algorithms - Probability and Average Complexity of Algorithms. T 1: Implementation of Sorting Algorithms T 2: Implementation of Greedy algorithm T 3: Implementation of Divide and Conquer algorithm	
Unit-2 - Design Strategies	9 Hour
Major Design Strategies - The Greedy Method – Divide and Conquer - Dynamic Programming - Backtracking and Branch and Bound T 4: Implementation of Dynamic Programming algorithm T 5: Implementation of Backtracking algorithms T 6: Implementation of Branch and Bound algorithms	
Unit-3 - Graph and Network Algorithms	9 Hour
Graph and Network Algorithms - Graphs and Digraphs - Minimum Spanning Tree and Shortest Path Algorithms - Graph Connectivity and Fault-Tolerance of Networks - Matching and Network Flow Algorithms – Case study on water management system T 7: Implementation of Minimum spanning Tree T 8: Implementation of Shortest Path algorithms T 9: Implementation of Network Flow algorithm	

Unit-4 - Parallel and Distributed Algorithms	9 Hour
Parallel and Distributed Algorithms - Introduction to Parallel Algorithms and Architectures - Parallel Design Strategies - Internet Algorithms -Distributed Computation Algorithms - Distributed Network Algorithms. T 10: Implementation of Parallel algorithms T 11: Implementation of Internet algorithms T 12: Implementation of Distributed Network Algorithms	
Unit-5 - Search Algorithms	9 Hour
String Matching and Document Processing - Balanced Search Trees - The Fast Fourier Transform - Heuristic Search Strategies: A* - Search and Game Trees 24 - Probabilistic and Randomized Algorithms - Lower-Bound Theory - NP-Complete Problems - Approximation Algorithms – case study on bin packing, Dock management system. T 13: Implementation of String-Matching Algorithms T 14: Implementation of Randomized algorithms T 15: Case study for NP Complete Problem	

Learning Resources	<ol style="list-style-type: none"> 1. Kenneth A. Berman, Jerome L. Paul, "Algorithms: Sequential, Parallel, and Distributed", Amazon Bestsellers, 2004. 2. Russ Miller, Laurence Boxer, "Algorithms Sequential and Parallel: A Unified Approach", Prentice Hall, 1 edition, 1999. 3. Dimitri P. Bertsekas and John N. Tsitsiklis, "Parallel and Distributed Computation: Numerical Methods", Prentice Hall, 1989. 4. Michael Goodrich, Roberto Tamassia, "Algorithm Design" Wiley Student Edition 5. Horowitz, Sahni, Mehta: Fundamentals of Data Structures in C++, 2nd edition, University Press, 2007
---------------------------	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		Dr. Radha R, SRMIST

Course Code	21CSE522T	Course Name	FUNCTIONAL PROGRAMMING	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		The purpose of learning this course is to:	Program Outcomes (PO)												Program Specific outcomes		
CLR-1:	Learn the purpose of functional programming paradigm and Scala basic constructs	1	2	3	4	5	6	7	8	9	10	11	12				
CLR-2:	Comprehend the different types of functions in scala	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning	PSO-1	PSO-2	PSO-3	
CLR-3:	Utilize traits and mixins in functional programming																
CLR-4:	Learn the basics of lists and collections data structures																
CLR-5:	Explore the functors, monads, and monoids																
Course Outcomes (CO):		At the end of this course, learners will be able to:															
CO-1:	Identify and apply the appropriate construct in functional programming	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	
CO-2:	Construct programs using different types of functions	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	
CO-3:	Create programs using traits and mixins	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	
CO-4:	Construct programs using lists and different types of collections	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	
CO-5:	Create programs using functors, monads, and monoids	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	

Unit-4 – Data Structures	9 Hour
Lists definitions and usage - Working with Lists - Constructing Lists - Basic operations on lists - head, tail, isEmpty demo - List Patterns - Lists First Order methods - Lists Higher Order methods - Sequences Overview and operations - Tuples Overview and operations - Sets and Maps – Lists and Collections T7: Lists and basic operations in lists T8: Tuples and Collections	
Unit-5 – Applicative Development	9 Hour
Functors Purpose and Use - Writing a simple functor - Functor Laws - Applicatives Concepts and use - Defining an applicative - Demo of Applicatives - Monads - Defining Monads - Monad Laws - Demo of Monads and Monad Laws - Monoid Concept, Purpose, and Use - Examples of Monoid T9: Applicatives development T10: Traversable functors development	

Learning Resources	1. Chiusano.P,Bjarnason R,Functional Programming in Scala,Manning Publications,2015 2. Oderskey M, SpoonL, Venners B, Programming in Scala, Third edition.	3. Hortsman, C., Scala for the Impatient, 2nd ed., Addison-Wesley, 2016. 4. Raychaudhuri R, Scala in Action, 1st ed. Manning Publications, 2013.
---------------------------	---	---

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Dr. K. Somalakshmi, SRMIST

Course Code	21CSE524T	Course Name	COMPUTER VISION TECHNIQUES	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Recognize and describe both the theoretical and practical aspects of computing with images. Connect issues from Computer Vision to Human Vision															
CLR-2:	Describe the foundation of image formation and image analysis. Understand the basics of 2D and 3D Computer Vision.															
CLR-3:	Become familiar with the major technical approaches involved in computer vision. Describe various methods used for registration, alignment, and matching in images.															
CLR-4:	Get an exposure to advanced concepts leading to object and scene categorization from images.															
CLR-5:	Build computer vision applications.															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	understand computer vision including fundamentals of image formation	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2:	Learn about image formation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Apply image processing techniques	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
CO-4:	Calibrate computational photography	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO-5:	learn about Image rendering	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

Unit-1 - Introduction to Computer Vision	9 Hour
Review of image processing techniques – classical filtering operations – thresholding techniques – edge detection techniques – corner and interest point detection.	
T1: Implementation of 2D and 3D Projections	
T2: Build a color constancy algorithm that uses the assumption that the spatial average of reflectance is constant. Use finite-dimensional linear models.	
Unit-2 – Image Formation	9 Hour
Points and patches-An Introduction - Binary shape analysis – connectedness – object labeling and counting – size filtering – distance functions – skeletons and thinning – deformable shape analysis – boundary tracking procedures – active contours – shape models and shape recognition - Feature detectors -Feature descriptors, Matching - Feature tracking - Edge detection - Edge linking - Successive approximation - Hough transforms -Hough Transform (HT) for line detection – foot-of-normal method – line localization – line fitting – RANSAC for straight line detection – HT based circular object detection – accurate center location – speed problem – ellipse detection – Case study: Human Iris location – hole detection – generalized Hough Transform (GHT) – spatial matched filtering – GHT for ellipse detection – object location – GHT for feature collation. Vanishing points	
T3: Implementation Two-dimensional Fourier transforms, Wiener filtering	
T4: Write a program that produces a Gaussian pyramid from an image	

Unit-3 – Image Processing Techniques	9 Hour
Active contours - Snakes -Dynamic snakes and Condensation - Scissors, Level Sets - Split and merge - Mean shift and mode finding - Normalized cuts - Graph cuts and energy-based methods - 2D and 3D feature-based alignment - Pose estimation T5: Obtain an implementation of Canny's edge detector T6: Implement a Hough transform based line finder	
Unit-4 – Computational Photography	9 Hour
Triangulation - Two-frame structure from motion - Projective reconstruction - Self-calibration - Perspective and projective factorization - Bundle adjustment - Exploiting sparsity - Constrained structure and motion - Hierarchical motion estimation - Fourier-based alignment - Incremental refinement T7: Count lines with an HT line finder. How well does it work? T8: Implement a mean shift segmenter.	
Unit-5 – Image Rendering	9 Hour
Motion models - Planar perspective motion - Rotational panoramas - Gap closing - Cylindrical and spherical coordinates - Bundle adjustment - Parallax removal - Recognizing panoramas – Compositing T9: Case Study T10: Case Study	

Learning Resources	<ol style="list-style-type: none"> 1. RichardSzeliski, "Computer Vision: Algorithms and Applications", Springer, 2010. 2. Forsyth/Ponce, "ComputerVision: AModernApproach", PearsonEducationIndia;2edition (2015) 3. S. Nagabhushana, "Computer Vision and Image Processing", NewAge International Pvt Ltd; First edition (2005) 4. Rafael C. Gonzales"Digital Image Processing", Pearson Education; Fourth edition (2018)
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Mr. N. Mohanraj, Software Engineer 2, Pay Pal Inc, Chennai	1. Dr. A.P. Shanthi, CEG Campus Anna University	1. Dr.T.Veeramakali, SRMIST

Course Code	21CSE527T	Course Name	TEXT MINING AND ANALYTICS	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Understand the fundamentals of text mining	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Utilize text for prediction techniques															
CLR-3:	Understand the relevance between information retrieval and text mining															
CLR-4:	Understand the goals of information extraction															
CLR-5:	Analyze different case studies related to text mining															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Acquire knowledge on fundamentals of text mining	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
CO-2:	Perform prediction from text and evaluate it	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-3:	Perform document matching	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-4:	Identify patterns and entities from text	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-
CO-5:	Understand how text mining is implemented	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

Unit-1 - Overview of Text Mining	9 Hour
Overview of text mining-Special about Text Mining-Structured Data-Unstructured Data-Is text different from numbers-Types of Problem can be solved. -Document Classification-Informational Retrieval-Prediction and Evaluation From Textual Information to Numerical Vectors-Collecting Documents-Document Standardization-Tokenization-Lemmatization-Inflectional Stemming-Stemming to a Root-Vector Generation for Prediction-Multiword Features T1 - String Tokenization- Stemming T2- Root vector Generation T3 – Multiword Features	
Unit-2 - Textual Predication	9 Hour
Labels for the Right Answers-Feature selection by attribute ranking-Sentence-Boundary Determination-Part of speech Tagging-Word Sense Disambiguation-Phrase Recognition-Named Entity Recognition-Parsing-Feature Generation-Using text for prediction-Recognizing that document Fit a pattern-Document Classification-Learning to Predict from Text-Similarity and Nearest-Neighbor Method-Document Similarity-Decision Rules-Decision Trees-Scoring by Probabilities T4 - Attribute Ranking using Feature Selection T5 – Text Similarity Practice T6- Decision Tree	

Unit-3 - Information Retrieval for Text Mining	9 Hour
Linear scoring Methods-Evaluation of Performance-Estimating current and future performance-Getting the most from a Learning Method-Errors and Pitfalls in Big data Evaluation-Graph models for social Networks-Information Retrieval and Text Mining-Keyword Search-Nearest-Neighbor Methods-Measuring Similarity-Shared Word Count-Word count and Bonus-Cosine Similarity-Web based Document Search-Link Analysis-Document Matching-Inverted List-Evaluation of Performance T7- Assigning Scores using Linear Scoring method, T8 - Finding Cosine Similarity of Given Text T9 – Web Based Document Search	
Unit-4 - Finding Structure in Document Collection	9 Hour
Clustering Documents by similarity-Similarity of composite documents-K-means Clustering-Hierarchical Clustering-The EM Algorithm-Goals for Information Extraction-Finding Patterns and Entities from Text-Entity Extraction as Sequential Tagging-Tag Prediction as Classification-The maximum Entropy method-Linguistic Features and Encoding-Local Sequence Prediction Models-Global sequence Prediction Models-Reference and relationship Extraction-Template Filling And Database Construction-Commercial Extraction System: Application-Criminal Justice : Application-Intelligence Application T10- Implementing K-means Clustering T11- EM Algorithm implementation T12 – Template Filling and Database Construction practice	
Unit-5 - Case Studies	9 Hour
Ideal Model of Data-Practical Data Sourcing-Prototypical Examples-Hybrid Example-Mixed Data in Standard Table Format-Case study: Market Intelligence from the web-Case Study: Lightweight Document Matching for Digital Libraries-Generating Model cases for Help desk Application: case study-Assigning topics to news articles: Case study-E-mail Filtering: Case study-Search Engines : case study Extracting Named Entities from Documents-Mining Social Media-Customized Newspapers-Emerging Directions-Different ways of collecting samples-Learning to-Unlabeled data-Distributed Text Mining T13- Case study Analysis for Search Engines T14- Hybrid Exercise Practice T15- social media – Data customized	

Learning Resources	1. By Sholom M. Weiss, Nitin Indurkha, Tong Zhang., Fundamentals of Predictive Text Mining 2010 2. Text Mining Classification, Clustering, and Applications, By Ashok N. Srivastava, Mehran Sahami, 2009 3. Springer- ISBN:9781849962261, 184996226X
---------------------------	--

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	15%	-	15%	-	15%	-
Level 2	Understand	25%	-	20%	-	25%	-
Level 3	Apply	30%	-	25%	-	30%	-
Level 4	Analyze	30%	-	25%	-	30%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	5%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
1. Ms.Sabna Sulamain,Nokia	1. Dr.M.Venkatesan, IITM	1. Dr.A.Murugan,SRMIST

Course Code	21CSE529T	Course Name	WEB INTELLIGENCE	Course Category	E	PROFESSIONAL ELECTIVE	L	T	P	C
							2	1	0	3

Pre-requisite Courses	Nil	Co- requisite Courses	Nil	Progressive Courses	Nil
Course Offering Department	School of Computing	Data Book / Codes / Standards	Nil		

Course Learning Rationale (CLR):		Program Outcomes (PO)												Program Specific outcomes		
		1	2	3	4	5	6	7	8	9	10	11	12	PSO-1	PSO-2	PSO-3
CLR-1:	Learn the Environment and Foundations of Business Intelligence	Engineering Knowledge	Problem Analysis	Design/development of solutions	Conduct investigations of complex problems	Modern Tool Usage	The engineer and society	Environment & Sustainability	Ethics	Individual & Team Work	Communication	Project Mgt. & Finance	Life Long Learning			
CLR-2:	Know to explore Web Usage Data Pre-processing															
CLR-3:	Utilize Sentimental Analysis in applications															
CLR-4:	Explore the Web Usage Based Adaptive Systems															
CLR-5:	Implement Recommender Systems in applications															
Course Outcomes (CO):		At the end of this course, learners will be able to:														
CO-1:	Discover Foundations in Web Intelligence	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
CO-2:	Explore web Usage data Preprocessing and its tools	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO-3:	Explore and Implement Sentimental Analysis using Web intelligence	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-4:	Implement Web Usage Based Adaptive Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO-5:	Develop Web Intelligence based Recommendation Systems	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

Unit-1 - Introduction: Web Intelligence	9 Hour
Web Information System Environment and Foundations: Web information description and query languages- the semantic Web-Web information system development tools, Web Human-Media Engineering: Web page design-information representation-information processing-visualization of Web information, Web Information Management: information transformation, Internet and Web-based data management: OLAP (on-line analytical processing)- Web knowledge management- web page automatic generation and updating-Web security, integrity, privacy and trust. The Web Operation- Parsing Common Document Types: Representing Styled Text- Approaches for Modeling the Web User Behaviour T1: Ruby's TextResource class: Plain Text, Binary Document Formats, HTML and XHTML, OpenDocument, RSS T2: Handling Document Formats (PDF) T3: Handling Document Formats (Word)	
Unit-2 - Web Usage Data Pre-processing	9 Hour
Data Sources and Collection: Nature of Web Usage Data- Merging and Cleaning Data, Web Session Reconstruction and User Identification: Heuristics and Methods for Sessionization- Dealing with Incomplete Information- Model Assessment for Sessionization Algorithms. Discovering Usage Patterns for Web: Web Usage Data Collection- Web Usage Data Preprocessing- Web Usage Pattern Discovery - Application of Web Usage Patterns. Cleaning, Segmenting, and Spell-Checking Text: Extracting All Text from Any XML File- Segmenting Text- Stemming Text. T4: Spell-Checking Text T5: Recognizing and Removing Noise Characters from Text T6: Custom Text Processing	

Unit-3 - Sentimental Analysis	9 Hour
Web Opinion Mining (WOM): Aspect-Based Opinion Mining- Document Level Opinion Mining. Sources for Web Opinion Mining: Blogs, News and Forums, Twitter, Other Media. Natural Language Processing: Automating Text Categorization: Using Word-Count Statistics for Categorization- Bayesian Classifier for Categorization- LSI for Categorization, Clustering Text Documents: K-means Document Clustering T7: Supporting Indexing and Search. T8: Using Web Scraping to Create Semantic Relations. T9: Taking Advantage of Linked Data	

Unit-4 - Web Usage Based Adaptive Systems	9 Hour
An Overview on Web Usage Based Adaptive Systems- Web Usage Based Adaptive Systems Evolution- Process Framework: Domain Model- User Model- Adaptation Model- Approaches for Web Usage Based Systems: Content Adaptation- Navigation Adaptation- Presentation Adaptation- Privacy Issues in User Data Collection and Usage. T10: Using RDF and RDFS Data Formats T11: Data Quality Evaluation Tweets Performing SPARQL Queries T12: Code Implementing SPARQL Endpoint Web Portals	

Unit-5 - Recommender Systems	9 Hour
Introduction - Classification of Recommender Systems: Rule-Based Recommender Systems- Content-Based Recommender Systems- Collaborative Filtering Recommender Systems- Hybrid Recommender Systems- Sources of Knowledge for Recommender Systems: Ratings- Implicit Feedback- Social Tags- Online Social Networks – Context- Heterogeneous Sources of Knowledge. Evaluation Metrics for Recommender Systems: Prediction-Based Metrics- Information Retrieval Related Metrics- Diversity, Novelty and Coverage- T13: Learning user profiles T14: Extracting Significant Information from Tweets T15: Combining the TextResource Class with NLP	

Learning Resources	1. Marks Watson, "Scripting Intelligence: Web 3.0 Information Gathering and Processing", Apress, 2009	4. Shroff, Gautam (January 2014). The Intelligent Web: Search, smart algorithms, and big data, Oxford University Press
	2. Juan D. Velásquez, Vasile Palade, and Lakhmi C. Jain, "Advanced Techniques in Web Intelligence-2 Web User Browsing Behaviour and Preference Analysis"	5. Richard Chbeir, Youakim Badr, Ajith Abraham Aboul-Ella Hassanien, "Emergent Web Intelligence: Advanced Information Retrieval" Springer, 2010
	3. Ning Zhong, Jiming Liu, Yiyu Yao, "Web Intelligence", Springer, 2003	

Learning Assessment							
	Bloom's Level of Thinking	Continuous Learning Assessment (CLA)				Summative Final Examination (40% weightage)	
		Formative CLA-1 Average of unit test (50%)		Life-Long Learning CLA-2 (10%)			
		Theory	Practice	Theory	Practice	Theory	Practice
Level 1	Remember	40%	-	20%	-	40%	-
Level 2	Understand	40%	-	20%	-	40%	-
Level 3	Apply	10%	-	20%	-	10%	-
Level 4	Analyze	10%	-	20%	-	10%	-
Level 5	Evaluate	-	-	10%	-	-	-
Level 6	Create	-	-	10%	-	-	-
	Total	100 %		100 %		100 %	

Course Designers		
Experts from Industry	Experts from Higher Technical Institutions	Internal Experts
		1. Dr. Paul T Sheeba, SRMIST



SRM INSTITUTE OF SCIENCE AND TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

**Kattankulathur, Chengalpattu District 603203, Tamil Nadu,
India**