Faculty of
Engineering and Technology

SRM UNIVERSITY
(Under section 3 of UGC Act 1956)

Curriculum, Pre-Requisites/ Co-Requisites Chart, and Syllabus for B.Tech

UNDER CHOICE BASED FLEXIBLE CREDIT SYSTEM

REGULATIONS 2015

(For students admitted from 2015-16 onwards)

Specialization	:	Electronics and Communication Engineering
Offering Department	:	Electronics and Communication Engineering

Placed in the 32nd Academic Council Meeting held on 23rd July 2016

CONTENTS

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

B.TECH ELECTRONICS AND COMMUNICATION ENGINEERING CHOICE BASED FLEXIBLE CREDIT SYSTEM (CBFCS) Curriculum Under Regulations 2015 (For students admitted from 2015-16 onwards)

L	Lecture Hours / Week	T	Tutorial Hours / Week	C	Credits	P	Practical Hours / Week	L	Laboratory Course	E	Elective Courses	J	Theory jointly with Lab	M	Course with Multidisciplinary content

Category	Category - wise % of Credits	Year 1												Year 2											
		1st Semester						2nd Semester						1st Semester						2nd Semester					
		Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C
Arts & Humanities-G	8.33%	15LE101	English	2	0	0	2	15LE102	Value Education	2	0	0	2	15LE201E	German Language I	2	0	0	2	15LE207E	German Language II	2	0	0	2
		15PD101	Soft Skills I	1	1	0	1	15PD102	Soft Skills II	1	1	0	1	15LE202E	French Language I					15LE208E	French Language II				
								15NC101	NCC- National Cadet Corps	0	0	1	1	15LE203E	Japanese Language I					15LE209E	Japanese Language II				
								15NS101	NSS- National Service Scheme					15LE204E	Korean Language I					15LE210E	Korean Language II				
								15SP101	NSO- National Sports Organization					15LE205E	Chinese Language I					15LE211E	Chinese Language II				
								15YG101	Yoga					15PD201	Quantitative Aptitude & Logical Reasoning –I	1	1	0	1	15PD202	Verbal Aptitude	1	1	0	1
	15		Total	3	1	0	3		Total	3	1	1	4		Total	3	1	0	3		Total	3	1	0	3
Basic Sciences - B	19.44%	15MA101	Calculus And Solid Geometry	3	1	0	4	15MA102	Advanced Calculus And Complex Analysis	3	1	0	4	15MA201	Transforms And Boundary Value Problems	4	0	0	4	15MA209	Probability And Random Process	4	0	0	4
		15PY101	Physics	3	0	0	3	15PY102L	Materials Science	2	0	2	3												
		15PY101L	Physics Laboratory	0	0	2	1	15CY102	Principles of Environmental Science	2	0	0	2												
		15CY101	Chemistry	3	0	0	3																		
		15CY101L	Chemistry Laboratory	0	0	2	1																		
		15BT101	Biology For Engineers	2	0	0	2																		
	35		Total	11	1	4	14		Total	7	1	2	9			4	0	0	4		Total	4	0	0	4
Engineering Sciences -E	8.33%	15CE101	Basic Civil Engineering	2	0	0	2	15ME101	Basic Mechanical Engineering	2	0	0	2												
		15EE101	Basic Electrical Engineering	2	0	0	2	15EC101	Basic Electronics Engineering	2	0	0	2												
		15ME105L	Engineering Graphics	1	0	4	3	15EC102L	Electronics Engineering Practices	0	0	2	1												
		15CS101L	Programming Laboratory	1	0	2	2	15EE102L	Electrical Engineering Practices	0	0	2	1												
	15		Total	6	0	6	9		Total	4	0	4	6		Total	0	0	0	0		Total	0	0	0	0
Professional - Core -P	40.56%							15EE103	Analysis of Electric Circuits	3	0	0	3	15EC201J	Electron Devices	3	0	2	4	15EC202	Electronic Circuits	3	0	0	3
								15EE103L	Electric Circuits Laboratory	0	0	2	1	15EC203J	Digital Systems	3	0	2	4	15EC204J	Linear Integrated Circuits	3	0	2	4
														15EC205	Signals and Systems	3	1	0	4	15EC212L	Electronic Circuits Laboratory	0	0	3	2
														15EC207	Electromagnetics and Transmission Lines	3	0	0	3	15EE211	Control Systems	3	0	0	3
	73		Total	0	0	0	0		Total	3	0	2	4		Total	12	1	4	15		Total	9	0	5	12
Prof - Electives -P	8.33%																				**Dept Elective-I**	**3**	**0**	**0**	**3**
	18		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0		Total	3	0	0	3
Project / Seminar / Internship-P	8.33%																								
	21		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0
Open Electives	`																								
	6		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0
Total	**180**			**20**	**2**	**10**	**26**			**17**	**2**	**9**	**23**			**19**	**2**	**4**	**22**			**19**	**1**	**5**	**22**
			Contact hours	**32**					**Contact hours**	**28**					**Total contact hours**	**25**					**Total Contact hours**	**25**			

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

B.TECH ELECTRONICS AND COMMUNICATION ENGINEERING CHOICE BASED FLEXIBLE CREDIT SYSTEM (CBFCS) Curriculum Under Regulations 2015 (For students admitted from 2015-16 onwards)

L	Lecture Hours / Week	T	Tutorial Hours / Week	C Credits	P Practical Hours / Week	L	Laboratory Course	E Elective Courses	J	Theory jointly with Lab	M Course with Multidisciplinary content

	Year 3												Year 4										
	1st Semester					2nd Semester						1st Semester						2nd Semester					
Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C	Course Code	Course Title	L	T	P	C
15PD301	Communication & Reasoning Skills	1	1	0	1	15PD302	Quantitative Aptitude & Logical Reasoning –II	1	1	0	1												
	Total	1	1	0	1		Total	1	1	0	1		Total	0	0	0	0		Total	0	0	0	0
15MA302	Discrete Mathematics	4	0	0	4																		
	Total	4	0	0	4		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0
	Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0
15EC301	Microprocessor, Microcontroller and Interfacing Techniques	3	0	0	3	15EC302J	VLSI Design	3	0	2	4	15EC401M	Multidisciplinary Design	2	2	0	3						
15EC303	Digital Signal Processing	3	1	0	4	15EC304	Antenna and Wave Propagation	3	0	0	3	15EC403	Wireless Communication	3	0	0	3						
15EC305J	Communication Systems	3	0	2	4	15EC306J	Digital Communication	3	0	2	4	15EC405J	Computer Communication	3	0	2	4						
15EC311L	Processor Laboratory	0	0	3	2							15EC407	Microwave Theory and Techniques	3	0	0	3						
												15EC409	Optical Communication	3	0	0	3						
												15EC411L	Microwave and Optical Communication Laboratory	0	0	3	2						
	Total	9	1	5	13		Total	9	0	4	11		Total	14	2	5	18		Total	0	0	0	0
	Dept Elective-II	**3**	**0**	**0**	**3**		**Dept Elective-III**	**3**	**0**	**0**	**3**		**Dept Elective-V**	**3**	**0**	**0**	**3**						
							Dept Elective-IV	**3**	**0**	**0**	**3**		**Dept Elective-VI**	**3**	**0**	**0**	**3**						
	Total	3	0	0	3		Total	6	0	0	6		Total	6	0	0	6		Total	0	0	0	0
15EC375L / 15EC380L / 15EC385L / 15EC490L	Minor Project I / Seminar I / MOOC I / Industry Module I	0	0	3	2	15EC376L / 15EC381L / 15EC386L / 15EC491L	Minor Project II / Seminar II / MOOC II / Industry Module II	0	0	3	2							15EC496L	Major Project	0	0	24	12
						15EC390L	Internship / Industrial Training (To be done after Level-2)	0	0	3	2												
	Total	3	0	3	2		Total	3	0	6	4		Total	29	2	0	3		Total	0	0	24	12
	Open Elective I	3	0	0	3		**Open Elective II**	3	0	0	3												
	As per list / as taken by the student						As per list / as taken by the student																
	Total	3	0	0	3		Total	3	0	0	3		Total	0	0	0	0		Total	0	0	0	0
		23	**2**	**8**	**26**			**22**	**1**	**10**	**25**			**49**	**4**	**5**	**24**			**0**	**0**	**24**	**12**
	Total Contact hours	**33**					**Total contact hours**	**33**					**Total contact hours**	**26**					**Total contact hours**	**24**			

B.Tech. (Full Time) - Electronics and Communication Engineering

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Choice Based Flexible Credit System (CBFCS)
Semester-Wise List of Courses (2015 – 16 onwards)

Level-I / Semester-I

Course Code	Course Title	Category	L	T	P	C	Page No.
15LE101	English	G	2	0	0	2	-
15PD101	Soft Skills-I	G	1	1	0	1	-
15MA101	Calculus and Solid Geometry	B	3	1	0	4	-
15PY101	Physics	B	3	0	0	3	-
15PY101L	Physics Laboratory	B	0	0	2	1	-
15CY101	Chemistry	B	3	0	0	3	-
15CY101L	Chemistry Laboratory	B	0	0	2	1	-
15BT101	Biology For Engineers	B	2	0	0	2	-
15CE101	Basic Civil Engineering	E	2	0	0	2	-
15EE101	Basic Electrical Engineering	E	2	0	0	2	-
15ME105L	Engineering Graphics	E	1	0	4	3	-
15CS101L	Programming Laboratory	E	1	0	2	2	-
	Total		**20**	**2**	**10**	**26**	**-**

Level-I / Semester-II

Course Code	Course Title	Category	L	T	P	C	Page No.
15LE102	Value Education	G	2	0	0	2	-
15PD102	Soft Skills-II	G	1	1	0	1	-
15NC101 / 15NS101 / 15SP101 / 15YG101	NCC- National Cadet Corps / NSS- National Service Scheme / NSO- National Sports Organization / Yoga	G	0	0	1	1	-
15MA102	Advanced Calculus and Complex Analysis	B	3	1	0	4	-
15PY102L	Materials Science	B	2	0	2	3	-
15CY102	Principles of Environmental Science	B	2	0	0	2	-
15ME101	Basic Mechanical Engineering	E	2	0	0	2	-
15EC101	Basic Electronics Engineering	E	2	0	0	2	2
15EC102L	Electronics Engineering Practices	E	0	0	2	1	4
15EE102L	Electrical Engineering Practices	E	0	0	2	1	-
15EE103	Analysis of Electric Circuits	P	3	0	0	3	-
15EE103L	Electric Circuits Laboratory	P	0	0	2	1	-
	Total		**17**	**2**	**9**	**23**	**-**

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Choice Based Flexible Credit System (CBFCS)
Semester-Wise List of Courses (2015 – 16 onwards)

Level-II / Semester-I

Course Code	Course Title	Category	L	T	P	C	Page No.
15LE201E / 15LE202E / 15LE203E / 15LE204E / 15LE205E /	German Language-I / French Language-I / Japanese Language-I / Korean Language-I / Chinese Language-I	G	2	0	0	2	-
15PD201	Quantitative Aptitude & Logical Reasoning –I	G	1	1	0	1	-
15MA201	Transforms And Boundary Value Problems	B	4	0	0	4	-
15EC201J	Electron Devices	P	3	0	2	4	7
15EC203J	Digital Systems	P	3	0	2	4	10
15EC205	Signals and Systems	P	3	1	0	4	13
15EC207	Electromagnetics and Transmission Lines	P	3	0	0	3	16
	Total		**19**	**2**	**4**	**22**	**-**

Level-II / Semester-II

Course Code	Course Title	Category	L	T	P	C	Page No.
15LE207E / 15LE208E / 15LE209E / 15LE210E / 15LE211E /	German Language-II / French Language-II / Japanese Language-II / Korean Language-II / Chinese Language-II	G	2	0	0	2	-
15PD202	Verbal Aptitude	G	1	1	0	1	-
15MA209	Probability And Random Process	B	4	0	0	4	-
15EC202	Electronic Circuits	P	3	0	0	3	19
15EC204J	Linear Integrated Circuits	P	3	0	2	4	22
15EC212L	Electronic Circuits Laboratory	P	0	0	3	2	25
15EE211	Control Systems	P	3	0	0	3	-
	Department Elective-I		3	0	0	3	79-93
	Total		**19**	**1**	**5**	**22**	**-**

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Choice Based Flexible Credit System (CBFCS)
Semester-Wise List of Courses (2015 – 16 onwards)

Level-III / Semester-I

Course Code	Course Title	Category	L	T	P	C	Page No.
15PD301	Communication and Reasoning Skills	G	1	1	0	1	-
15MA302	Discrete Mathematics	B	4	0	0	4	-
15EC301	Microprocessor, Microcontroller and Interfacing Techniques	P	3	0	0	3	28
15EC303	Digital Signal Processing	P	3	1	0	4	31
15EC305J	Communication Systems	P	3	0	2	4	34
15EC311L	Processor Laboratory	P	0	0	3	2	37
	Dept Elective-II	P	3	0	0	3	94-130
15EC375L / 15EC380L / 15EC385L / 15EC490L	Minor Project-I / Seminar-I / MOOC-I / Industry Module-I	P	0	0	3	2	39-48
	Open Elective-I	P	3	0	0	3	-
	Total		**20**	**2**	**8**	**26**	**-**

Level-III / Semester-II

Course Code	Course Title	Category	L	T	P	C	Page No.
15PD302	Quantitative Aptitude & Logical Reasoning–II	G	1	1	0	1	-
15EC302J	VLSI Design	P	3	0	2	4	50
15EC304	Antenna and Wave Propagation	P	3	0	0	3	53
15EC306J	Digital Communication	P	3	0	2	4	56
	Department Elective-III	P	3	0	0	3	94-130
	Department Elective-IV	P	3	0	0	3	94-130
15EC376L / 15EC381L / 15EC386L / 15EC491L	Minor Project-II / Seminar-II / MOOC-II / Industry Module-II	P	0	0	3	2	39-48
15EC390L	Internship / Industrial Training*	P	0	0	3	2	39-48
	Open Elective-II	P	3	0	0	3	-
	Total		**19**	**1**	**10**	**25**	**-**

* To be done after Level-2

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Choice Based Flexible Credit System (CBFCS)
Semester-Wise List of Courses (2015 – 16 onwards)

Level-IV / Semester-I

Course Code	Course Title	Category	L	T	P	C	Page No.
15EC401M	Multidisciplinary Design	P	2	2	0	3	60
15EC403	Wireless Communication	P	3	0	0	3	63
15EC405J	Computer Communication	P	3	0	2	4	65
15EC407	Microwave Theory and Techniques	P	3	0	0	3	68
15EC409	Optical Communication	P	3	0	0	3	71
15EC411L	Microwave and Optical Communication Laboratory	P	0	0	3	2	74
	Department Elective-V	P	3	0	0	3	131-161
	Department Elective-VI	P	3	0	0	3	131-161
	Total		**20**	**2**	**5**	**24**	**-**

Level-IV / Semester-II

Course Code	Course Title	Category	L	T	P	C	Page No.
15EC496L	Major Project	P	0	0	24	12	77
	Total		**0**	**0**	**24**	**12**	**-**
		Grand Total of Credits				**180**	**-**

Choice Based Flexible Credit System (2015 – 16 onwards)
Department Electives

Course Code	Course Title	L	T	P	C	Page No.
Department Elective - I						
15EC221E	Nano Scale Devices	3	0	0	3	80
15EC222E	Opto Electronics	3	0	0	3	82
15EC223E	Electronic Testing	3	0	0	3	84
15EC224E	Electronics Packaging	3	0	0	3	86
15EC225E	Electronic Measurements & Instrumentation	3	0	0	3	89
15EC226E	Sensors and Transducers	3	0	0	3	92
Department Elective - II, III and IV						
15EC321E	Electromagnetic Interference and Electromagnetic Compatibility	3	0	0	3	95
15EC322E	Fundamentals of MEMS	3	0	0	3	98
15EC323E	Embedded System Design	3	0	0	3	101
15EC324E	Introduction to Multimedia Communications	3	0	0	3	103
15EC325E	Digital Logic Design with PLDs and VHDL	3	0	0	3	105
15EC326E	Embedded C	3	0	0	3	107
15BM324E	Principles of Bio Medical Instrumentation	3	0	0	3	-
15EC327E	ASIC Design	3	0	0	3	110
15EC328E	CMOS Analog IC Design	3	0	0	3	112
15EC329E	Communication Switching Techniques	3	0	0	3	114
15CS253E	Speech Recognition System	3	0	0	3	-
15EC330E	Radar And Navigational Aids	3	0	0	3	116
15EC331E	Advanced Digital Signal Processing	3	0	0	3	118
15EC332E	Advanced Microcontrollers	3	0	0	3	120
15EC333E	Communication Network Protocols	3	0	0	3	122
15EC334E	Communication for Micro/ Nano Robots	3	0	0	3	124
15EC335E	Fundamentals of RF System Design	3	0	0	3	127
15EC336E	Adhoc and Sensor Networks	3	0	0	3	129
15CS325E	Digital Image Processing	3	0	0	3	-

B.Tech. (Full Time) - Electronics and Communication Engineering
Faculty of Engineering and Technology, SRM University

Choice Based Flexible Credit System (2015 – 16 onwards)
Department Electives

Course Code	Course Title	L	T	P	C	Page No.
Department Elective - V and VI						
15EC421E	Multigate Transistors.	3	0	0	3	132
15EC422E	Design of Microwave Integrated Circuits	3	0	0	3	134
15CS423E	Software Defined Networks	3	0	0	3	-
15EC423E	Advanced Mobile Communication Systems	3	0	0	3	136
15EC424E	Indoor Radio Planning	3	0	0	3	138
15EC425E	Telecommunications Management Network	3	0	0	3	140
15EC426E	Satellite Communication and Broadcasting	3	0	0	3	142
15CS254E	Mobile and Pervasive Computing	3	0	0	3	-
15EC430E	Cryptography and Network Security	3	0	0	3	145
15EC431E	Photonics and Optical Networks	3	0	0	3	147
15EE459E	Solar Photovoltaic Systems	3	0	0	3	-

All core / elective courses will be listed / delisted every semester, under open electives, based on the availability of resources and demand

Choice Based Flexible Credit System (2015 – 16 onwards)
Courses Customised to Other Departments

Course Code	Course Title	L	T	P	C	Offered To	Page No.
15EC323E	Embedded System Design	3	0	0	3	CSE	101
15EC353	Digital Signal Processing Techniques	3	0	0	3	CSE	159
15EC252	Principles of Communication Systems	3	0	0	3	CSE, IT, EEE	154
15EC352E	Introduction to VLSI Design	3	0	0	3	EEE, CSE	157
15EC204J	Linear Integrated Circuits	3	0	2	4	EEE	22
15EC226E	Sensors and Transducers	3	0	0	3	EEE	92
15EC251J	Introduction to Electronic Devices and Circuits	3	0	2	4	BME	151

B.Tech. (Full Time) - Electronics and Communication Engineering

Faculty of Engineering and Technology, SRM University

Choice Based Flexible Credit System (CBFCS)
Cumulative Credits and Categorization of Courses

Level / Semester	L / T / P / C				Category				No. of Credits	Cumulative Credits
	L	**T**	**P**	**C**	**G**	**B**	**E**	**P**		
Level-1 / Semester-I	20	2	10	26	3	14	9	0	26	26
Level-1 / Semester-II	17	2	9	23	4	9	6	4	23	49
Level-2 / Semester-I	19	2	4	22	3	4	0	15	22	71
Level-2 / Semester-II	19	1	5	22	3	4	0	15	22	93
Level-3 / Semester-I	20	2	8	26	1	4	0	21	26	119
Level-3 / Semester-II	19	1	10	25	1	0	0	24	25	144
Level-4 / Semester-I	20	2	5	24	0	0	0	24	24	168
Level-4 / Semester-II	0	0	24	12	0	0	0	12	12	**180**
Total	**134**	**12**	**75**	**180**	**15**	**35**	**15**	**115**	**180**	

STUDENT OUTCOMES

The curriculum and syllabus for B.Tech programs (2013) conform to outcome based teaching learning process. In general, ELEVEN STUDENT OUTCOMES (a-k) have been identified and the curriculum and syllabus have been structured in such a way that each of the courses meets one or more of these outcomes. Student outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire as they progress through the program. Further each course in the program spells out clear instructional objectives which are mapped to the student outcomes.

The student outcomes are:

(a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(d) an ability to function on multidisciplinary teams

(e) an ability to identify, formulate, and solve engineering problems

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in global, economic, environmental, and societal context

(i) a recognition of the need for, and an ability to engage in life-longlearning

(j) a knowledge of contemporary issues

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

C-D-I-O FRAMEWORK

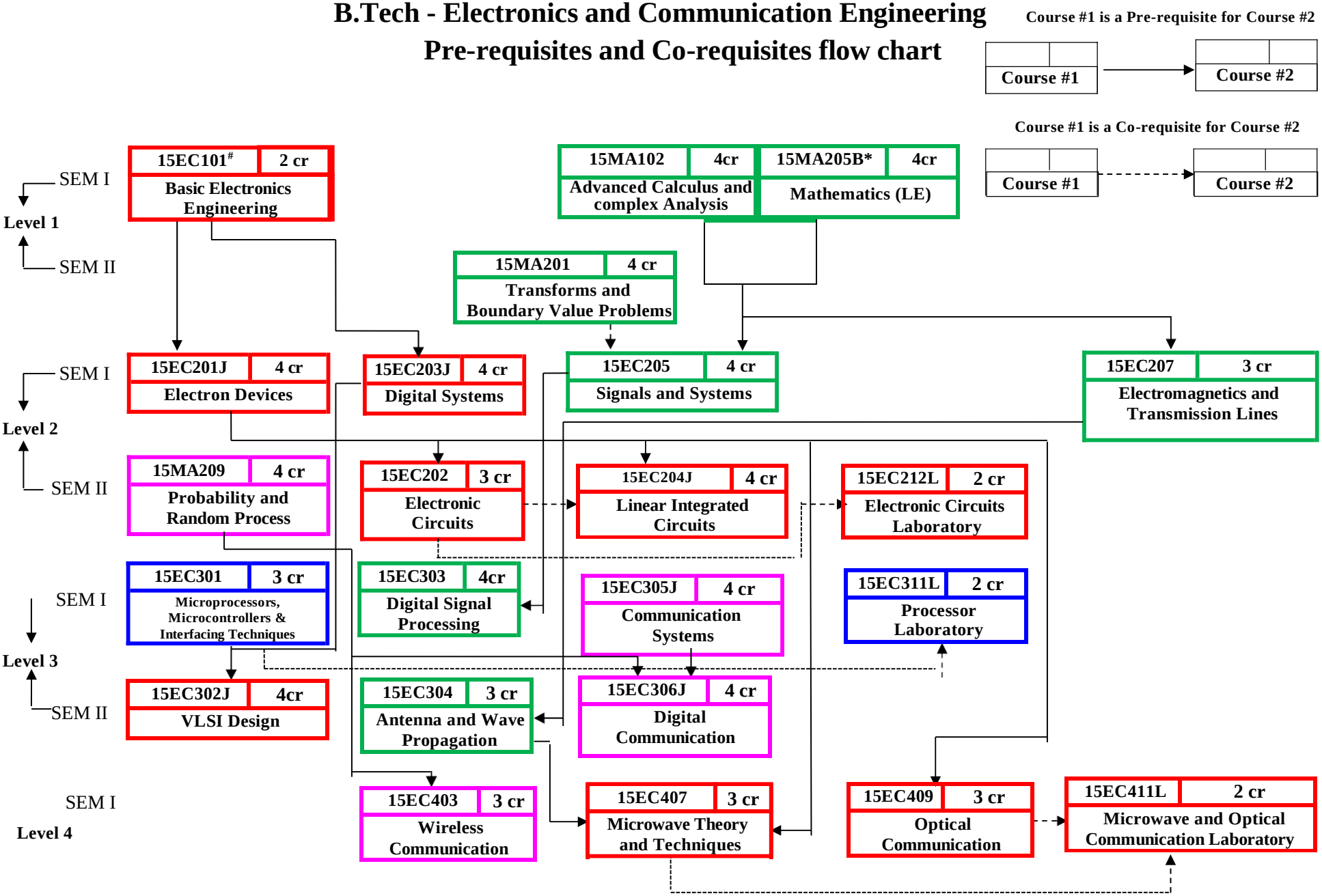
The CDIO Initiative (CDIO is a trademarked initialism for **Conceive** — **Design — Implement — Operate**) is an innovative educational framework for producing the next generation of engineers. The framework provides students with an education stressing engineering fundamentals set in the context of Conceiving — Designing — Implementing— Operating real-world systems and products. Throughout the world, CDIO Initiative collaborators have adopted CDIO as the framework of their curricular planning and outcome-based assessment.

In the syllabus, every topic has been classified under one or more of C-D-I-O so that students and faculty alike are clear about the scope of learning to take place under each one of the topics.

LEGENDS, SYMBOLS AND ABBREVIATIONS

AR	**Architecture Courses**
B	**Courses under Basic Science and Mathematics**
BT	**Biotechnology Courses**
C-D-I-O	**Conceive-Design-Implement-Operate**
CE	**Civil Engineering Courses**
CS	**Computer Science and Engineering Courses**
CY	**Chemistry Courses**
'E'as a prefix in the course code	**Elective Courses**
'E' in the course category	**Courses under Engineering Sciences**
'J'as a prefix in the course code	**Theory cum Lab joint course**
EC	**Electronics and Communication Engineering Courses**
EE	**Electrical and Electronics Engineering Courses**
G	**Courses under Arts and Humanities**
IOs	**Instructional Objectives**
L	**Laboratory / Project / Industrial Training Courses**
LE	**Foreign Language Courses**
L-T-P-C	**L- Lecture Hours Per Week** **T- Tutorial Hours Per Week** **P- Practical Hours Per Week** **C- Credits for a Course**
M	**Courses with Multidisciplinary Content**
MA	**Mathematics Courses**
ME	**Mechanical Engineering Courses**
NC	**NCC- National Cadet Corps**
NS	**NSS – National Service Scheme**
P	**Professional Core Courses**
PD	**Personality Development Courses**
PY	**Physics Courses**
SO/SOs	**Student Outcomes (a-k)**
SP	**NSO- National Sports Organization**
YG	**Yoga Course**

B.Tech - Electronics and Communication Engineering
Pre-requisites and Co-requisites flow chart



Department of Electronics and Communication Engineering			
B. Tech Electronics and Communication Engineering			
Course Code	**Course Title**	**Prerequisite course**	**Co requisite courses**
15EC201J	Electron Devices	15EC101#	Nil
15EC203J	Digital Systems	15EC101#	Nil
15EC205	Signals and Systems	15MA102 / 15MA205B*	15MA201
15EC207	Electromagnetics and Transmission Lines	15MA102	Nil
15EC202	Electronic Circuits	15EC201J	Nil
15EC204J	Linear Integrated Circuits	15EC201J / 15EE208	15EC202$
15EC212L	Electronic Circuits Laboratory	Nil	15EC202
15EC303	Digital Signal Processing	15EC205	Nil
15EC311L	Processor Laboratory	Nil	15EC301
15EC302J	VLSI Design	15EC203J	Nil
15EC304	Antenna and Wave Propagation	15EC207	Nil
15EC306J	Digital Communication	15MA209,15EC305J	Nil
15EC403	Wireless Communication	15MA209	Nil
15EC407	Microwave Theory and Techniques	15EC201J,15EC304	Nil
15EC409	Optical Communication	15EC201J	Nil
15EC411L	Microwave and Optical Communication Laboratory	Nil	15EC407, 15EC409

As the lateral entry students have undergone equivalent courses in their diploma degree, they may be exempted from studying 15EC101 as a pre-requisite

* 15MA205B Mathematics (LE) is a pre-requisite course to 15EC205 & 15EC207 for lateral entry students, and 15MA205B is an equivalent to 15MA102

$ 15EC202 is a co-requisite for 15EC204J only for B.Tech (ECE) program

Level-1 Courses

15EC101	Basic Electronics Engineering			L	T	P	C
				2	0	0	2
Co-requisite:	Nil						
Prerequisite:	Nil						
Data Book / Codes/Standards	Nil						
Course Category	**P**	**Professional Core**		**Electronics**			
Course designed by	Department of ECE						
Approval	30th Academic Council Meeting,24th March, 2016						

Purpose	This course provides comprehensive idea about working principle, operation and characteristics of electronic devices, transducers, Digital Electronics and Communication Systems.			
Instructional Objectives At the end of the course,the learners will be able to gain knowledge about the		**Student Outcomes**		
		H	**M**	**L**
1.	Fundamentals of semiconductor, electronic components/devices, optoelectronic devices and transducers	a		
2.	Principles of digital electronics	e		
3.	Principles of various communication systems	a	e	

H: High correlation, **M:** Medium correlation, **L:** Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Semiconductor Devices	**9**			
1	Overview of Semiconductors, PN junction diode	1	C	1	1
2	Zener diode	1	C	1	1
3	Diode circuits: rectifiers (bridge-type only)	1	C,D	1	1
4	Filters	1	C	1	1
5	Clippers and Clampers	1	C	1	1
6	BJT construction, operation, characteristics (CB,CC,CE configurations) and uses	2	C	1	1
7	JFET and MOSFET construction, operation, characteristics (CS configuration) and uses.	2	C	1	1
	Unit – II : Optoelectronic Devices	**4**			
10	Photoconductive cell - photovoltaic cell - solar cell	1	C	1	1
11	Photodiode - phototransistor	1	C	1	1
12	LED - infrared emitters	1	C	1	1
13	LCD - optocouplers	1	C	1	1
	Unit-III:Transducers	**4**			
14	Basic requirements of transducers - classification of transducers - passive transducers: capacitive, inductive	1	C	1	1
15	LVDT, potentiometric, strain gauge	1	C	1	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
16	Thermistor, Hall-Effect Transducer	1	C	1	1
17	Active transducers- piezoelectric, photoelectric and thermocouple	1	C	1	1
	Unit - IV:Digital Electronics	**7**			
18	Number systems	2	C,D	2	1
19	Binary codes – Binary Arithmetic	1	C,D	2	1
20	Logic gates	1	C,D	2	1
21	Boolean algebra, laws and theorems	1	C,D	2	1
22	Simplification of Boolean expressions	1	C,D	2	1
23	Implementation of Boolean expressions using logic gates Standard forms of Boolean expression	1	C,D	2	1
	Unit- V:Communication Systems	**6**			
24	Block diagram of a basic communication system, Frequency spectrum, Need for modulation, Methods of modulation	1	C	3	1
25	principles of AM, FM, pulse analog and pulse digital modulation	2	C	3	1
26	AM/FM transmitters and receivers(block diagram description only)	1	C	3	1
27	Satellite Communication,Radar systems	1	C	3	1
28	Data transmissionand MODEM	1	C	3	1
	Total contact hours	**30**			

Learning resources (Text books / other reading materials)	
1.	R. Muthusubramanian, S. Salivahanan, *"Basic Electrical and Electronics Engineering"*, Tata McGraw-Hill Education, Reprint 2012.
2.	B. Somanathan Nair, S.R. Deepa, "*Basic Electronics",* I.K. International Pvt. Ltd., 2009.
3.	Thomas L. Floyd, *"Electronic Devices",* Pearson Education, 9th Edition, 2011.
4.	R.K. Rajput, *"Basic Electrical and Electronics Engineering"*, Laxmi Publications, First Edition, 2007.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC102L	Electronics Engineering Practices	L	T	P	C
		0	0	2	1
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**		**Electronics**	
Course designed by	Department of ECE				
Approval	30th Academic Council Meeting,24th March, 2016				

Purpose	To equip the learners with the knowledge of PCB design and fabrication processes.			
Instructional Objectives At the end of the course,the learners will be able to:		**Student Outcomes**		
		H	**M**	**L**
1.	To familiarize the electronic components and basic electronic instruments.	a	k	
2.	To make familiar with PCB design and various processes involved.	b	c	k
3.	To provide in-depth core knowledge in the fabrication of Printed Circuit Boards.	b	c	k
4.	To provide the knowledge in assembling and testing of the PCB based electronic circuits.	k		

H: High correlation, **M:** Medium correlation, **L:** Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Introduction to Basics of Electronic Components and Instruments	**4**			
1.	Study of electronic components- active & passive	1	C	1	1
2.	Electronic Instruments: CRO, Function generator, Power Supply, Multi-meter, IC tester	2	C	1	1
3.	Solder practice	1	I,O	1	1
	Unit-II:Schematic Capture	**6**			
4.	Introduction to ORCAD/TINA schematic capture tool	3	C	2	1,2
5.	Simulation of simple electronic circuit	1	C,D	2	1,2
6.	Schematic to layout transfer	1	C,D	2	1,2
7.	Layout Printing	1	C,D	2	1,2
	Unit-III: **PCB Design Process**	**6**			
8.	Conception Level Introduction: Specifying Parts, Packages and Pin Names, Libraries and Checking foot prints of the components, Partlist, Netlist	3	C,D,I	2	1,3
9.	Making Netlist Files, Placing Parts, Routing Traces, Modifying Traces, Mounting Holes, Adding Text, PCB Layout, DRC, Pattern Transfer.	3	C,D,I	2	1,3
	Unit IV-PCB Fabrication Process	**6**			
10.	Etching, cleaning, drying	3	I,O	3	1,3
11.	Drilling	3	I,O	3	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit V-Assembling and Testing	**8**			
12.	Identifying the components and its location on the PCB	2	D,I	4	1,3
13.	soldering of active and passive components	3	D,I,O	4	1,3
14.	Testing the assembled circuit for correct functionality	3	D,I,O	4	1,3
	Total Contact Hours	**30**			

Learning resources (Text books / other reading materials)	
1.	Department Laboratory Manual for “Electronic Engineering Practices’.
2.	ORCAD/TINA User manual
3.	Raghbir Singh Khandpur,“Printed Circuit Boards: Design, Fabrication, and Assembly”, McGraw-Hill Electronic Engineering, 2006.

Course nature					**Practical**	
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	Quiz/Viva Voce	Model examination	**Total**
	Weightage	40%	5%	5%	10%	**60%**
					End semester examination Weightage :	**40%**

Level-2 / Semester-1 Courses

15EC201J	Electron Devices	L	T	P	C
		3	0	2	4
Co-requisite:	Nil				
Prerequisite:	15EC101				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Electronics**		
Course designed by	Department of ECE				
Approval	30th Academic Council Meeting, 24th March, 2016				

Purpose	The purpose of this course is to provide a basis for understanding various semiconductor devices. It explains how each device operates, discusses device characteristics and parameters, and presents appropriate circuit applications. The lab course will help the learner gain better understanding of the principles of various semiconductor devices and to give them experience with instruments and methods used by technicians and electronic engineers. The main concentration will be on the devices with most emphasis their forward conduction properties.

Instructional Objectives The goals of the course is to ensure that the learners will be able to:		**Student Outcomes**		
		H	**M**	**L**
1.	Understand the operation, characteristics, parameters and specifications of semiconductor diodes and special diodes.	a		
2.	Discuss the operation and performance of important applications of diodes.	b	e	
3.	Explain the bipolar and field-effect transistor construction, operation, characteristics and parameters, as well as its application in amplification and switching.	a, b	e	
4.	Build a circuit, then make functional measurements to understand the operating characteristics of the device / circuit.	b		
5.	Give a specific design problem to the students, which after completion they will verify using modern engineering tools such as PSPICE to carry out design experiments.	k	e	

H: High correlation, **M:** Medium correlation, **L:** Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Semiconductor Diodes	**9**			
1	**Basic semiconductor theory:** Intrinsic & extrinsic semiconductors, Current flow in semiconductors	1	C	1	1, 2,5,6
2	**PN junction theory:** Equilibrium PN junction, Reverse biased PN junction, Forward biased PN junction, Current-Voltage relationship, Calculation of depletion width, potential barrier, diode current, Capacitive effects in PN junction, Energy band structure	5	C	1	1, 2,5,6
3	**PN diodes:** Ideal diode and its current-voltage characteristics, Terminal characteristics and parameters, Diode modeling, DC load line and analysis	3	C	1	1, 2,5,6
	Unit-II: Special Diodes	**9**			
4	Zener diode	1	C	1	1, 2,6

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
5	Backward diode, Varactor diode, Step recovery diode	2	C	1	4
6	Point-contact diode, Metal-semiconductor junctions	2	C	1	4
7	Tunnel diode, Gunn diode, IMPATT diode, PIN diode	2	C	1	4
8	PIN photodiode, Avalanche photodiode, Laser diode	2	C	1	4
	Unit-III: Diode Circuits	**9**			
9	HWR, precision HWR	2	C,D	2	1
10	FWR, bridge rectifier	2	C,D	2	1
11	Rectifiers with filter capacitors	2	C,D	2	1
12	Clippers and Clampers	1	C,D	2	1
13	Voltage multipliers	1	C	2	1
14	Zener diode voltage regulator	1	C,D	2	1
	Unit-IV: Bipolar Junction Transistors	**9**			
15	Physical structure and device operation of BJT	1	C	3	1, 2, 3
16	Current-Voltage characteristics of BJT configurations	2	C	3	1, 2, 3
17	BJT as an amplifier and as a switch	1	C	3	1, 2, 3
18	BJT circuit models (h-parameter & hybrid-π parameter)	1	C	3	1, 2, 3
19	**Classical discrete circuit bias arrangements for BJT and its stabilization analysis:** Base bias, Emitter bias, Voltage-divider bias, Collector-feedback bias	4	C,D	3	1, 2, 3
	Unit-V: MOS Field-Effect Transistors	**9**			
20	Physical structure and device operation of E-MOSFET & D-MOSFET	1	C	3	1, 2, 3
21	I-V characteristics of E-MOSFET, including derivation for drain current and transconductance	2	C	3	1, 2, 3
22	CMOS FET	1	C	3	1, 2, 3
23	MOSFET as an amplifier and as a switch	1	C	3	1, 2, 3
24	MOSFET models	1	C	3	1, 2, 3
25	**Classical discrete circuit bias arrangements for MOSFET:**Gate bias, Self bias, Voltage divider bias	3	C,D	3	1, 2, 3
	Total contact hours	**45**	Exclusive of Assessment hours		

S. No.	Description of Experiments	Contact hours	C-D-I-O	IOs	Reference
1.	PN diode characteristics	2	I,O	1, 4	7, 8
2.	Zener diode characteristics	2	I,O	1, 4	7, 8
3.	Diode rectifier circuits	2	D,I,O	1,2,4	7, 8
4.	Diode clipping and clamping circuits	2	D,I,O	1,2,4	7, 8
5.	Zener diode voltage regulator circuit	2	D,I,O	1,2,4	7, 8
6.	BJT characteristics (either of the configurations)	2	I,O	3,4	7, 8
7.	MOSFET characteristics (either of the configurations)	2	I,O	3,4	7, 8

S. No.	Description of Experiments	Contact hours	C-D-I-O	IOs	Reference
8.	BJT biasing circuits (any two circuit arrangements)	2	D,I,O	3,4	7, 8
9.	MOSFET biasing circuits (any two circuit arrangements)	2	D,I,O	3,4	7, 8
10.	BJT & MOSFET switching	2	D,I,O	3,4	7, 8
11.	Photoconductive Cell, LED, and Solar Cell	2	I,O	1, 2	7, 8
12.	Simulation experiments using PSPICE	8	D, I, O	2,3,5	7, 8
	Total contact hours	**30**			

Learning resources (Text books / other reading materials)	
1.	David A. Bell, *"Electronic Devices and Circuits"*, 5th edition, Oxford University Press, 2015.
2.	Donald Neamen, *"Electronic Circuits: Analysis and Design"*, 3rd edition, McGraw-Hill Education, 2011.
3.	Muhammad Rashid, *"Microelectronic Circuits: Analysis & Design"*, 2nd edition, Cengage Learning, 2010.
4.	Adel S. Sedra, Kenneth C. Smith, *"Microelectronic Circuits: Theory and Applications"*, OUP, 2014.
5.	Robert L. Boylestad and Louis Nashelsky, *"Electronic Devices and Circuit Theory",* Pearson Education, 11th Edition, 2013.
6.	Thomas L. Floyd, *"Electronic Devices",* 9th edition, Pearson Education, 2013.
7.	Laboratory Manual, Department of ECE, SRM University
8.	Muhammed H Rashid, "Introduction to PSpice using OrCAD for circuits and electronics", 3rd edition, Pearson/Prentice Hall, 2004.

Course nature							**Theory + Practical**
Assessment Method for Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle Test-I	Cycle Test-II	Cycle Test-III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**
Assessment Method for Practical Component (Weightage 50%)							
In-semester	**Assessment tool**	Experiments	Record	Quiz/Viva Voce	Model examination		**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**		**60%**
End semester examination Weightage :							**40%**

15EC203J	Digital Systems	L	T	P	C
		3	0	2	4
Co-requisite:	NIL				
Prerequisite:	15EC101				
Data Book / Codes/Standards	NIL				
Course Category	**P**	**Professional Core**	**Computers**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	To develop a strong foundation in analysis, design and implementation of digital electronic circuits.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, learner will be able to		**H**	**M**	**L**
1.	Understand and design combinational and sequential systems.	a,b,c	k	
2.	Analyse the synchronous logic circuits.	b,c	k	
3.	Understand concepts of memory, and design digital systems using Programmable Logic Devices.	b,c	k	
4.	Understand concepts of digital integrated circuits.	a,b,c	k	

H – High Correlation; **M**—Medium Correlation; **L**—Low Correlation;

S. No.	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Binary Codes, Digital Arithmetic and Simplification of Boolean Functions	**9**			
1.	Error detecting and error correcting codes.	2	C	1	1
2.	**Arithmetic:** Arithmetic number representation, Binary arithmetic, Hexadecimal arithmetic, BCD arithmetic.	2	C	1	1,3,4,5
3.	**Minimization of Boolean Functions:** Algebraic simplification, Karnaugh map simplification, Quine-McCluskey or Tabulation method.	5	C,D	1	1-5
	Unit-II: Logic Families	**8**			
4.	**Logic Families:** TTL Logic Family: Totem-pole, open-collector and tristate TTL, Schottkey TTL, standard TTL characteristics.	3	C	4	1,3,4,5
5.	Metal Oxide Semiconductor logic families: N-MOS, P-MOS and CMOS logic circuits, Characteristics of MOS logic, Comparison of MOS logic circuits(CMOS) with that of a TTL digital circuit.	3	C	4	1,3,4,5
6.	**Electrical characteristics:** Fan-out, Propagation Delay, Power dissipation, Noise margin, Supply voltage levels, Operational voltage levels.	2	C	4	1,3,4,5
	Unit-III: Combinational Systems	**9**			
7.	Binary arithmetic units (Adder, subtractor, n-bit parallel adder &subtractor, look ahead carry generator).	2	C,D	1	1-5
8.	Decoder, Encoder, Multiplexer, Demultiplexer.	2	C,D	1	1-5
9.	Code converters, Magnitude comparators, Parity generators, Implementation of combinational logic by	5	C,D	1	1-5

S. No.	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	standard IC's.				
	Unit-IV: Sequential Systems	**10**			
10	**Flip-flop and Latch**: SR latch, JK flip-flop, T flip-flop, D flip-flop and latch, Master-slave RS flip-flop, Master-slave JK flip-flop, asynchronous inputs.	3	C	1	1-5
11	**Registers & Counters:** Shift registers (SISO, SIPO, PISO, PIPO), Universal shift register, Counters: Asynchronous/Ripple counters, Synchronous counters, Modulus-n Counter, Ring counter, Johnson counter, Up-Down counter.	3	C,D	1,2	1-5
12	**Synchronous (Clocked) sequential circuits:** Mealy and Moore model, Analysis and design of synchronous sequential circuits, State machine design with SM charts.	4	C,D	1,2	1-5
	Unit-V: Memory and Programmable Logic	**9**			
13	RAM, memory decoding, ROM.	2	C	1,3	1,3,4,5
14	Programmable Logic Devices (PLDs): Basic concepts, PROM as PLD, Programmable Array Logic (PAL), Programmable Logic Array (PLA).	3	C,D	1,3	1-5
15	Design of combinational and sequential circuits using PLD's.	4	C,D	1,3	1-5
	Total contact hours	**45**	Exclusive of Assessment hours		

S. No.	Description of Experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Design and implementation of Adder and Subtractor using logic gates.	4	D,I,O	1	6
2.	Design and implementation of 2 bit Magnitude Comparator using logic gates.	2	D,I,O	1	6
3.	Design and implementation of encoder and decoder using logic gates.	4	D,I,O	1	6
4.	Design and implementation of Multiplexer and De-multiplexer using logic gates.	2	D,I,O	1	6
5.	Design and implementation of code converters using logic gates.	2	D,I,O	1	6
6.	Implementation of combinational logic functions using standard ICs.	4	D,I,O	1	6
7.	Characteristic table verification of flip-flops.	2	I,O	1,2	6
8.	Construction and verification of 4-bit ripple counter and Mod-10 / Mod-12 ripple counters.	4	I,O	1,2	6
9.	Design and implementation of Synchronous Counters.	4	D,I,O	1,2	6
10.	Construction and verification of shift registers.	2	I,O	1,2	6
	Total contact hours	**30**			

Learning Resources	
1.	Morris Mano M, Michael D. Ciletti, *"Digital Design with an Introduction to the Verilog HDL",* Pearson Education, 5th Edition, 2014.
2.	Charles H Roth (Jr), Larry L. Kinney, *"Fundamentals of Logic Design",* Cengage Learning India Edition, 5th Edition, 2010.
3.	Thomas L. Floyd, *"Digital Fundamentals",* Pearson Education, 10th Edition, 2013.
4.	Ronald J. Tocci, *"Digital System Principles and Applications"*, Pearson Education 10th edition, 2009.
5.	Donald P Leach, Albert Paul Malvino, GoutamSaha, *"Digital Principles and Applications"*, Tata-Mcgraw Hill, 6th Edition, 2008.
6	"LAB MANUAL", Department of ECE, SRM University.

Course nature							**Theory + Practical**
Assessment Method – Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**
Assessment Method – Practical Component (Weightage 50%)							
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination		**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**		**60%**
						End semester examination Weightage :	**40%**

15EC205	Signals and Systems	L	T	P	C
		3	1	0	4
Co-requisite:	15MA201				
Prerequisite:	15MA102 / 15MA205B*				
Data Book / Codes/Standards	NIL				
Course Category	**P**	**Professional Core**	**Signal Processing**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March ,2016				

* for lateral entry students

Purpose	To impart knowledge of fundamentals of signals and systems, and to mathematically analyze different types of signals and their associated systems.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, learner will be able to		**H**	**M**	**L**
1.	Acquire knowledge of various classifications of Signals and Systems	b	a	
2.	Utilize the mathematical computing tool for analysis of signals and systems	b	a	k
3.	Analyze Periodic and Aperiodic Continuous time Signals using Fourier series.	b	a	
4.	Analyze and characterize the Continuous time system through Laplace transform and Fourier transform.	b	a	c
5.	Analyze and characterize the Discrete time system through DFT and Z transform and also realize Discrete time system using Z transform	b	a	c

H – High Correlation; **M**—Medium Correlation; **L—**Low Correlation;

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Classification of Signals and Systems	**12**			
1.	Continuous time signals , Discrete time signals, Basic operations on Signals, Periodic and Aperiodic signals, Even and odd signals	2	C,D	1	1-4
2.	Energy and power signals, Deterministic and random signals, Complex exponential and Sinusoidal signals	2	C,D	1	1-4
3.	Unit step, Unit ramp, Unit impulse, Representation of signals in terms of unit impulse	3	C,D	1	1-4
4.	Continuous time systems, Discrete time systems, Linear system, Time Invariant system	2	C,D	1	1-4
5.	causal system, BIBO system, Systems with and without memory, LTI system	2	C,D	1	1-4
6.	Programs using mathematical computing tool for mathematical operations on CT, DT signals	1	D,I	1,2	6
	Unit-II: Analysis of Continuous Time Signals	**12**			
7.	**Fourier series:** Representation of Continuous time Periodic signals, Trigonometric	2	C,D	3	1-4
8.	Cosine representation and exponential, Symmetry conditions	2	C,D	3	1-4
9.	Properties of Continuous time Fourier series,	2	C,D	3	1-4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Parseval's relation for power signals, Frequency spectrum				
10.	**Fourier transform:** Representation of Continuous time signals, Properties of Continuous time Fourier transform, Parseval's relation for energy signals, Energy density spectrum	3	C,D	4	1-4
11.	Analysis of LTI system using Fourier methods	2	C,D	4	1-4
12.	Programs using mathematical computing tool for Fourier series and Fourier transform of CT	1	D,I	2,4	6
	Unit-III: LTI CT System	**12**			
13.	**System modeling:** Solution of Differential equation with initial conditions, Zero state response and Zero input response	3	C,D	4	1-4
14.	Impulse response, Frequency response	1	C,D	4	1-4
15.	Convolution, Convolution integral	2	C,D	4	1-4
16.	Laplace transform and its properties	2	C,D	4	1-4
17.	Analysis and characterization of LTI system using Laplace transform	3	C,D	4	1-4
18.	Programs using mathematical computing tool for CT system analysis using LT	1	D,I	2,4	6
	Unit-IV: Analysis of DT Signals and Systems	**12**			
19.	Representation of sequences, Discrete Time Fourier Transform (DTFT)	1	C	5	1-6
20.	Discrete Fourier Transform (DFT) and its properties	3	C,D	5	1-6
21.	Solution of linear constant coefficient difference equations with initial conditions, Zero state response and Zero input response	4	C,D	5	1-6
22.	Impulse response, Convolution sum, Frequency response.	3	C,D	5	1-6
23.	Programs using mathematical computing tool for DT system analysis using DFT	1	D,I	2,5	6
	Unit-V: LTI DT System Characterization and Realization	**12**			
24.	Unilateral and Bilateral Z transforms and its properties	2	C,D	5	1-6
25.	Inverse Z transform: Power series expansion and Partial fraction methods	3	C,D	5	1-6
26.	Analysis and characterization of DT system using Z transform	3	C,D	5	1-6
27.	Realization of structures for DT systems, Direct form I, Direct form II, Parallel, Cascade forms	3	C,D	5	1-6
28.	Programs using mathematical computing tool for DT system analysis using ZT	1	D,I	2,5	6
	Total contact hours	**60**	Exclusive of Assessment hours		

Learning Resources	
1.	Alan V Oppenheim, Ronald W. Schafer "Signals & Systems", Pearson Education, 2nd Edition 2015(Imprint).
2.	P.Ramakrishna Rao, Shankar Prakriya, "Signals & Systems", McGraw Hill Education, 2nd Edition, 4th reprint 2015
3.	Simon Haykin and Barry Van Veen, "Signals and Systems", John Wiley & Sons Inc, 2nd Edition, 2007.
4.	Lathi B.P, "Linear Systems & Signals", Oxford Press, Second Edition, 2009.
5.	John G. Proakis and Manolakis, "Digital Signal Processing, Principles, Algorithms and Applications", Pearson Education, 4th Edition, 2007.
6.	A.Nagoor Kani, "Signals & Systems", McGraw Hill Education, 12th reprint 2015.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC207	Electromagnetics and Transmission Lines	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	15MA102 / 15MA205B*				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Communication**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March, 2016				

* for lateral entry students

Purpose	To acquire knowledge on theoretical concepts and analysis techniques to find solutions for problems related to electromagnetic wave propagation and transmission line theory.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, learner will be able to		**H**	**M**	**L**
1.	Gain knowledge on the basic concepts and insights of electric and magnetic fields	a	e	
2.	Emphasize the significance of Maxwell's equations	a	e	
3.	Interpret the wave propagation in guided waveguide	a	e	
4.	Acquire fundamental knowledge on transmission line theory and impedance matching techniques.	a	e	b

H= High Correlation, **M**= Medium Correlation, **L** = Low Correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Electrostatics	**10**			
1.	Introduction to co-ordinate system: Cartesian, Cylindrical and Spherical, Review of vector calculus	2	C	1	1,2,3
2.	Coulomb's law and field intensity: Electric Field due to continues charge distribution, Electric flux density	3	C,D	1	1,2,3
3.	Gauss Law: Applications of Gauss Law	2	C,D	1	1,2,3
4.	Electric potential: Relationship between E and V	1	C	1	1,2,3
5.	Electric dipole and flux lines: Energy density in the electrostatic field	2	C	1	1,2,3
	Unit-II: Magnetostatics and Maxwells Equations	**9**			
6.	Biot Savart Law	1	C	1	1,2,3
7.	Ampere's circuital law: Applications circuital law	2	C,D	1	1,2,3
8.	Magnetic flux density	1	C	1	1,2,3
9.	Maxwell's equation for static fields	1	C	2	1,2,3
10.	Faradays law: Transformer and Motional EMF	1	C	**2**	1,2,3
11.	Displacement current: Maxwell's Equation in Final forms	2	C	2	1,2,3
12.	Time varying potentials	1	C	2	1,2,3
	Unit-III: Electromagnetic Waves and Waveguides	**9**			
13.	Waves in general: Plane waves in Lossless dielectric, Free space, Good Conductor	3	C,D	3	1,2,3,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
14.	Rectangular waveguide: Transverse Magnetic (TM) and Transverse Electric (TE) mode	3	C,D	3	1,2,3,4
15.	wave propagation in guide	1	C,D	3	1,2,3,4
16.	Power Transmission and Attenuation	2	C,D	3	1,2,3,4
	Unit IV: Transmission Line Theory	**9**			
17.	Transmission line parameters	1	C	4	1,2,3,5
18.	Transmission line Equation	2	D	4	1,2,3,5
19.	Input impedance, standing wave ratio	3	C,D	4	1,2,3,5
20.	Power calculation for various cases	3	D	4	1,2,3,5
	Unit V: Transmission Line Calculator and Impedance Matching	**8**			
21.	Smith chart: Solutions to transmission line and stub matching problems using Smith chart	3	D	4	1,2,3,5
22.	Impedance Matching using Quarter wave Transformer, single stub Tuner	3	C	4	1,2,3,5
23.	Impedance Measurement using slotted lines	1	C	4	1,2,3,5
24.	Transmission lines as circuit elements	1	C	4	1,2,3,5
	Total contact hours	**45**	Exclusive of Assessment hours		

Learning Resources	
1.	Matthew N. O. Sadiku., S. V. Kulkarni *"Elements of Electromagnetics",* Oxford University Press, 6th Edition, Asian Edition, 2015
2.	G.S.N.Raju., *"Electromagnetic Field Theory and Transmission Lines",* Pearson Education, First Indian print, 2006
3.	Nannapaneni Narayana Rao, "Principles of Engineering Electromagnetics", Pearson Education, Sixth Edition, 2016.
4.	William H. Hayt,Jr and John A.Buck., *"Engineering Electromagnetics",* Tata McGraw-Hill Publishing Ltd, 8th Edition, 2012
5.	John D.Ryder, *"Networks, Lines and Fields"*, PHI, 2009

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

Level-2 / Semester-2 Courses

15EC202	Electronic Circuits	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	15EC201J				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Electronics**		
Course designed by	Department of ECE				
Approval	30th Academic Council Meeting,24th March, 2016				

Purpose	This course deals with the analysis and design of circuits containing electronic devices, such as diodes and transistors. With the assumed knowledge on physical characteristics and operation of major semiconductor devices, this course introduces basic circuits employing semiconductor devices and its utilization in switching and amplification applications.

Instructional Objectives After completing this course, the learners should be able to do the following:		**Correlates to Student Outcomes**		
		H	**M**	**L**
1.	Analyse and design bipolar and FET amplifier circuits to meet certain specifications.	b	e	
2.	Analyse the frequency response of amplifier circuits, taking into account various circuit capacitors, to determine the bandwidth of the circuit.	b		
3.	Understand the characteristics of the various types of feedback configurations to be able to determine the type of feedback circuit required for a specific design application and to design a stable feedback amplifier.	b	e	
4.	Understand the principle of sine-wave oscillators, and to analyse and design various audio & radio frequency oscillator circuits.	b	e	
5.	Analyse three principle classes of power amplifiers, and determine the maximum possible conversion efficiency of each type of power amplifier.	b, c	e	
6.	Understand how matched transistor characteristics are used in the IC design and to be able to design BJT and MOSFET current sources.	b, c	e	

H: High correlation, **M**: Medium correlation, **L**: Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: BJT Amplifiers	**9**			
1	Overview of DC analysis of BJT circuits and models	1	C	1	1
2	AC load line analysis	1	C	1	1
3	AC analysis of basic BJT amplifier configurations using classical discrete circuit bias arrangements: Common-Emitter, Common-Base, Common-Collector and single-tuned circuits. (analysis using hybrid-π model)	3	C,D	1	1-4
4	Multi-stage amplifier configurations: CE - CE, CE - CC, CE - CB, and CC - CC amplifiers	2	C,D	1	1-4
5	Frequency response analysis of a basic BJT CE amplifier	2	C,D	2	2-4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-II: FET Amplifiers	**9**			
6	Overview of FET DC circuit analysis	1	C	1	1
7	Graphical analysis, load lines, and small-signal models	1	C	1	1
8	AC analysis of basic MOSFET amplifier configurations using classical discrete circuit bias arrangements: Common-Source, Common-Drain and Common-Gate circuits	4	C,D	1	2-4
9	BiFET amplifier configuration	1	C,D	1	1-4
10	Frequency response analysis of FET CS amplifier	2	C,D	2	2-4
	Unit-III: Feedback Amplifiers and Oscillators	**10**			
11	**Feedback amplifiers:** Basic feedback concepts, general feedback structure, properties of negative feedback	1	C	3	1-4
12	Feedback topologies	2	C	3	1-4
13	Practical feedback amplifier circuits	1	D	3	1-4
14	Stability analysis	1	C	3	3-4
15	Frequency compensation	1	C	3	3-4
16	**Oscillators:** Principles of oscillation	1	C	4	1-4
17	Audio-frequency oscillators		C,D	4	1-4
18	Radio-frequency oscillators	1	C,D	4	1-4
19	Crystal oscillators	2	C	4	5
20	Negative-Resistance oscillator (using tunnel diode)		C	4	5
	Unit-IV: Output Stages and Power Amplifiers	**7**			
21	Definitions and amplifier types, Q point placement, maximum dissipation hyperbola, heat sink	2	C	5	1, 5
22	Class A amplifier	1	C,D	5	2-5
23	Class B and Class AB push-pull amplifiers	1	C,D	5	2-5
24	Class C amplifiers	1	C,D	5	2-5
25	Class D and Class E amplifiers	1	C	5	2-6
26	Amplifier distortions	1	C	5	6
	Unit-V: IC Biasing & Amplifiers with Active Load	**10**			
27	IC design philosophy	2	C	6	2, 4
28	**Bipolar transistor current sources:** 2-transistor current source, 3-transistor current source, cascode current source, Widlar current source, and Multi-transistor current source		C,D	6	2, 4
29	**FET current sources:** 2-transistor MOSFET current source, cascode current mirror and Wilson current mirror	2	C,D	6	2, 4
30	Analysis of CE and CS amplifier circuit with active load	2	C,D	6	2, 4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
31	DC and small-signal analysis of basic BJT and FET differential pairs	2	C,D	6	2, 4
32	Analysis of differential amplifier with active loads	2	C,D	6	2, 4
	Total contact hours	**45**	Exclusive of Assessment hours		

Learning resources (books / other reading materials)	
1.	David A. Bell, *"Electronic Devices and Circuits"*, 5th edition, Oxford University Press, 2015.
2.	Donald Neamen, *"Electronic Circuits: Analysis and Design"*, 3rd edition, McGraw-Hill Education, 2011.
3.	Muhammad Rashid, *"Microelectronic Circuits: Analysis & Design"*, 2nd edition, Cengage Learning, 2010.
4.	Adel S. Sedra, Kenneth C. Smith, *"Microelectronic Circuits: Theory and Applications"*, OUP, 2014.
5.	Robert L. Boylestad and Louis Nashelsky, *"Electronic Devices and Circuit Theory",* Pearson Education, 11th Edition, 2013.
6.	Albert P. Malvino, David J. Bates, *"Electronic Principles",* 8th edition, Tata McGraw Hill, 2015.

Course nature					**Theory**		
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC204J	Linear Integrated Circuits	L	T	P	C
		3	0	2	4
Co-requisite:	15EC202$				
Prerequisite:	15EC201J				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**		**Electronics**	
Course designed by	Department of ECE				
Approval	30th Academic Council Meeting, 24th March, 2016				

$ 15EC202 is a co-requisite for 15EC204J only for B.Tech (ECE) program

Purpose	This is a course on the design and applications of operational amplifiers and analog integrated circuits. This course introduces basic op-amp principles and show how the op-amp can be used to solve a variety of application problems. Much attention is given to basic op-amp configurations, linear and non-linear applications of op-amp and active filter synthesis, including switched capacitor configurations. It also deals with oscillators, waveform generators and data converters.

Instructional Objectives The goals of the course is to ensure that the learners become familiar to:		**Correlates to Student Outcomes**		
		H	**M**	**L**
1.	Learn the basics of op-amp, its characteristics, circuit model, its frequency response and compensation, and its internal schematic.	b	k	e
2.	Analyze the operation and discuss the performance of several fundamentally important op-amp circuits that have certain features or characteristics oriented to special applications.	b, c	k	e
3.	Describe the basic operating principles of oscillator and discuss how different types of oscillators produce various types of outputs including sine waves, square waves, triangular waves, and sawtooth waves.	b	k	e
4.	Use popular integrated circuits, such as 555 timer and 565 PLL in a wide variety of oscillator and communication applications.	b, c	k	e
5.	Describe the filter types, filter response characteristics and filter parameters, and analyse the four basic categories of active filters, which are low-pass, high-pass, band-pass, and band-stop.	b	k	e
6.	Discuss the principles of voltage regulation, linear regulator, switching regulator and IC voltage regulators.	b	k	e
7.	Introduce data converter terminology and its performance parameters, and discuss several circuit arrangements for A/D and D/A conversions.	b, c	k	e

H: High correlation, **M:** Medium correlation, **L**: Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Operational Amplifier Characteristics	**9**			
1	Op-amp symbol, terminals, packages and specifications	1	C	1	1
2	Block diagram Representation of op-amp- Ideal op-amp & practical op-amp - Open loop & closed loop configurations	1	C	1	1
3	DC & AC performance characteristics of op-amp	2	C	1	1
4	Frequency response and compensation	2	C	1	1, 2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
5	Basic op-amp internal schematic	2	C	1	1, 2
6	Review of data sheet of an op-amp.	1	C	1	1, 2
	Unit-II: Op–Amp Applications	**9**			
7	**Basic op-amp circuits:** Inverting & Non-inverting voltage amplifiers, Voltage follower, Summing, scaling & averaging amplifiers, AC amplifiers	2	D, I	2	1, 2
8	**Linear Applications:** Instrumentation Amplifiers, V-to-I and I-to-V converters, Differentiators and Integrators	3	D, I	2	1, 2
9	**Non-linear Applications:** Precision Rectifiers, Wave Shaping Circuits (Clipper and Clampers), Log and Antilog Amplifiers, Analog voltage multiplier circuit and its applications, Operational Trans-Conductance Amplifier (OTA), Comparators and its applications, Sample and Hold circuit.	4	D, I	2	1, 2
	Unit-III: Waveform Generators and PLL	**9**			
10	**Waveform Generators:** Sine-wave Generators, Square / Triangle / Saw-tooth Wave generators.	3	D, I	3	1-5
11	**IC 555 Timer:** Monostable operation and its applications, Astable operation and its applications	3	D, I	4	1-5
12	**PLL:** Operation of the Basic PLL, Closed loop analysis of PLL, Voltage Controlled Oscillator, PLL applications	3	C,D,I	4	1-5
	Unit-IV: Active Filters & Voltage Regulator	**9**			
13	**Filters:** Comparison between Passive and Active Networks, Active Network Design , Filter Approximations, Design of LPF, HPF, BPF and Band Reject Filters	3	C,D,I	4	1-5
14	State Variable Filters – All Pass Filters, Switched Capacitor Filters.	3	C,D,I	4	1-5
15	**Voltage Regulators:** Basics of Voltage Regulator, Linear Voltage Regulators using Op-amp, IC Regulators (78xx, 79xx, LM 317, LM 337, 723), Switching Regulators	3	C	5	1-5
	Unit-V: Data Conversion Devices	**9**			
16	**Digital to Analog Conversion:** DAC Specifications, Weighted Resistor DAC	2	C,D,I	6,7	1-5
17	R-2R Ladder DAC and Inverted R-2R Ladder DAC, Monolithic DAC	2	C,D,I	6,7	1-5
18	**Analog to Digital conversion:** ADC specifications, Ramp Type ADC, Successive Approximation ADC	3	C,D,I	6,7	1-5
19	Dual Slope ADC, Flash Type ADC, Monolithic ADC	2	C,D,I	6,7	1-5
	Total contact hours (Exclusive of Assessment hours**)**	**45**			

S. No.	Description of Experiments	Contact hours	C-D-I-O	IOs	Reference
1	Basic op-amp circuits	2	D,I,O	1,2,4	6-10

S. No.	Description of Experiments	Contact hours	C-D-I-O	IOs	Reference
2	Integrators and Differentiators	2	D,I,O	1,2,4	6-10
3	Rectifiers	2	D,I,O	1,2,4	6-10
4	Comparators	2	D,I,O	1,2,4	6-10
5	Wave shaping circuits	2	D,I,O	1,2,4	6-10
6	Waveform generators: using op-amp & 555 Timer	6	D,I,O	1,2,4	6-10
7	Design of LPF, HPF, BPF and Band Reject Filters	4	D,I,O	1,2,4	6-10
8	IC Voltage regulators	2	D,I,O	1,2,4	6-10
9	R-2R ladder DAC	2	D,I,O	1,2,4	6-10
10	Flash Type ADC	2	D,I,O	1,2,4	6-10
11	Simulation experiments using EDA tools	4	D,I,O	1,2,4	6-10
	Total contact hours	**30**			

Learning Resources	
1.	Ramakant A.Gayakwad, "Op-Amps and Linear Integrated Circuits", 4th Edition, Prentice Hall, 2000.
2.	David A. Bell, "Operational Amplifiers and Linear ICs", 3rd edition, OUP, 2013.
3.	Roy Choudhury and Shail Jain, "Linear Integrated Circuits", 4th Edition, New Age International Publishers, 2014.
4.	Robert F. Coughlin, Frederick F. Driscoll, "Operational-Amplifiers and Linear Integrated Circuits", 6th Edition, Prentice Hall, 2001.
5.	Sergio Franco, "Design with operational amplifier and analog integrated circuits", McGraw Hill, 1997
6.	LABORATORY MANUAL, Department of ECE, SRM University
7.	David A Bell, "Laboratory Manual for Operational Amplifiers & Linear ICs", 2nd edition, D.A. Bell, 2001.
8.	David LaLond, "Experiments in Principles of Electronic Devices and Circuits", Delmar Publishers, 1993.
9.	Muhammed H Rashid, "Introduction to PSpice using OrCAD for circuits and electronics", 3rd edition, Pearson/Prentice Hall, 2004.
10.	L. K. Maheshwari, M. M. S. Anand, "Laboratory Experiments and PSPICE Simulations in Analog Electronics", PHI, 2006.

Course nature							**Theory + Practical**
Assessment Method for Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle Test-I	Cycle Test-II	Cycle Test-III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**
Assessment Method for Practical Component (Weightage 50%)							
In-semester	**Assessment tool**	Experiments	Record	Quiz/Viva Voce	Model examination		**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**		**60%**
End semester examination Weightage :							**40%**

15EC212L	Electronic Circuits Laboratory	L	T	P	C
		0	0	3	2
Co-requisite:	15EC202				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Electronics**		
Course designed by	Department of ECE				
Approval	30th Academic Council Meeting,24th March, 2016				

Purpose	This lab course is to train the learners to design and analyze the operation of discrete electronic circuits and understand their functionality. It also supports many experiments and new ideas which are evolved in the mind of students. More emphasis is given to troubleshooting which is designed to simulate realistic circuit faults.

Instructional Objectives At the end of the course, the learner will be able to:		**Correlates to Student Outcomes**		
		H	**M**	**L**
1.	Design, analyze and implement basic discrete electronic circuits such as amplifiers and oscillators using discrete transistors (BJT & FET).	b	c	
2.	Gain hands-on experience to put theoretical concepts learned in '15EC202 Electronic Circuits' course to practice.	b	c	
3.	Solve a specific design problem, which after completion they will verify using modern engineering tools such as PSPICE to carry out design experiments.	k	e	

H: High correlation, **M:** Medium correlation, **L**: Low correlation

S. No.	Description of Experiments	Contact hours	C-D-I-O	IOs	Reference
	Using discrete components only	**21**			
1.	Design and analysis of BJT amplifier configurations	3	D,I,O	1, 2	1 – 4
2.	Design and analysis of MOSFET amplifier configurations	3	D,I,O	1, 2	1 – 4
3.	Design and analysis of multistage amplifier configurations	6	D, I	1, 2	1 – 4
4.	Design and analysis of RC oscillators	3	D, I	1, 2	1 – 4
5.	Classes of power amplifier (efficiency calculation)	3	D, I	1, 2	1 – 4
6.	Design and analysis of basic BJT differential pairs	3	D, I	1, 2	1 – 4
	Simulation experiments using PSPICE	**24**			
7.	Design and analysis of negative feedback amplifier configurations	3	D, I	3	5 – 6
8.	Design and analysis of LC oscillators	6	D, I	3	5 – 6
9.	BJT current sources	3	D,I,O	3	5 – 6
10.	FET current sources	3	D,I,O	3	5 – 6
11.	Design & analysis of BJT CE amplifier with active load	3	D, I	3	5 – 6
12.	Design & analysis of FET CS amplifier with active load	3	D, I	3	5 – 6
13.	Design & analysis of differential amplifier with active load	3	D, I	3	5 – 6
	Total contact hours (Exclusive of Assessment hours**)**	**45**			

Learning resources (books / other reading materials)	
1.	Laboratory Manual, Department of ECE, SRM University
2.	David A Bell, “Laboratory Manual for Electronic Devices and Circuits”, 4th edition, D.A. Bell, 2001.
3.	David LaLond,“Experiments in Principles of Electronic Devices and Circuits”, Delmar Publishers, 1993.
4.	Howard M. Berlin, “Experiments in Electronic Devices”, 5th edition, Prentice Hall, 1998.
5.	Muhammed H Rashid, “Introduction to PSpice using OrCAD for circuits and electronics”, 3rd edition, Pearson/Prentice Hall, 2004.
6.	L. K. Maheshwari, M. M. S. Anand, “Laboratory Experiments and PSPICE Simulations in Analog Electronics”, PHI, 2006.

Course nature						**Practical**
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	Quiz/Viva Voce	Model examination	**Total**
	Weightage	40%	5%	5%	10%	**60%**
					End semester examination Weightage :	**40%**

Level-3 / Semester-1 Courses

15EC301	Microprocessors, Microcontrollers and Interfacing Techniques	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	NIL				
Course Category	**P**	**Professional Core**	**Computers**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March, 2016				

Purpose	This course covers the important features and applications of 8086 microprocessor and 8051 microcontroller with details on the internal architecture, programming, system design and interfacing concepts.			
Instructional Objectives		**Student Outcomes**		
The objectives of this course is to provide learners with understanding the:		**H**	**M**	**L**
1.	8086 architecture, pin functions and operating modes	a	b	d
2.	8086 instructions and programming	c	b	a
3.	8051 architecture, pin functions, memory organization, instruction set and programming	b	c	d
4.	Hardware features of 8051 microcontroller such as parallel port, serial port, timer and interrupt	d	b	c
5.	Interfacing 8086 / 8051 to memory and various other peripherals and programmable devices	d	b	c

H-High correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Intel 8086 – Architecture, Signals and Features	**9**			
1	8086 architecture	2	C	1	1,3,6
2	Pin functions	2	C	1	1,3,6
3	Memory Organization	1	C	1	1,3,6
4	Operating modes (configurations and system bus timings)	2	C,D	1	1,3,6
5	Multiprocessor system having 8086 & 8087, and 8086 & 8089 Register Organization	2	C,D	1	1,3
	Unit-II: Programming with Intel 8086	**9**			
6	Addressing Modes	1	C	2	1,3,6
7	Instruction set	6	C,D	2	1,3,6
8	Assembly Language Programs (ALPs)		C,D,I	2	1,3,6
9	Stack structure and related programming-I	1	C,D,I	2	1,3,6
10	Interrupt structure and related programming	1	C,D,I	2	1,3,6
	Unit-III: 8086 Interfacing with Memory and Programmable Devices	**9**			
11	Interfacing RAM / EPROM chips	1	C,D,I	3	1,2,3,4

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
12	Intel 8255 Programmable Peripheral Interface, Interfacing switches and LEDs, Interfacing DAC/ADC, Interfacing DC / stepper / servo motors	4	C,D,I	3	1,2,3,4
13	Intel 8253 Programmable Interval Timer	1	C,D,I	3	1,2,3,4
14	Intel 8251 Universal Synchronous / Asynchronous Receiver / Transmitter	1	C,D,I	3	1,2,3,4
15	Intel 8259 Programmable Interrupt Controller	1	C,D,I	3	1,2,3,4
16	Intel 8257 / 8237 Programmable DMA controller	1	C,D,I	3	1,2,3,4
	Unit-IV:Intel 8051 – Hardware Features and Interfacing	**9**			
17	8051 architecture	1	C	4	2,4,5
18	Pin functions	1	C	4	2,4,5
19	Memory organization	1	D	4	2,4,5
20	Special Function Registers	1	C	4	2,4,5
21	Instruction set	5	C,D	4	2,4,5
22	Assembly Language & C Programming		C,D,I	4	2,4,5
	Unit-V: Interfacing of 8051	**9**			
22	8051 parallel ports and its programming	1	D,I	5	2,4,5
23	8051 timers and its programming	1	C,D,I	5	2,4,5
24	8051 interrupts and its programming	1	D,I	5	2,4,5
25	8051 serial port and its programming	1	D,I	5	2,4,5
26	Interfacing external memory: program memory and data memory	1	D,I	5	2,4,5
27	Interfacing input devices: push-button / matrix keypad	1	D,I	5	2,4,5
29	Interfacing display devices: LED / 7-segment / LCD displays	1	D,I	5	2,4,5
30	Interfacing DAC / ADC	1	D,I	5	2,4,5
31	Interfacing DC motor / stepper motor / servo motor	1	D,I	5	2,4,5
	Total contact hours	**45**	Exclusive of Assessment hours		

Learning Resources	
1.	K. M. Bhurchandi and A. K. Ray, "*Advanced Microprocessors and Peripherals-with ARM and an Introduction to Microcontrollers and Interfacing* ", Tata McGraw Hill, 3rd edition 2015
2.	Muhammad Ali Mazidi and Janice GillispieMazidi, "*The 8051 - Microcontroller and Embedded systems*", 7th Edition, Pearson Education, 2011.
3.	Doughlas.V.Hall, "*Microprocessor and Interfacing : Programming and Hardware*", 3rd edition, McGraw Hill, 2015
4.	Kenneth.J.Ayala, "*8051 Microcontroller Architecture, Programming and Applications*", 3rd edition, Thomson, 2007
5.	Subrataghoshal " *8051 Microcontroller Internals Instructions ,Programming And Interfacing",*2nd edition Pearson 2010
6.	Yu-cheng Liu, Glenn A.Gibson, "*Microcomputer systems: The 8086/8088 family-Architecture,programming and design*",2nd edition, Prentice Hall of India,2007

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15EC303	Digital Signal Processing	L	T	P	C
		3	1	0	4
Co-requisite:	NIL				
Prerequisite:	15EC205				
Data Book / Codes/Standards	NIL				
Course Category	**P**	**Professional Core**	**Signal Processing**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	To provide the fundamentals of discrete time signals, systems and modern digital processing as well as applications.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		H	M	L
1	Acquire knowledge on frequency analysis of DTLTI and Efficient computation of the DFT by using FFT algorithm	a	b	c
2.	Utilize the power of computational tools like MATLAB or Scilab to implement sophisticated signal processing systems on their own personal computers which gain confidence in the fundamentals,	e	c	k
3.	Design FIR and IIR filters using several methods	e	c	
4.	Understand the finite world length effects that arise in digital filters.	a	e	
5.	Understand the DSP processors architectures and its addressing modes	b	e	

H-High correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I: Introduction to Discrete Time Signals, Systems, DFT and FFT	**12**			
1.	Introduction to Discrete time signals and systems.	1	C	1	1-4
2.	Implementation of Discrete time systems.	2	C,D	1	1-4
3.	Analysis of Linear Time-Invariant systems in the Z domain	2	C,D	1	1-4
4.	Introduction to Discrete Fourier Transform Properties , circular convolution	1	C,D	1	1-4
5.	Efficient Computation of the DFT-Divide and Conquer Approach to Computation of the DFT Using FFT	1	C,D	1	1-4
6.	N Point DFT Decimation-in-Time Radix-2 FFT Algorithms and IDFT	2	C,D	1	1-4
7.	N Point DFT Decimation-in-Frequency Radix-2 FFT Algorithms and IDFT	2	C,D	1	1-4
8.	Matlab/ Scilab programs for DFT and FFT	1	D, I	1,2	1-4
	UNIT-II: Design of Digital Filters	**12**			
9.	Design of Finite Impulse Response Filters-Symmetric and Antisymmetric FIR filters	1	C	3	1-4
10.	Design of Linear- Phase FIR filters Fourier Series Method	1	C,D	3	1-4
11.	Design of Linear- Phase FIR filters Frequency	2	C,D	3	1-4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Sampling Method				
12.	Design of Linear- Phase FIR filters Using Rectangular Hamming Window	2	C,D	3	1-4
13	Design of Linear- Phase FIR filters Using Hanning Window	2	C,D	3	1-4
14	Design of Linear- Phase FIR filters Using Blackman Window	2	C, D	3	1-4
15	Design of Optimum Equiripple Linear- Phase FIR filters	1	C	3	1-4
16	MATLAB / Scilab program for FIR filters	1	D, I	2,3	1-4
	Unit–III: Design of IIR filters from Analog Filters	**12**			
17	Frequency Response and Characteristics of Analog Filters	1	C	3	1-4
18	IIR Filter Design by the Bilinear Transformation	1	C,D	3	1-4
19	IIR Filter Design by Impulse Invariance	1	C.D	3	1-4
20	Design of Butterworth filter using Bilinear Transformation	2	C.D	3	1-4
21	Design of Butterworth filter using Impulse Invariance	2	C.D	3	1-4
22	Chebyshev Filter Designs based on the Bilinear Transformation	2	C.D	3	1-4
23	Chebyshev Filter Designs based on the Impulse Invariance	2	C.D	3	1-4
24	Frequency Transformations, MATLAB / Scilabprograms on IIR Filters	1	D,I	2,3	1-4
	Unit-IV: Finite Word Length Effects and Multirate Digital Signal Processing	**12**			
25	Representation of Numbers in Digital Filters	2	C	4	1-4
26	Quantization of Filter Coefficients	2	C,D	4	1-4
27	Round off Effects in Digital filters	2	C,D	4	1-4
28	Multirate Signal Processing – Decimation and Interpolation	2	C	4	1-4
29	Sampling Rate Conversion by a Rational Factor I/D	2	D,I	4	1-4
30	Filter Design and Implementation for Sampling Rate Conversion	2	D,I	4	1-4
	UNIT-V: DSP Processor and Applications	**12**			
31	Architecture of TMS320C5X family of DSP processors	2	C	5	5
32	Addressing Modes of TMS320C5X	2	C	5	5
33	Instruction Set of TMS320C5X	2	C	5	5
34	Assembly Language Programming for TMS320C5X	2	D,I	5	5
35	Applications on Speech Processing	2	C	5	5
36	Applications on Bio Medical Signal Processing	2	C	5	5
	Total contact Hours	**60**	Exclusive of Assessment hours		

Learning Resources	
1	John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing, Principles, Algorithms and Applications", Pearson Education, 4th edition, 2007
2	Alan V. Oppenheim, Ronald W. Schafer, John R. Buck, "Discrete Time Signal Processing", Pearson Education, 8th edition, 2011
3	SanjitMitra, "Digital Signal Processing –A Computer Based Approach", McGraw Hill, India, 4th Edition,2013.
4	A. NagoorKani, ,"Digital Signal Processing", McGrawHill Education, (India) , 2nd Edition, 2014.
5	Venkataramani.B, Bhaskar.M, "Digital Signal Processors, Architecture, Programming and Application",Tata McGraw Hill, New Delhi, 2003.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC305J	Communication Systems	L	T	P	C
		3	0	2	4
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Communication**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	To learn the fundamentals of analog communication and analyze the performance of communication system.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Understand the concepts of analog modulation and demodulation techniques	a		
2.	Learn the function of radio transmitters and receivers	e	c	
3.	Get familiarize with the basics of noise theory and performance of various receivers	e		
4.	Acquire the knowledge about the sampling process and pulse modulation	e	i	
5.	Design and conduct the experiments to analyze the characteristics of the communication systems	e, b	k	j

H-High correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Amplitude Modulation	**9**			
1.	Need for modulation, Amplitude modulation	2	C	1	1,2
2.	Power efficiency relations	1	C, D	1	1,2
3.	Generation of AM, DSB-SC, SSB-SC,	3	C	1	1,2
4.	Demodulation of AM, VSB	2	C	1	1,2
5.	Comparison of various amplitude modulation systems.	1	C	1	1,2
	Unit-II: Angle Modulation	**9**			
6.	Frequency modulation, Types of FM	1	C	1	1,2
7.	Phase modulation, Relationship between PM and FM	2	C	1	1,2
8.	Generation of FM, Direct method, Indirect method	3	C	1	1,2
9.	Demodulation of FM	3	C	1	1,2
	Unit-III: Radio Transmitter and Receivers	**9**			
10.	AM transmitter , Low Level, High Level Transmitter, FM transmitter	4	C	2	1,2
11.	Classification of radio receiver, Functions and Characteristics of radio receiver	1	C	2	1,2
12.	Tuned Radio Frequency receiver	1	C,D	2	1,2
13.	Super-heterodyne receiver- AM, FM.	3	C,D	2	1,2

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
	Unit-IV: Noise Performance of Communication Systems	**9**			
14.	Sources of Noise, Noise Bandwidth, Noise in two port networks, Cascaded stages	3	C,D	3	1,2
15.	Noise in AM (Envelope Detection), Noise in PM and FM	3	C,D	3	1,2
16.	Threshold effect, Pre-emphasis and De-emphasis, Comparison of Noise performance in AM, PM and FM.	3	C	3	1,2
	Unit-V: Sampling and Pulse Modulation	**9**			
17.	Sampling, Aliasing, Natural sampling, Flat top sampling	4	C,D	4	1,2,3
18.	Pulse amplitude modulation, Other forms of Pulse modulation	2	C,D	4	1,2,3
19.	Multiplexing – TDM, FDM	3	C,D	4	1,2,3
	Total contact hours	**45**	Exclusive of Assessment hours		

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	AM modulator and Demodulator	2	D,I,O	1,5	6
2.	DSB-SC modulator and Demodulator	2	D,I,O	1,5	6
3.	SSB modulator and Demodulator	2	D,I,O	1,5	6
4	FM Modulator and Demodulator	2	D,I,O	1,5	6
5.	Pre emphasis and De-emphasis in FM	2	D,I,O	3,5	6
6.	PAM modulator and Demodulator	2	D,I,O	4,5	6
7.	TDM multiplexer and Demultiplexer	2	D,I,O	4,5	6
8.	FDM multiplexer and Demultiplexer	2	D,I,O	4,5	6
9.	Simulation experiments using P-SPICE and MATLAB	14	D,I,O	1-5	4,5,6
	Total contact hours	**30**			

Learning Resources	
1.	Simon Haykin and Michael Moher, "*Communication Systems*," 5th edition, John Wiley & Sons, 2013
2.	Singh. R. P & Sapre. S. D, "*Communication Systems: Analog & Digital*," 3rd edition, McGraw-Hill Education, Seventh Reprint, 2016.
3.	Herbert Taub, Donald L Schilling and Goutam Saha, " Principles of Communication Systems," 4th edition, Mc Graw Hill Education, Fourth Reprint, 2015.
4.	John G Proakis, Masoud Salehi, and Gerhard Bauch, "Contemporary Communication Systems using MATLAB," 3rd edition, Cengage Learning, 2013.
5.	Dennis Fitzpatrick, "Analog Design and Simulation Using OrCAD Capture and PSpice", Illustrated edition, Elsevier, 2011
6.	Lab Manual of the course 15EC305J , Department of ECE, SRM University

Course nature							**Theory + Practical**
Assessment Method – Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**
Assessment Method – Practical Component (Weightage 50%)							
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination		**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**		**60%**
						End semester examination Weightage :	**40%**

15EC311L	Processor Laboratory	L	T	P	C
		0	0	3	2
Co-requisite:	15EC301				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	**P**	**Professional Core**	**Computers**		
Course designed by	Department of Electronics And Communication Engineering				
Approval	30th Academic Council Meeting, 24th March, 2016				

Purpose	To develop skills in designing and conducting experiments related to applications of 8086 microprocessor and 8051 microcontroller.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Demonstrate program proficiency using the various addressing modes and data transfer instructions of the target microprocessor.	b	k	
2.	Apply knowledge of the microprocessor's internal registers and operations by use of a PC based microprocessor simulator.	b	k	
3.	Interface the processor to external devices.	c	d, k	
H-High correlation, **M**-Medium Correlation, **L**-Low correlation				

	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
	Part-A: General-Purpose Programming using Intel 8086 / 8051	**18**			
1.	Program(s) to demonstrate data transfer operation	3	I,O	1	1
2.	Program(s) to demonstrate logical operation		I,O	1,2,3	1
3.	Program(s) to demonstrate arithmetic operation	3	I,O	1,2,3	1
4.	Program(s) to demonstrate decision making and looping operation	3	I,O	1,2,3	1
5.	Program(s) to demonstrate shift operation	3	I,O	1,2,3	1
6.	Program(s) to demonstrate string operation	3	I,O	1,2,3	1
7.	Program(s) to demonstrate 'parameter passing' methods (8086)	3	I,O	1,2,3	1
	Part-B: Interfacing 8086/8051 with peripherals and programmable devices	**27**			
8.	Interfacing switches / keypad / keyboard	3	I,O	1,2,3	1
9.	Interfacing LED / 7-segment / LCD displays	3	I,O	1,2,3	1
10.	Interfacing DC motor / stepper motor / servo motor	3	I,O	1,2,3	1
11.	Interfacing DAC / ADC	3	I,O	1,2,3	1
12.	Programming timer / counter	3	I,O	1,2,3	1
13.	Programming serial communication	3	I,O	1,2,3	1
14.	Programming interrupts	3	I,O	1,2,3	1
15.	Programming DMA	3	I,O	1,2,3	1
16.	Programming parallel ports (8255)	3	I,O	1,2,3	1
	Total contact hours	**45**			

Learning Resources	
1.	15EC311L Processor Lab Manual, Department of ECE, SRM University

Course nature						Practical
Assessment Method (Weightage 100%)						
In-semester	Assessment tool	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	Total
	Weightage	40%	5%	5%	10%	60%
					End semester examination Weightage :	40%

15EC375L / 15EC376L	Minor Project – I/II	L	T	P	C
		0	0	3	2
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Application**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March, 2016				

Purpose	To obtain hands-on experience in converting a small novel idea / technique into a working model / prototype involving multi-disciplinary skills and / or knowledge and working in at team.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, learner will be able to		**H**	**M**	**L**
1	To conceptualise a novel idea / technique into a product	a, b, c, e, h,	d, f, g, j, k	i
2	Apply the acquired knowledge to carry out a capstone project having substantial multidisciplinary component	a, b, c, e, h,	d, f, g, j, k	i
3	To understand the management techniques of implementing a project	a, b, c, e, h,	d, f, g, j, k	i
4	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.	a, b, c, e, h,	d, f, g, j, k	i

H= High Correlation, **M**= Medium Correlation, **L** = Low Correlation

Description of Topic

A multidisciplinary project to be taken up by a team of maximum of ten students. Development of prototype product, a 3D model, simulation, blueprint for a larger project and any other development work are permitted. The contribution of the individuals in the project should be clearly brought out. A combined report is to be submitted. A presentation is to be made for the reviewers on the work done by the candidate.

Sl. No.	Description of project work progress	Contact hours	C-D-I-O	IOs	Reference
1.	Review - 1 Minor design project identification, the objective and methodology and expected outcome of the proposed work.	10	C-D-I	1,2	1-4
2.	Review – 2 Presentation of the proposed work design, implementation and partial result	15	C-D-I-O	1,2	1-4
3.	Review – 3 Presentation of complete project work with results and discussion Demonstration of project work	15	C-D-I-O	1,2	1-4
4.	Minor Project Report	5	C-D-I	1,2	1-4
	Total Contact Hours	45			

Learning Resources	
1.	IEEE Journal, Elsevier Journals, Springer Journals, and any open access journal, reference / user manuals, etc.

Assessment Method (Weightage 100%)			
In-semester	**Assessment tool**	Refer the table	**Total**
	Weightage	Refer the table below	**100%**
End semester examination Weightage :			**0%**

Assessment component	Expected outcome	Evaluators	Criteria or basis	Marks
Project proposal (Review – I)	A short presentation to be delivered on: • A brief, descriptive project title (2-4 words). This is critical! • The 3 nearest competitors (existing solutions) and price. • Team members name, phone number, email, department/ degree program, and year. • A description of the product opportunity that has been identified. To include: Documentation of the market need, shortcomings of existing competitive products, and definition of the target market and its size. • Proposed supervisor / guide	Panel of reviewers	• Viability / feasibility of the project • Extent of preliminary work done.	**0**
Review II	• Mission Statement / Techniques • Concept Sketches, Design Specifications / Modules & Techniques along with System architecture • Coding	Panel of reviewers	• Originality, • Multi-disciplinary component, • clarity of idea and presentation, • team work, handling Q&A.	**20**
Review III	• Final Concept and Model / Algorithm/ Technique • Drawings, Plans / programme output • Financial Model / costing • Prototype / Coding • Final Presentation and Demonstration	Panel of reviewers	• Originality, • Multi-disciplinary component, • clarity of idea and presentation, • team work, handling Q&A.	**50**
Final technical Report	A good technical report	Supervisor / Guide	• Regularity, • systematic progress, • extent of work and • quality of work	**30**
			Total	**100**

15EC380L / 15EC381L	Seminar - I / II	L	T	P	C
		0	0	3	2
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Application**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March, 2016				

Purpose	To learner must identify a sub domain of the degree of specialization that is the interest of the learner collecting research paper and give presentation in one of the specializations of Electronics and Communication Engineering			
Instructional Objectives		**Student Outcomes**		
At the end of the course, learner will be able to		**H**	**M**	**L**
1.	Acquire the skill in reading, understanding the journal article and capability to present Journal article/technical paper and also able to identify the potential area of research in the specializations of Electronics and Communication Engineering	g, h, j	i	E
2.	To understand the research methodology adopted by various researchers	h	i	j
3.	To mathematically model a problem, critically analyse it and adopt strategies to solve	b	c	e
4.	To understand and present a well documented research	e	g	

H= High Correlation, **M**= Medium Correlation, **L** = Low Correlation

Guidelines for conducting Seminar

1. Upon registering for the course the student must identify a sub-domain of the degree specialization that is of interest to the student and start collecting research papers as many as possible.
2. After collecting sufficient number of research papers the student must peruse all the papers, meet the course faculty and discuss on the salient aspects of each and every paper.
3. The course faculty, after discussion with the student will approve TWO research papers that is appropriate for presentation.
4. The student must collect additional relevant reference materials to supplement and compliment the two research papers and start preparing the presentation.
5. Each student must present a 15-minute presentation on each of the approved research paper to the panel of evaluators.
6. The presenter must present one research paper within the first half of the semester (6 weeks) and another research paper in the next half of the semester (6 weeks) as per the schedule.
7. All other students registered for the course will form the audience.
8. The audience as well as the evaluators will probe the student with appropriate questions and solicit response from the presenter.
9. The presentation will be evaluated against 7 to 8 assessment criteria by 4 to 5 evaluators.
10. The score obtained through the presentations of TWO research papers will be converted to appropriate percentage of marks.

Total Contact Hours: 30

Course nature				Practical
Assessment Method (Weightage 100%)				
In-semester	**Assessment tool**	Presentation - 1	Presentation - 2	**Total**
	Weightage	**50%**	**50%**	**100%**
			End semester examination Weightage :	**0%**

Department of ECE
Evaluation of Seminar Presentations (Sample)

Name of the Student: Date:
Register Number: Degree and Branch:
Topic:

Sl. No.	Criteria for Assessment	Evaluator 1	Evaluator 2	Evaluator 3	Evaluator 4	Evaluator 5
1	Understanding of the subject					
2	Clarity of presentation					
3	Appropriate use of Audio visual aids					
4	Whether cross references have been consulted					
5	Ability to respond to questions on the subject					
6	Time scheduling					
7	Completeness of preparation					

Poor	1	Below Average	2	Average	3	Good	4	Very Good	5

Overall Grades:
Remarks:
Signature of Course Coordinator

15EC385L / 15EC386L	MOOC – I / II	L	T	P	C
		0	0	3	2
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Application**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	To offer students the opportunity to study with the world's best universities by integrating select MOOCs in a regular degree programme and providing students full credit transfer, as per university regulations, if they earn a "Verified / Completion Certificate" and take a proctored examination through a secure, physical testing center.

Instructional Objectives		**Student Outcomes**		
At the end of the course, learner will able to		**H**	**M**	**L**
1.	Improve their knowledge and skills relevant to their chosen domain	a, b, c, e, h,	d, f, g, j, k	i
2.	To apply the concepts, theories, laws, technologies learnt herein to provide engineering solutions.	f	h	i, j

H= High Correlation, **M**= Medium Correlation, **L** = Low Correlation

Session	Course Description	Contact hours	C-D-I-O	IOs	Reference
1	This course is designed for the learner to study high quality courses online with prestigious universities. The department has well in advance identified the courses and publicized to students. The student has to choose online courses listed by the department and should undergo for the minimum period of 8-12 weeks. Upon completion of the course, the student must submit the completed certificate for credit transfer.	**45**	C,D,I,	1	1,2,3,4
	Total contact hours	**45**			

Learning Resources	
1.	www.cousera.org
2.	www.edx.org
3.	www.it.iitb.ac.in
4.	Any other online courses offered by reputed entity

Course nature				**Practical**		
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Quiz	Assignment	Non-proctored / Unsupervised Tests	Proctored / Supervised Test	**Total**
	Weightage	**25%**	**25%**	**10%**	**40%**	**100%**
End semester examination Weightage :						**0%**

Registration process, Assessment and Credit Transfer

1. Students can register for courses offered by approved global MOOCs platforms like edX, Coursera or Universities with which SRM partners specifically for MOOCs.
2. Annually, each department must officially announce, to the students as well as to the Controller of Examinations, the list of courses that will be recognised and accepted for credit transfer.
3. The department must also officially announce / appoint one or more faculty coordinator(s) for advising the students attached to them, monitoring their progress and assist the department in proctoring the tests, uploading the marks / grades, and collecting and submitting the graded certificate(s) to the CoE, within the stipulated timeframe.
4. Student who desires to pursue a course, from the above department-approved list, through MOOCs must register for that course during the course registration process of the Faculty of Engineering and Technology, SRM University.
5. The maximum credit limits for course registration at SRM will include the MOOCs course registered.
6. The student must periodically submit the marks / grades obtained in various quizzes, assignments, tests etc immediately to the Faculty Advisor or the Course Coordinator for uploading in the university's academic module.
7. The student must take the final test as a Proctored / Supervised test in the university campus.
8. The student must submit the "Certificate of Completion" as well as the final overall Marks and / or Grade within the stipulated time for effecting the grade conversion and credit transfer, as per the regulations. It is solely the responsibility of the individual student to fulfil the above conditions to earn the credits.
9. The attendance for this course, for the purpose of awarding attendance grade, will be considered 100% , if the credits are transferred, after satisfying the above (1) to (7) norms; else if the credits are not transferred or transferable, the attendance will be considered as ZERO.

15EC390L	Internship / Industrial Training			L	T	P	C
				0	0	3	2
Co-requisite:	Nil						
Prerequisite:	Nil						
Data Book / Codes/Standards	Nil						
Course Category	**P**	**Professional Core**	**Application**				
Course designed by	Department of Electronics and Communication Engineering						
Approval	30th Academic Council Meeting, 24th March 2016						

Purpose	To provide short-term work experience in an Industry/ Company/ Organisation			
Instructional Objectives		**Student Outcomes**		
At the end of the course, learner will able to		**H**	**M**	**L**
1	Understand one or more practical application of the core courses learned	a d	b, c	J
	To get an inside view of an industry and organization/company	F	G	I
	To gain valuable skills and knowledge	F	G	I
	To make professional connections and enhance networking	F	G	I
	To get experience in a field to allow the student to make a career transition	F	G	I

H= High Correlation, **M**= Medium Correlation, **L** = Low Correlation

Guidelines

1. It is mandatory for every student to undergo this course.
2. Every student is expected to spend a minimum of 15-days in an Industry/ Company/ Organization, during the summer vacation.
3. The type of industry must be NOT below the Medium Scale category in his / her domain of the degree programme.
4. The student must submit the "Training Completion Certificate" issued by the industry / company / Organisation as well as a technical report not exceeding 15 pages, within the stipulated time to be eligible for making a presentation before the committee constituted by the department.
5. The committee will then assess the student based on the report submitted and the presentation made.
6. Marks will be awarded out of maximum 100.
7. Appropriate grades will be assigned as per the regulations.
8. Only if a student gets a minimum of pass grade, appropriate credit will be transferred towards the degree requirements, as per the regulations.
9. It is solely the responsibility of the individual student to fulfill the above conditions to earn the credits.
10. The attendance for this course, for the purpose of awarding attendance grade, will be considered 100%, if the credits are transferred, after satisfying the above (1) to (8) norms; else if the credits are not transferred or transferable, the attendance will be considered as ZERO.
11. The committee must recommend redoing the course, if it collectively concludes, based on the assessment made from the report and presentations submitted by the student, that either the level of training received or the skill and / or knowledge gained is NOT satisfactory.

Course nature				Training – 100% internal continuous assessment
Assessment Method (Weightage 100%)				
In-semester	Assessment tool	Presentation	Report	Total
	Weightage	80%	20%	100%
End semester examination Weightage :				0%

15EC490L/ 15EC491L	Industry Module – I / II			L	T	P	C
				0	0	3	2
Co-requisite:	Nil						
Prerequisite:	Nil						
Data Book / Codes/Standards	Nil						
Course Category	**P**	**Professional Core**	**Application**				
Course designed by	Department of Electronics and Communication Engineering						
Approval	30th Academic Council Meeting, 24th March 2016						

Purpose	The learners can enrich their knowledge through interactions from core domain industry / research/ service industry personnel			
Instructional Objectives		**Student Outcomes**		
At the end of the course, student will able to		**H**	**M**	**L**
1.	To obtain an insight into the current industrial trends and practices	a, d	b, c	j
2.	To obtain an insight into the technologies adopted by industries	a, d	b, c	j
3.	To obtain an insight into the technical problems encountered by the industries and the scope for providing solutions.	a, d	b, c	j
4.	To network with industry	a, d	b, c	j

H= High Correlation, **M**= Medium Correlation, **L** = Low Correlation

1. The department will identify and shortlist few emerging topics that are trending in industry.
2. The department will identify experts from industry who are willing to deliver modules on the shortlisted topics.
3. The identified expert will assist the department in formulating the course content to be delivered as a 30-hour module, prepare lectures notes, ppt, handouts and other learning materials.
4. The department will arrange to get the necessary approvals for offering the course, from the university's statutory academic bodies well before the actual offering.
5. The department must officially announce, to the students as well as to the Controller of Examinations, the list of courses that will be offered as industry module.
6. The department must also officially announce / appoint one or more faculty coordinator(s) for advising the students attached to them, monitoring their progress and assist the department in proctoring/supervising/assessment the quizzes, assignments, tests etc, uploading the marks, attendance etc, within the stipulated timeframe.
7. The Student who desires to pursue a course, from the above department-approved list, must register for that course during the course registration process of the Faculty of Engineering and Technology, SRM University.
8. The maximum credit limits for course registration at SRM will include the Industry Module also.
9. All academic requirements of a professional course like minimum attendance, assessment methods, discipline etc will be applicable for this Industry Module.
10. The course will be conducted on week-ends or beyond the college regular working hours.

Course nature		**Practical**	
Assessment Method (Weightage 100%)			
In-semester	**Assessment tool**	Review Tests, Quiz, Assignments, projects, presentation, etc.	**Total**
		Weightage	**100%**
		End semester examination Weightage	**0%**

Level-3 / Semester-2 Courses

15EC302J	VLSI Design	L	T	P	C
		3	0	2	4
Co-requisite:	Nil				
Prerequisite:	**15EC203J**				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Electronics**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March, 2016				

Purpose	To Learn the technology, design concepts, electrical properties and modeling of Very Large Scale Integrated Circuits. To understand the digital systems design using verilog HDL and implementation using FPGAs / CPLDs.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Design digital system using Hardware Description Language	c	e	k
2.	Acquire the knowledge of MOS Transistor	e		
3.	Understand the CMOS Fabrication process		c	
4.	Learn the design of CMOS Logic circuits and subsystems	c	e	
5.	Apply concepts and methods of digital system design techniques through experiments.	b,c	d	f
6.	Develop skills, techniques and learn state-of-the-art engineering EDA tools to design, implement and test digital systems using FPGAs / CPLDs.	k		

H-High Correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I: Verilog HDL	**9**			
1.	VLSI design flow ,Hierarchical modeling concepts	1	C	1	2
2.	Basic Concepts: Data types ,Modules and ports	2	C	1	2
3.	Gate Level Modeling	1	C,D	1	2
4.	Data Flow Modeling	1	C,D	1	2
5.	Behavioral Modeling	2	C,D	1	2
6.	Switch level Modeling	1	C,D	1	2
7.	Task and Function	1	C	1	2
	UNIT-II : MOS Transistor Theory	**9**			
8.	Introduction and I-V Characteristics	1	C	2	1,3
9.	Non ideal I-V effects: Velocity saturation, mobility degradation and Channel length modulation	1	C	2	1,3
10.	Non ideal I-V effects: Body Effect, Sub threshold conduction, Junction leakage and Geometry Dependence	1	C	2	1,3
11.	CMOS Inverter DC characteristics	2	C	2	1,3
12.	Scaling: Transistor scaling, Interconnect scaling and impacts on design	2	C	2	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
13.	Static and dynamic power dissipation	1	C	2	1,3
14.	Implementation of complex logic gates/expressions using CMOS logic	1	C,D	2	1,3
	Unit-III: CMOS Processing Technology	**9**			
15.	Introduction to IC Technology	1	C	3	1,3
16.	CMOS Technologies: Wafer formation, Photolithography, Gate oxide, gate and drain formation and Contacts and Metallization	1	C	3	1,3
17.	nMOS Fabrication	1	C	3	1,3
18.	CMOS Fabrication: p-well, n-well and Twin- tub fabrication process.	2	C	3	1,3
19.	Latch up in CMOS Circuits	1	C	3	1,3
20.	Layout Design rules	1	C	3	1,3
21.	Stick diagrams	1	C	3	1,3
22.	Interconnects: Resistance and capacitance	1	C	3	1,3
	Unit-IV: Combinational and Sequential CMOS Logic Circuits	**9**			
23.	Static CMOS	1	C	4	1,4
24.	Ratioed circuits	2	C	4	1,4
25.	Dynamic circuits , Domino logic	2	C	4	1,4
26.	Pass transistor circuits	2	C	4	1,4
27.	CMOS with Transmission gate	1	C	4	1,4
28.	Conventional CMOS latches and flip-flops	1	C	4	1,4
	Unit-V: Subsystem Design	**9**			
29.	Carry Look Ahead Adder	2	C	4	3,5
30.	Carry skip adder	1	C,D	4	3,5
31.	Carry select adder	1	C,D	4	3,5
32.	Design of Multipliers, Braun array multiplier	2	C,D	4	3,5
33.	Wallace tree Multiplier	1	C,D	4	3,5
34.	Booth multiplier	1	C,D	4	3,5
35.	Barrel Shifter	1	C,D	4	3,5
	Total contact hours	**45**	Exclusive of Assessment hours		

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
	Tanner Spice/HSPICE				
1.	CMOS Logic gate and circuits	4	D-I-O	1,5,6	6,7,8
2.	Dynamic circuits	4	D-I-O	1,5,6	6,7,8
3.	CMOS latches and flip flops	4	D-I-O	1,5,6	6,7,8

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
	Modelsim/Xilinx				
4.	Carry Look Ahead Adder	2	D-I-O	1,5,6	6,7,8
5.	Carry Skip Adder	2	D-I-O	1,5,6	6,7,8
6.	Multiplier: Braun Array/ Booth Encoding/ Wallace Tree	4	D-I-O	1,5,6	6,7,8
7.	Memory: RAM and ROM	4	D-I-O	1,5,6	6,7,8
8.	Finite State Machine	2	D-I-O	1,5,6	6,7,8
9.	Barrel Shifter	2	D-I-O	1,5,6	6,7,8
10.	Switch level modeling of CMOS gates and Boolean Expressions	2	D-I-O	1,5,6	6,7,8
	Total contact hours	**30**			

Learning Resources	
1.	Neil H.E.Weste, David Harris, "*CMOS VLSI Design*", Pearson,3rd Edition. 2005,Reprint 2012
2.	Samir Palnitkar, *"Verilog HDL Guide to Digital Design and synthesis"*, 2rd Edition, Pearson Education, 2003.
3.	Douglas A.Pucknell, Kamran Eshraghian,"*Basic VLSI Design",* Prentice Hall of India, 3rdEdition, Reprint 2009.
4.	Sung Mo Kang,YusufLeblebici, "*CMOS Digital Integrated Circuits Analysis and Design"*, Tata McGraw Hill, 3rd Edition,2003.
5.	John P. Uyemura, "*Introduction to VLSI circuits and systems*", Wiley, 2rd Edition2002, Reprint 2014.
6.	15EC302J VLSI Design Laboratory Manual, Department of ECE, SRM University.
7.	Samir Palnitkar, *"Verilog HDL Guide to Digital Design and synthesis"*, 2rd Edition, Pearson, Education 2003
8.	Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL", 2rd Edition, Prentice Hall Higher Education, 2010.

Course nature							**Theory + Practical**
Assessment Method for Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle Test-I	Cycle Test-II	Cycle Test-III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**
Assessment Method for Practical Component (Weightage 50%)							
In-semester	**Assessment tool**	Experiments	Record	Quiz/Viva Voce	Model examination		**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**		**60%**
End semester examination Weightage :							**40%**

15EC304	Antenna and Wave Propagation			L	T	P	C
				3	0	0	3
Co-requisite:	Nil						
Prerequisite:	15EC207						
Data Book / Codes/Standards	Nil						
Course Category	**P**	**Professional Core**	**Communication**				
Course designed by	Department of Electronics and Communication Engineering						
Approval	30th Academic Council Meeting, 24th March 2016						

Purpose	To explore fundamental theory together with techniques for the practical design, measurement and application of antennas over the radio-frequency range.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1	Acquire knowledge about the various antenna parameters.	e	a	
2	Enumerate the concept of antenna arrays and its radiation pattern.	e	a	
3	Understand the basic working of antenna.	e	a	b
4	Analyze the various methods involved in the measurement of antenna parameters	e	a	b
5	Understand the radio wave propagation in the atmosphere.	c		

H-High Correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I:Antenna Fundamentals and Radiations	**9**			
1	Basic Antenna parameters, Antenna field zones	2	C,D	1	1,2
2	Antenna Reciprocity Theorems	1	C,D	1	1,2
3	Friis transmission equation	1	C,D	1	1,2
4	Radiation: Retarded potential	1	C	1	1,2
5	Far Field due to an alternating current element, Power Radiated by a current element	2	C,D	1	1,2,3
6	Far field due to sinusoidal current distribution for half wave dipole and Quarter wave monopole.	2	C,D	1	1,2,3
	Unit-II:Antenna Arrays and Synthesis	**9**			
7.	Point source, Array of Two isotropic point sources	1	C,D	2	1,2
8.	Non isotropic similar point sources and the principle of pattern multiplication.	2	C,D	2	1,2,4
9.	Linear arrays of n isotropic point sources: Broad side Array, End fire Array	2	C,D	2	1,2,4
10.	Phased arrays, Binomial arrays	1	C,D	2	1,2
11.	Synthesis methods: Schelkunhoff polynomial method.	2	D	2	1,2
12.	Fourier transform method	1	D	2	1,2
	Unit-III:Antenna Types and its Applications	**9**			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
13.	Traveling wave antennas	1	C	3	1,2
14.	Square Loop antenna and its Radiation Resistance	2	C,D	3	1,2
15.	Folded dipole antenna	1	C,D	3	1,2
16.	Horn antenna, Helical antenna	1	C,D	3	1,2
17.	Reflector antenna	1	C,D	3	1,2
18.	Yagi -Uda antenna	1	C,D	3	1,2
19.	Log periodic antenna	1	C,D	3	1,2
20.	Micro strip antenna	1	C,D	3	1,2
	Unit-IV:Antenna Measurements	**9**			
21.	Impedance measurement	1	C	4	1
22.	Gain measurement, Radiation pattern measurement	1	C	4	1
23.	Beam width measurement, Radiation resistance measurement,	1	C	4	1
24.	Antenna efficiency measurement, Directivity measurement,	1	C	4	1
25.	Polarization measurement, phase Measurements	1	C	4	1
26.	Typical sources of errors in antenna measurement	2	C	4	1,2
27.	Numerical Techniques For Antenna Analysis: Method of Moment (MoM).	2	C,D	4	1,2,3
	Unit-V:Radio Wave Propagation	**9**			
28.	Basics of propagation: Definition and General classification	1	C	5	1
29.	Different Modes of propagation	2	C	5	1,4
30.	Structure of ionosphere	1	C	5	1
31.	Refraction and Reflection of sky wave by ionosphere.	1	C,D	5	1
32.	Ray path, Critical frequency, MUF, LUF , OF, Virtual Height and skip distance	1	C,D	5	1
33.	Relation between MUF & Skip distance, Ionospheric abnormalities, Impact of solar activity	2	C,D	5	1
34.	Multi-Hop propagation and wave characteristics	1	C	5	1
	Total contact hours	**45**	Exclusive of Assessment hours		

Learning Resources	
1.	John D Kraus , Ronald J Marhefka, Ahmed S Khan “Antenna and wave propagation” 4th Edition 2010
2.	Constantine Balanis. A, “Antenna Theory: Analysis and Design”, 3rd Edition, John Wiley and Sons, 2012.
3.	Stutzman, Warren L, Gary A.Thiele, “Antenna theory and design”, 3rd Edition, John Wiley and Sons 2012
4.	C. Jordan E and Balmain, “Electromagnetic waves and Radiating Systems”, 2nd Pearson Education/ PHI, 2006.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC306J	Digital Communication	L	T	P	C
		3	0	2	4
Co-requisite:	Nil				
Prerequisite:	**15MA209, 15EC305J**				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Communication**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	To gain a comprehensive coverage of digital communication systems including digital transmission and digital radio.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1	Apply the engineering concepts that describes the functionality of digital communication techniques	e, k	e	
2	Analyze the effect of ISI in baseband reception techniques and show the working of matched filter receiver and correlative coding	e	k	
3	Understand various pass band transmission techniques and identify the suitable modulation technique for different application based on bandwidth, data-rate and probability of error	e, k	b	c
4	Understand the basics of information theory and coding	e	b	c
5	Apply the concepts of linear algebra to communication	e	b	

H-High Correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Digital Modulation Systems	**9**			
1	Sampling and Quantization-PCM Systems	2	C	1	1
2	Data Formatting -Noise consideration in PCM system-Bandwidth of PCM	2	C,D	1	1
3	PCM TDM signal multiplexing-Limitations of PCM system	1	C,D	1	1
4	Differential PCM (DPCM)	1	C	1	1
5	Delta Modulation (DM)- Noise in DM	2	C	1	1
6	Adaptive DPCM (ADPCM), Comparison of PCM, DPCM, ADPCM & DM	1	C	1	1
	Unit-II: Base Band Demodulation and Detection	**9**			
7	Demodulation and Detection Process	1	C	2	1,2
8	Maximum Likelihood Receiver Structure	1	C	2	1,2
9	Matched Filter receiver, Probability error of the Matched filter	2	C		
10	Inter symbol Interference – Eye pattern	2	C	2	1
11	Nyquist criterion for distortion less baseband transmission	1	C	2	1
12	Correlative coding	2	C,D	2	1,2,3,4
	Unit-III: Pass Band Data Transmission	**9**			

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
13	Pass band transmission model	1	C	3	1,2
14	Generation, Detection, Signal Space Diagram, Probability of Error for Coherent PSK	2	C	3	1,2
15	Generation, Detection, Signal Space Diagram, Probability of Error for QPSK	2	C	3	1,2
16	Generation, Detection, Signal Space Diagram, Probability of Error for OQPSK	2	C	3	1,2
17	Generation, Detection, Signal Space Diagram of $\pi/4$ QPSK	1	C	3	1,2
18	M-ary signaling, Vectoral view of MPSK	1	C	3	2
	Unit-IV: Amplitude – Phase Modulation Schemes &its Applications to Advanced Systems	**9**			
19	Generation, Detection, Probability of Error for QAM, M-ary QAM	2	C	3	1,2,4
20	Application of QAM in OFDM Systems-an Overview	2	I	3	1,2,4
21	Generation , Detection, Probability of Error for Coherent FSK	2	C	3	1,2,4
22	Generation and Detection of MSK	1	C	3	1,2,4
23	Generation and Detection of GMSK and Its application in Wireless Systems	2	C,D,I	3	1,2,4
	Unit-V: Information Theory & Vector Algebra	**9**			
24	**Information theory:** Information & Entropy	1	C, I	4,5	5
25	Conditional Entropy & Mutual Information	1	C,I	4,5	5
26	Shannon Fano Coding-Huffman Coding	2	C, D, I	4,5	5
27	Shannon Hartley Theorem for Channel Capacity	1	C,I	4,5	5
28	**Vector Algebra:** Groups-fields-Vector spaces	2	C,D,I	4,5	6
29	Linear independence and dependence, Inner Products	1	C,D,I	4,5	6
30	Gramh-Schmidt Orthogonalization Process.(Theorems without proof)	1	C,D,I	4,5	6
	Total contact hours	**45**	Exclusive of Assessment hours		

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Pulse Modulation Systems(PAM, PWM, PPM) and its Demodulation	3	I,O	1	7
2.	Pulse Code Modulation and Demodulation	3	I,O	1	7
3.	DPCM and its Demodulation	3	I,O	1	7
4.	DM and its Demodulation	3	I,O	1	7
5.	Data Formatting	3	I,O	1	7
6.	PSK Modulation and Demodulation	3	I,O	1	7
7.	QPSK Modulation and Demodulation	3	I,O	1	7
8.	DPSK Modulation and Demodulation	3	I,O	1	7

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
9.	FSK Modulation and Demodulation	3	I,O	1	7
10.	BER performance analysis of various Modulation Schemes	3	I,O	1	7
	Total contact hours	**30**			

Learning Resources	
1	Simon Haykin, "Communication Systems", John Wiley & Sons, 4th Edition, 2000.
2	Bernard Sklar, "Digital Communication, Fundamentals and Application", Pearson Education Asia, 2nd Edition, 2001.
3	Taub& Schilling, "Principle of Communication Systems", 2nd Edition, 2003.
4	John G. Proakis, "Digital Communication", McGraw Hill Inc, 5th Edition, 2008.
5	Singh, R.P. &Sapre, S.D, "Communication Systems: Analog & Digital", Tata McGraw-Hill, 5th reprint, 2000.
6	Shu Lin, Daniel Costello, "Error control coding – Fundamentals and Applications", Second Edition,Prentice Hall, Upper Saddle River, NJ, 2004.
7	Lab Manual of 15EC304J.

Course nature							**Theory + Practical**
Assessment Method – Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**
Assessment Method – Practical Component (Weightage 50%)							
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination		**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**		**60%**
						End semester examination Weightage :	**40%**

Level-4 / Semester-1 Courses

15EC401M	Multidisciplinary Design	L	T	P	C
		2	2	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Application**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting 24th March 2016				

Purpose	Students of any specialization at an undergraduate level learn courses related to various sub-domains (Multi-disciplinary) of their specialization individually. They are not exposed to understanding how the various multi-disciplinary fields interact and integrate in real life situations. It is very common that an expert in a particular domain models and designs systems or products oblivious of the impact of other subsystems. This lack of multi-disciplinary thinking is very blatantly visible when the students take up their major project during their final year. This course aims to develop appropriate skills on systemic thinking on how to identify and formulate a problem, decompose the problem into smaller elements, conceptualize the design, evaluate the conceptual design by using scientific, engineering and managerial tools, select, analyze and interpret the data, consideration of safety, socio-politico-cultural, risks and hazards, disposal, regional and national laws, costing and financial model and undertake documentation and finally presentation.

Instructional Objectives		**Student Outcomes**		
At the end of the course, learner will be able to		**H**	**M**	**L**
1.	To subdivide a complex system into smaller disciplinary models, manage their interfaces and reintegrate them into an overall system model	a	c	e,f,i
2.	To rationalize a system architecture or product design problem by selecting appropriate design variables, parameters and constraints	a	c	e,f,i
3.	To design for value and quantitatively assess the expected lifecycle cost of a new system or product	a	c	e,f,i
4.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.	a	c	e,f,i

H: High Correlation M: Medium Correlation L: Low Correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	Introduction: Facilitating Multidisciplinary Projects	4	C, D, I, O	1-4	
2.	Identifying and formulating a problem	4	C, D, I, O	1-4	
3.	System Modelling	4	C, D, I, O	1-4	
4.	Thinking perspectives: Decomposition–Composition Thinking Hierarchical Thinking, Organizational Thinking, Life-Cycle Thinking, Safety Thinking, Risk Thinking, Socio-politico-cultural thinking, Environment thinking	6	C, D, I, O	1-4	
5.	Decomposing a system – Identifying the major sub-systems	4	C, D, I, O	1-4	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
6.	Mathematical Modeling and Governing equations for each sub systems	4	C, D, I, O	1-4	
7.	Objectives, Constraints and Design Variables	4	C, D, I, O	1-4	
8.	Conceptual Design	6	C, D, I, O	1-4	
9.	Collaborative Design – Disciplinary teams satisfy the local constraints while trying to match the global constraints set by the project coordinator.	6	C, D, I, O	1-4	
10.	Tools for modeling, designing, analysis, data interpretation, decision making etc	6	C, D, I, O	1-4	
11.	Design Analysis, evaluation and selection	4	C, D, I, O	1-4	
12.	Costing and Financial model	4	C, D, I, O	1-4	
13.	Documentation, reviewing and presentation	4	C, D, I, O	1-4	
	Total contact hours	**60**			

Learning Resources	
1.	G. Maarten Bonnema, Karel T. Veenvliet, Jan F. Broenink, “Systems Design and Engineering: Facilitating Multidisciplinary Development Projects”, December 15, 2015, CRC Press, ISBN 9781498751261.
2.	Ina Wagner , Tone Bratteteig , Dagny Stuedahl, “Exploring Digital Design-Multi-Disciplinary Design Practices”, Springer-Verlag London, 2010, ISSN:1431-1496.
	Domain-1: Human Machine Interface
3.	Roberto Cipolla and Alex Pentland, “Computer Vision For Human-Machine Interaction”, Cambridge University Press, 1998
4.	Dix, Alan, et. al. “Human-Computer Interaction”, 3rd Edition. Prentice Hall, 2003
	Domain-2: Robotics for Electronics Automation
5.	Dominik Sankowski, Jacek Nowakowski, “Computer Vision in Robotics and Industrial Applications”, Series in Computer Vision: Volume 3, World Scientific, August 2014.
6.	Karl Mathia, “’Robotics for Electronics Manufacturing”, Cambridge University Press, 2010.
7.	Marco Ceccarelli, “Robots and Robotics: Design and Application”, University of Cassino, Italy, March, 2012.
	Domain-3: BioMedical Applications
8.	Rangaraj M. Rangayyan, “Biomedical signal analysis A case-study approach” Wiley, IEEE Press, 2013
9.	Joseph J. Carr, John No. Brown, “Introduction to Biodmedical Equipment Technology” 4th Edition, Pearson Education Seventh Impression, 2011
	Domain-4: Digital Image Processing
10.	R. Gonzalez and R. Woods, “Digital Image Processing”, 2nd ed.", Prentice-Hall, 2002, www.imageprocessingbook.com.
11.	K. Rao and P. Yip, “The Transform and Data Compression Handbook”, CRC Press, 2001, http://www.engnetbase.com/ejournals/books/book_summary/summary.asp?id=431
12.	J. Shapiro, “Embedded image coding using zerotreesofwavelet coefficients” IEEE Trans. on Signal Processing, vol. 41, pp. 3445–3462, 1993.

Learning Resources	
	Domain-5: Space Mission Analysis and Design: Astrionics
13.	James R. Wertz, *"Space Mission Engineering: The New SMAD",* Space Technology Library(Vol. 28), 3rd Edition
14.	Mukund R. Patel, *"Spacecraft Power Systems",* CRC Press, November 29, 2004.
15.	Howard Curtis, *"Orbital Mechanics for Engineering Students (Aerospace Engineering)",* Butterworth-Heinemann Ltd, 3rd Revised edition.
16.	Marcel J. Sidi, *"Spacecraft Dynamics and Control: A Practical Engineering Approach",* Cambridge University Press, Revised ed. edition.
17.	Charles Brown, *"Elements of Spacecraft Design",* AIAA, 1st edition.
18.	Jens Eickhoff, *"Onboard Computers, Onboard Software and Satellite Operations",* Springer Aerospace Technology, 2012.
	Domain-6: Networking
19.	Wireless Communication Standards: A Study of IEEE 802.11, 802.15, 802.16 By Todor Cooklev,Published By Standards Information Network IEEE Press,2004
20.	Network Analysis, Architecture, and Design THIRD EDITION James D. McCabe, Elsevier 2007
21.	Cisco Collaboration System 11.*x*Solution Reference Network Designs (SRND), January 19, 2016

Course nature						**Predominantly Practice complimented by theory**
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Review 1	Review 2	Review 3	Review 4	**Total**
	Weightage	**10%**	**25%**	**25%**	**40%**	**100%**
End semester examination Weightage :						**0%**

Pedagogy

Theme or major/broad domains will be announced by the department every semester. Multi-disciplinary designs will be made by the students in groups (group size may be decided by the course coordinator), with the topic of interest falling within the theme or major/broad domains as announced by the department, applying any combinations of the disciplines in engineering. 3D modelling and / or simulation must be used to validate the design.

In a combination of lecture and hands-on experiences, students must be exposed to understand and analyse engineering designs (or products) and systems, their realization process and project management. Analysis of the design criteria for safety, ergonomics, environment, life cycle cost and sociological impact is to be covered. Periodic oral and written status reports are required. The course culminates in a comprehensive written report and oral presentation. If required guest lecturers from industry experts from the sub-domains may be arranged to provide an outside perspective and show how the system design is being handled by the industry. The Conceive Design Implement Operate (CDIO) principles must be taught to the students.

A full-scale fabrication is not within the purview /scope of this course. Of course this design, if scalable and approved by the department, can be extended as the major project work. This course is 100% internal continuous assessment.

15EC403	Wireless Communication	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	15MA209				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Communication**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic council meeting, 24th March 2016				

Purpose	To understand the concepts of wireless systems and gain knowledge on mobile communication systems.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learners will be able to understand:		**H**	**M**	**L**
1.	The evolution of Wireless communication and basic cellular concepts	a	e	
2.	Radio wave propagation and mobile channel models	h	e	
3.	Various performance analysis of mobile communication system	h	i	
4.	Various Standards of Mobile communication systems	j	i	

H-High Correlation, **M**-Medium Correlation**, L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	References
	Unit-I: Introduction Tto Wireless Communication	**9**			
1.	Evolution of wireless communication and mobile radio communication	1	C	1	1,2
2.	Cellular concepts, Frequency reuse, Channel assignment	2	C	1	1,2
3.	Hand off, Interference and system capacity	2	C	1	1,2
4.	Trunking and erlang, Capacity calculation	2	C	1	1,2
5.	Improving coverage and capacity	2	C	1	1,2
	Unit-II: Mobile Radio Wave Propagation (Large Scale Fading)	**9**			
6.	Radio wave propagation, Transmit and receive signal models	2	C	2	1,2,5
7.	Free space path loss, Ray tracing	2	C	2	1,2,5
8.	Empirical path loss models, Simplified path loss model, Shadow fading	2	C	2	1,2,5
9.	Outage probability under path loss and shadowing	2	C	2	1,2,4,5
10.	Cell coverage area	1	C	2	1,2,3,5
	Unit-III: Mobile Radio Wave Propagation (Small Scale Fading & Multipath)	**9**			
11.	Small scale multipath propagation	2	C	3	1,2,3
12.	Impulse response model of multipath channel	2	C	3	1,2,3
13.	Small scale multipath measurements	2	C	3	1,2,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	References
14.	Parameters of mobile multipath channels	1	C	3	1,2,3
15.	Types of fading: Rayleigh and Ricean Distribution	2	C	3	1,2,3,4
	Unit-IV: Capacity, Diversity and Equalization in Wireless Systems	**9**			
16.	Capacity in AWGN, Capacity of flat fading channels, Channel and System Model, Channel distribution Information known	2	C	2	1,2,3,4
17.	CSI at receiver Diversity technique	2	C	2	1,2,4,5
18.	Selection combining, EGC,MRC	2	C	2	3,4,5
19.	Feedback, Time Frequency	2	C	3	1,2,3,5
20.	RAKE receiver and Interleaving	1	C	3	1,2,3
	Unit-V: Wireless System and Standards	**9**			
21.	GSM System Services, features and Architecture	1	C	4	1,2,3,5
22.	Discrete Sequence Spread Spectrum Technique and Frequency Hopping - Acquisition and Tracking	2	C	4	3,4
23.	Use of Spread spectrum with CDMA, Generation and characteristics of PN sequence	2	C	4	2,4
24.	CDMA Digital Cellular standards(UMTS), frequency and channel specification, Forward and reverse CDMA Channel	2	C	4	2,3
25.	Introduction to OFDM system, Case study: IEEE 802.11a Wireless LAN and Bluetooth standards	2	C	4	4
	Total contact hours	**45**	Exclusive of Assessment hours		

Learning Resources	
1.	Andreas.F.Molisch., "Wireless Communications", Wiley Publications,Second Edition-2005, Reprint-2014
2.	Rappaport.T.S,"Wireless Communications:Principles and Practice", Second Edition, Pearson Education, Reprint 2011.
3.	William Stallings, "Wireless Communication & Networking", Pearson Education Asia, 2009
4.	Feher K., "Wireless Digital Communications", PHI, New Delhi, 1995
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

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15EC405J	Computer Communication			L	T	P	C
				3	0	2	4
Co-requisite:	Nil						
Prerequisite:	Nil						
Data Book / Codes/Standards	Nil						
Course Category	**P**	**Professional Core**	**Computers**				
Course designed by	Department of ECE						
Approval	30th Academic Council Meeting, 24th March 2016						

Purpose	To learn the basics of computer communication networks, layer functionalities and the protocols involved in it.		
Instructional Objectives		**Student Outcomes**	
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Understand the basic services and concepts related to internetworking.	j	h	i
2.	Explain the basic OSI model architecture and its lower layer functions.	j	i	h
3.	Acquire knowledge in various network layer concepts, mechanisms and protocols.	j	i	h
4.	Explore the services and techniques of Transport layer.	j	i	h
5.	Analyze the various services and protocols in Application layer.	j	i	h
6.	Implement and analyze the various Networking concepts & Routing Protocols.	k	j	h

H-High Correlation, **M**-Medium Correlation**, L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
Unit-I: Data Communication & Networking Basics		**9**			
1.	Data transfer modes, Serial and Parallel transmission, Protocols & Standards, Layered Architecture	2	C	1	1-4
2.	Switching, Circuit, Message & Packet switching	2	C	1	1-4
3.	LAN, MAN & WAN, Network topologies	2	C	1	1-4
4.	IEEE standards for LAN, Ethernet, Token Bus, Token Ring, FDDI	3	C	1	1-4
Unit-II: OSI Lower Layers.		**9**			
5.	Network models , OSI layer architecture, Data Link Layer	2	C	2	1-4
6.	Error Detection and Correction schemes	1	C	2	1-4
7.	Data link control, MAC, LLC	3	C	2	1-4
8.	Flow &Error Control Protocol , ARQ schemes	2	C	2	1-4
9.	HDLC protocol	1	C	2	1-4
Unit-III: Network Layer		**9**			
10.	Need for Internetworking , Addressing	2	C	3	1-4

11.	Internet Protocol (IPV4/V6)	2	C	3	1-4
12.	Routing Issues, Delivery, Forwarding and Routing	2	C	3	1-4
13.	Routing Protocols, Distance Vector & Link State	3	C	3	1-4
Unit-IV: Transport Layer		**9**			
14.	TCP/IP Model	2	C	4	1-4
15.	Transport layer ,UDP,TCP	2	C	4	1-4
16.	Congestion Control mechanisms	3	C	4	1-4
17.	QOS ,Techniques to improve QOS	2	C	4	1-4
Unit-V: Application Layer		**9**			
18.	SIP	3	C	5	1-4
19.	Compression techniques		C	5	1-4
20.	Cryptography	2	C	5	1-4
21.	Email , FTP, HTTP	2	C	5	1-4
22.	SNMP	2	C	5	1-4
	Total contact hours	**45**	Exclusive of Assessment hours		

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Configuration of a simple wired network of four nodes connected with point-to-point links using QualNet Network Simulator.	2	I,O	1,6	5
2.	Simulation of CSMA/CD protocol and to study its performance	2	I,O	1,6	5
3.	Simulation of token bus and token ring protocols and to study the performance.	2	I,O	1,6	5
4.	Simulation of CSMA/CA protocol and to study its performance and comparison with CSMA/CD protocols.	2	I,O	1,6	5
5.	Frame based String Data transmission & Frame Data Transmission using Error check	4	I,O	1,6	5
6.	Implementation and study of stop and wait protocol using NS-2 Network Simulator.	4	I,O	2,6	5
7.	Implementation and study of Go back N and selective repeat protocols.	2	I,O	2,6	5
8.	Implementation of Distance Vector Routing algorithm.	4	I,O	3,6	5
9.	Implementation of Link state Routing algorithm.	4	I,O	3,6	5
10.	Create a Socket (TCP&UDP) between two computers and enable file transfer between them.	2	I,O	4,6	5
11.	Implementation of data encryption and decryption.	2	I,O	5,6	5
	Total contact hours	**30**			

Learning Resources	
1.	Behrouz A.Fehrouzan, “Data communication & Networking”, Mc-Graw Hill, 5th Edition Reprint, 2014
2.	Andrew S.Tanenbaum, “Computer Networks”, Pearson Education India, 5th Edition, 2013
3.	William Stallings, “Data & Computer Communication”, Pearson Education India, 10th Edition, 2014.
4.	James F. Kurose, Keith W. Ross, “Computer Networking: A Top–Down Approach Featuring the Internet”, Pearson Education,6th Edition, 2013
5.	“Lab Manual” , Department of ECE, SRM University

Course nature							**Theory + Practical**
Assessment Method – Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**
Assessment Method – Practical Component (Weightage 50%)							
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination		**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**		**60%**
End semester examination Weightage :							**40%**

15EC407	Microwave Theory and Techniques	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	15EC201J; 15EC304				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Communication**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March, 2016				

Purpose	To learn the basics of microwave theory and techniques and to enable the learner to become familiar with microwave devices and components used in microwave communication systems.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, learner will be able to		H	M	L
1.	Acquire knowledge on the theory of microwave transmission, microwave generators and associated components.	a	c	b
2.	Analyze microwave passive devices and components.	a	j	b
3.	Acquire knowledge on the concepts of microstrip lines and fabrication of MMICs	a, b	e	c
4.	Understand microwave measurements and associated techniques with equipment	b	c	k
5.	Analyze microwave communication system and its associated techniques	c	j	h

H-High Correlation, **M**-Medium Correlation**, L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	References
	Unit-I: Microwave Generators	**9**			
1.	History of Microwave Engineering, Microwave transmission and Applications; Maxwell Equations	1	C	1	1,2
2.	Microwave Tubes; High frequency limitations, Klystron amplifier, Reflex Klystron oscillators	2	C	1	1,3,4,5
3.	TWT amplifiers, Magnetron oscillators	2	C	1	1,3,4,5
4.	Microwave Bipolar Transistors, Field Effect Transistors	1	C	1	1,3,4,5
5.	Gunn diode , Gunn Oscillation modes	2	C	1	1,3,4,5
6.	IMPATT, TRAPATT and Tunnel diode	1	C	1	1,3,4,5
	Unit-II: Microwave Passive Devices and Components	**9**			
7.	High frequency parameters: S parameters and S matrix analysis for N-port microwave device	2	C,D	2	1,3,4,5
8.	Directional coupler, E and H plane Tee and Magic Tee	2	C,D	2	1,3,4,5
9.	Microwave Circulators, Isolators	1	C	2	1,3,4,5
10.	Attenuators and Phase Shifters	1	C	2	1,3,4,5
11.	Rectangular and Cylindrical Waveguides	2	C	2	1,3,4,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	References
12.	Power Dividers	1	C	2	1,3,4,5
	Unit-III: Microstrip Lines and Microwave Integrated Circuits	**9**			
13.	Characteristics of Microstrip lines and Quality Factor Q of Microstrip Lines	2	C	3	1,3,4,5
14.	Parallel strip line, Distributed Lines, Co-planar and Shielded strip line.	3	C,D	3	1,3,4,5
15.	Monolithic Microwave Integrated Circuits (MMICs); Introduction with Substrate, Conductor, Dielectric, Resistive Materials and Applications	2	C	3	1,3,4,5
16.	MMIC Fabrication Techniques; Hybrid Integrated circuit fabrication	2	C	3	1,3,4,5
	Unit-IV: Microwave Measurements	**9**			
17.	Impedance matching, VSWR and Impedance measurement.	2	C,D	4	1,2,4,5
18.	Measurement of Power, Frequency and Q factor	2	C,D	4	1,2,4,5
19.	Insertion loss and Attenuation measurements	2	C,D	4	1,2,4,5
20.	Measurement of Scattering parameters	1	C,D	4	1,2,4,5
21.	Functioning details of Vector Network Analyzer; Signal Analyzer; Spectrum analyzers	2	C	4	1,2,4,5
	Unit-V: Microwave Radio Systems	**9**			
22.	Microwave Transmitter, Receiver Architectures	2	C,D	5	1,2,5
23.	Microwave filters - LP,HP,BP and BS filters; Passive LC Filter Synthesis Using Insertion Loss M Method	2	C,D	5	1,4,6
24.	Noise Characterization; SNR and Figure of Merit; Link budget calculations	2	C,D	5	1,2,5
25.	Microwave Propagation: Atmospheric, Ground and Plasma Effects	2	C	5	1,2,5
26.	Microwave Heating; Biological Effects and Safety	1	C	5	2,4,5
	Total Contact Hours	**45**	Exclusive of Assessment hours		

Learning Resources	
1.	David M. Pozar, “Microwave Engineering”, 4th Edition, John Wiley & Sons, 2012.
2.	David M. Pozar, “Microwave & RF Design of Wireless Systems”, John Wiley & Sons, 2001.
3.	Samuel Y. Liao, “Microwave Devices and Circuits”, 3rd Edition, Pearson Education, 2013.
4.	Robert. E. Collin, “Foundations for Microwave Engineering”, 2nd edition, Wiley, Reprint 2014.
5.	Annapurna Das, Sisir K. Das, “Microwave Engineering”, 3rd Ed., McGraw Hill, 2015.
6.	I. Hunter, “Theory and design of microwave filters”, The Institution of Engineering &Technology, 2001

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Attendance	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15EC409	Optical Communication	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	15EC201J				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Communication**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th April , 2016				

Purpose	To acquire the basic essentials of Fiber Optical Communication			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		H	M	L
1.	Familiarize with the fundamentals of light transmission through fiber	a		
2.	Understand how signal degrades inside the fiber due to physical effects and externally due to various factors like alignment, splicing and connecterization	b	e	
3.	Understand the operation of optical sources, amplifiers and detectors and thereby build transmitter and receiver circuits	a, c	e	b
4.	Familiarize with optical measurements for performance analysis	b	a	
5.	Design a basic optical communication system	c	j	b
6.	Acquire fundamental concepts on multichannel system and related components	a	j	

H-High Correlation, **M**-Medium Correlation**, L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Introduction to Optical Fibers	**9**			
1	Elements of Optical fiber communication, Optical Spectral bands	1	C	1	1,2,3
2	Optical fiber structure, Light Propagation in Optical fibers: Ray theory , Total Internal reflection, Skew rays	1	C,D	1	1,2,3
3	Overview of Modes: Cutoff wavelength and V number	1	C,D	1	1,2,3
4	Fiber types: SI, GI, MM, SM	2	C,D	1	1,2,3
5	Wave Equations for Step index fiber, Modal equation, Modes in SI fibers, LPM	3	C	1	1,2,3
6	Special Fibers: Polarization Maintaining fibers, Photonic Crystal fibers, Dispersion compensated fiber	1	C	1	2
	Unit-II: Transmission Characteristics of Optical Fibers	**9**			
7	Difference between bounded and free space optical communication, Propagation characteristics of IR, Visible, UV in Atmosphere and space	1	C	2	1,4
8	Attenuation: Material Absorption, Scattering, bending and core cladding losses	1	C,D	2	1,2,4
9	Overview of Signal dispersion in fibers , its limitations, Intermodal dispersion	1	C	2	1,2,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
10	Intra-Modal dispersion: Material dispersion, Waveguide dispersion and PMD	2	C	2	1,2,4
11	Non linear effects : Non linear scattering, Kerr effects	1	C	2	1,2
12	Fiber alignment and Joint Loss, Fiber Splices Optical fiber connectors, Expanded Beam Connectors	2	C,D	2	1, 2,3, 5
13	Lensing schemes for coupling, Fiber couplers	1	C	2	1,3
	Unit-III: Optical Sources, Amplifier and Transmitter	**9**			
14	Optical Sources: Light source materials, LED Structures; Surface and Edge emitters, Quantum efficiency and power, LED Characteristics	2	C,D	3	1,2, 3, 4
15	Semiconductor Laser Diode, Modes and threshold conditions, External Quantum efficiency, LASER Characteristics	2	C,D	3	1,2, 3, 4
16	Single mode Laser: VCSEL	1	C	3	1,2, 3, 4
17	Fiber Amplifiers: EDFA, SOA	2	C	6	1,3
18	Modulation characteristics and Driver circuits	1	C,D	3	1,3,4
19	Functional block diagram of a Transmitter module	1	C,D	3	3
	Unit-IV: Optical Detectors , Receiver and Performance Measurements	**9**			
20	Optical Detectors: PIN and APD photo detector, Responsivity and efficiency	2	C,D	3	1,2,3,4
21	Photo detector noise , SNR, Detector Response time	1	C,D	3	1,3
22	Fundamental receiver operation, Error Sources, Front end Amplifier, decision circuit	3	C	3	1,3
23	Functional block diagram of a Receiver module	1	C,D	3	3
24	Measurement Standards, Basic Test Equipment: Optical Spectrum analyser, Optical power attenuator, Optical Power meter, Eye diagram tests, OTDR	2	C	4	1,2
	Unit-V: Optical Communication System Design and Concepts	**9**			
25	Point-to-Point link – Digital System and Analog system System design considerations and design steps	1	C,D	5	1,2
26	Digital Link Design: Link power budget; Rise time budget	2	C,D	5	1,2
27	Overview of Analog links: Radio over Fiber; Key link parameters	2	C,D	5	1,2
28	Multichannel System: Need for multiplexing; Operational principles of WDM, DWDM	1	C	6	1,2,6
29	WDM Components: Coupler/Splitter, Isolators and Circulator, Mach Zehnder Interferometer, Fabry Perot Filter and Optical MEMS switches	3	C	6	1,2,6
	Total Contact Hours	**45**	Exclusive of Assessment hours		

Learning Resources	
1.	Keiser G, “Optical Fiber Communication Systems”, 5th Edition, 6th Reprint, McGraw Hill Education (India), 2015.
2.	Vivekanand Mishra, Sunita P. Ugale, “Fiber Optic Communication: Systems and Components”, Wiley-India, 1st edition, 2013
3.	Djafar.K. Mynbaev and Lowell and Scheiner, “Fiber Optic Communication Technology”, Pearson Education Asia, 9th impression, 2013
4.	John M. Senior, “ Optical fiber Communications: Principles and Practice”, Pearson Education, 3rd Edition, 2009
5.	R.P. Khare, “Fiber Optics and Optoelectronics”, Oxford University Press, 2007.
6.	Rajiv Ramaswami, Kumar N. Sivaranjan, Galen H.Sasaki "Optical Networks A practical perspective", 3nd edition, 2013

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Attendance	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC411L	Microwave and Optical Communication Laboratory			L	T	P	C
				0	0	3	2
Co-requisite:	15EC407,15EC409						
Prerequisite:	Nil						
Data Book / Codes/Standards	Nil						
Course Category	**P**	**Professional Core**	**Communication**				
Course designed by	Department of Electronics and Communication Engineering						
Approval	30th Academic Council Meeting, 24th April , 2016						

Purpose	To acquire skills in measuring, designing by conducting and simulating experiments related to microwave and optical devices/components and systems			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1	Familiarise with basic microwave and optical measurements.	b	c	f
2	Characterize microwave and optical components/devices by measuring important parameters	b	c	f
3	Design and simulate devices/systems and study their performance	b, d, k	c	f

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Microwave Communication	**21**			
1	Characteristics of Reflex Klystron	3	I-O	1	1-2
2	Study of power distribution in Directional coupler, E plane, H plane and Magic Tee	6	I-O	1,2	1-2
3	Impedance measurement by slotted line method	3	I-O	1,2	1-2
4	Gain and radiation pattern of Horn antenna	3	I-O	1,2	1-2
5	Characteristics of filters, Microstrip patch antenna and parallel line coupler	6	I-O	1,2	1-2
	Optical Communication	**18**			
6	DC characteristics of LED and Laser diode	6	I-O	2	1
7	DC characteristics of PIN and APD photo-diode	6	I-O	2	1
8	Measurement of Numerical Aperture, propagation and bending losses of optical fiber	3	I-O	1,2	1
9	Analysis of Analog and digital optical link	3	I-O	2	1
	Simulation Study	**6**			
10	Design of RF Filters and Amplifier using computational tool	3	D-I-O	2,3	1,5,6,7
11	Design of basic Optical Communication system using computational tool	3	D-I-O	2,3	1,3,4
	Total contact hours	**45**			

Learning Resources	
1.	Laboratory Manual, ECE Department, SRM University
2.	Sisodia and Raghuvanshi – "Basic Microwave techniques and laboratory manual", New Age International, 01-Jan-1987-Microwaves.
3.	http://in.mathworks.com/support/learn-with-matlab-tutorials.html
4.	http://optilux.sourceforge.net/
5.	*www.agilent.co.in/about/newsroom/presrel/2014/08may-em14069.html*
6.	*www.ece.ucsb.edu/~long/ece594a/ADS_introduction.pdf*
7.	*cp.literature.agilent.com/litweb/pdf/5988-3326EN.pdf*

Course nature						**Practical**
Assessment Method (Weightage 100%)						
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination	**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**	**60%**
					End semester examination Weightage:	**40%**

Level-4 / Semester-2 Courses

15EC496L	Major Project	L	T	P	C
		0	0	24	12
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Application**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March, 2016				

Purpose	The Major Project experience is the culminating academic endeavor of learners who earn a degree in their Undergraduate Programs. The project provides learners with the opportunity to explore a problem or issue of particular personal or professional interest and to address that problem or issue through focused study and applied research under the direction of a faculty member. The project demonstrates the learner's ability to synthesize and apply the knowledge and skills acquired in his/her academic program to real-world issues and problems. This final project affirms learners' ability to think critically and creatively, to solve practical problems, to make reasoned and ethical decisions, and to communicate effectively.

Instructional Objectives		**Learner Outcomes**		
At the end of the course, learner will be able to		**H**	**M**	**L**
1.	To provide learners with the opportunity to apply the knowledge and skills acquired in their courses to a specific problem or issue.	a, c, e	f, k	g, h, i
2.	To allow learners to extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals.	a, c, e	f, k	g, h, i
3.	To encourage learners to think critically and creatively about academic, professional, or social issues and to further develop their analytical and ethical leadership skills necessary to address and help solve these issues.	a, c, e	f, k	g, h, i
4.	To provide learners with the opportunity to refine research skills and demonstrate their proficiency in written & oral communication skills.	a, c, e	f, k	g, h, i
5.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.	a, c, e	f, k	g, h, i

H= High Correlation, **M**= Medium Correlation, **L** = Low Correlation

Description of topic

1. The Major project is a major component of our engineering curriculum: it is the culmination of the program of study enabling the learners to showcase the knowledge and the skills they have acquired during the previous four years, design a product/service of significance, and solve an open-ended problem in engineering.
2. Each student must register to the project course related to his or her program
3. Major Project course consists of one semester and would be allowed to register only during the final year of study.
4. The Major Project may be initiated during the pre-final semester but will be assessed and credits transferred only during the last semester of study, upon completion of all other degree requirements. Generally the undergraduate major project is a team based one.
5. Each team in the major project course will consist of maximum of 5 learners.
6. Each project will be assigned a faculty, who will act as the supervisor.

7. The project shall be driven by realistic constraints like that related to economic, environmental, social, political, ethical, health & safety, manufacturability and sustainability.
8. Each group must document and implement a management structure. Group leadership roles must be clearly identified including who has responsibility for monitoring project deliverables and group coordination.
9. A group project may be interdisciplinary, with learners enrolled in different engineering degrees, or in Engineering plus other faculties such as Management, Medical and Health Sciences, Science and Humanities.
10. Each student team is expected to maintain a log book that would normally be used to serve as a record of the way in which the project progressed during the course of the session.
11. Salient points discussed at meetings with the supervisor (i.e., suggestions for further meetings, changes to experimental procedures) should be recorded by the student in order to provide a basis for subsequent work.
12. The logbook may be formally assessed;
13. The contribution of each individual team member will be clearly identified and the weightage of this component will be explicitly considered while assessing the work done.
14. A project report is to be submitted on the topic which will be evaluated during the final review.
15. Assessment components will be as spelt out in the regulations.
16. The department will announce a marking scheme for awarding marks for the different sections of the report.
17. The project report must possess substantial technical depth and require the learners to exercise analytical, evaluation and design skills at the appropriate level.

Sl. No.	Description of project work progress	C-D-I-O	IOs	Reference
1.	Review - 1 Major design project identification, the objective, methodology and expected outcome.	C-D-I	1-5	1-4
2.	Review – 2 Presentation of the proposed work design, implementation and partial result	C-D-I-O	1-5	1-4
3.	Review – 3 Presentation of complete project work with results and discussion, Demonstration of project work	C-D-I-O	1-5	1-4
4.	Project report/ Thesis submission	C-D-I	1-5	1-4

Learning Resources	
1.	IEEE Journals, Elsevier Journals, Springer Journals, Any open Access Journal, Reference / user manuals, etc.

Course nature		Project – 100 % Internal continuous Assessment			
Assessment Method (Weightage 100%)					
In-semester	Assessment tool	Review 1	Review 2	Review 3	**Total**
	Weightage	10%	15%	20%	**45%**
End semester examination	Assessment Tool	Project Report	Viva Voce		
	Weightage :	25%	30%		**55%**

Level-2 Elective Courses

15EC221E	Nanoscale Devices			L	T	P	C
				3	0	0	3
Co-requisite:	Nil						
Prerequisite:	Nil						
Data Book / Codes/Standards	Nil						
Course Category	**P**	**Professional Elective**	**Electronics**				
Course designed by	Department of Electronics and Communication Engineering						
Approval	30th, Academic Council Meeting,24th March , 2016						

Purpose	To learn a subset of beyond CMOS technologies, that show significant advantage over ultimate FETs in power, performance, density, and/or cost to enable the semiconductor industry performance trends for information technology.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, learner will be able to		**H**	**M**	**L**
1.	Familiarize with the scaling issues as the CMOS enters nanometer regime.	a	c	
2.	Understand several strategies introduced to extend Moore's Law by increasing the electrostatic control over the channel.	a	c	j
3.	Expose to the construction of the circuits represented by a cell operated using Coulombic interaction.	a	c	
4.	Analyze CNT based circuits are energy efficient with their superior carrier mobility	a	c	
5.	Focus on new phenomena for logic devices where Spin property of the matter is used to represent information.	a	c	j

H: high correlation, **M:** medium correlation **L:** low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I: Challenges in Nanoscale MOSFETs	**9**			
1.	Overview of MOS transistor	1	C	1	1,2,4,5
2.	Scaling of transistor dimensions and Moore's law	2	C	1	1,2,4,5
3.	Challenges for Nano MOSFETs; Sub-threshold Conduction, DIBL, Velocity Saturation, Hot electrons	3	C	1	1,2,4
4.	Emergence of new materials, Hi-k materials and its issues, metal gate, copper interconnect and low-k interlayer dielectric	3	C	1	1,2,4
	Unit-II : Nanoscale MOSFET	**9**			
5.	SOI MOSFET, partially depleted and fully depleted SOI	2	C	2	1,2
6.	Strained channel MOSFET, Hi-k gate dielectric, Metal gate electrode	3	C	2	1,2
7.	Double gate MOSFET	1	C	2	1,2
8.	FinFET, Ferro electric FET	3	C	2	1,2
	Unit-III : Quantum Transport Devices	**9**			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
9.	**Quantum Mechanics**: Limitations of classical mechanics	1	C	3	1,3
10.	Basics of quantum mechanics, Schrodinger equation	2	C	3	1,3
11.	Particle in a box, Tunnel Effect , tunneling through single barrier and double barrier	3	C	3	1,3
12.	**Quantum Transport Devices:** Coulomb blockade effect, Single Electron Transistor	2	C	3	1,2
13.	Resonant Tunneling Diode	1	C	3	1,2
	Unit-IV: CNT Devices	**9**			
14.	Carbon Nano Tube, Electronic properties of CNT	2	C	4	1,2
15.	Geometrical structure, Electronic structure of CNT	2	C	4	1,2
16.	Transport properties	2	C	4	1,2
17.	CNTFET, comparison of Si MOSFET with CNT MOSFET	3	C	4	1,2
	Unit-V: Spintronics	**9**			
18.	Principle of Spintronics	3	C	5	1
19.	Spin valves, SpinFET	2	C	5	1
20.	Magnetic Tunnel Junctions	2	C	5	1
21.	MRAM	2	C	5	1
	Total contact hours	**45**	Exclusive of Assessment hours		

Learning Resources	
1.	Rainer Waser (Ed.), "*Nanoelectronics and Information Technology",Wiley-VCH, Third, Completely Revised and Enlarged Edition, 2012.*
2.	T.Pradeep, "*A Textbook of Nanoscience and Nanotechnology*", Mc Graw Hill, 2012.
3.	Ajoy Ghatak and S. Lokanathan, "Quantum Mechanics: Theory and Applications", Fifth Edition, Macmillan Publishers, 2009.
4.	Yong-Bin Kim, "*Challenges for Nanoscale MOSFETs and Emerging Nanoelectronics"*, KIEEME Transactions on Electrical and Electronic Materials, Vol. 11, No. 3, pp. 93-105, 2010.
5.	Kerry Bernstein, "*Device and Architecture Outlook for Beyond CMOS Switches*", Proceedings of the IEEE Vol. 98, No. 12, pp. 2169-2184,2010

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC222E	Opto Electronics	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Electronics**		
Course designed by	Department of Electronics and Communication				
Approval	30th Academic Council Meeting, 24th March, 2016				

Purpose	To gain insight about the electro-optic devices			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Revive the basics of wave optics	a		
2.	Understand the principles of various display devices and light sources	a		
3.	Acquire knowledge on different types of optical detection devices and modulators	a		
4.	Matriculate the concepts of optoelectronic integrated circuits and components	a	e	j

H: high correlation, **M:** medium correlation **L:** low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Elements of Light and Solid State Physics	**9**			
1.	Wave nature of light, Polarization, Interference, Diffraction	2	C	1	1,5
2.	Energy bands in solids	1	C	1	1
3.	Conduction processes in semiconductors	2	C	1	2
4.	Optical processes in semiconductors	2	C	1	2
5.	Junction Theory	2	C	1	1,5
	Unit-II: Display Devices and Light Sources	**9**			
6.	Photo Luminescence, Cathode Luminescence, Electro Luminescence, Injection Luminescence	2	C	2	1
7.	Plasma Displays, LCD, Numerical Display	2	C	2	1,2
8.	LED : Choice of LED Material, Light output from LED, Device performance characteristics	2	C	2	2
9.	Laser: Operating principle, Emission and Absorption of Radiation, Population Inversion, Optical feedback, Threshold Condition, Semiconductor Lasers	3	C	2	2
	Unit-III: Detection Devices	**9**			
10.	Photo detection Principle	1	C	3	1
11.	Photoconductors, Noise in photoconductors	2	C	3	1
12.	Photodiodes: PIN Photodiode, APD	2	C	3	1, 4, 5
13.	Detector performance parameters	1	C	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
14.	Detectors for long wavelength operation, wavelength selective detection	2	C	3	1,5
15.	Charge Coupled Device (CCD)	1	C	3	1,3
	Unit-IV: Optoelectronic Modulators and Switching Devices	**9**			
16.	Electro Optic Modulators	2	C	3	1, 2
17.	Acousto - Optic Modulators	2	C	3	1
18.	Interferometric Modulators	2	C	3	3
19.	Semiconductor Optical Amplifiers	1	C	3	2, 5
20.	Optical switching and Logic devices	2	C	3	2
	Unit-V: Optoelectronic Integrated Circuits	**9**			
21.	Hybrid and Monolithic Integration	1	C	4	2
22.	Slab and Stripe waveguides	2	C	4	2
23.	Guided wave devices and Active couplers	3	C	4	2
24.	Integrated transmitters and Receivers	3	C	4	2
	Total contact hours	**45**	Exclusive of Assessment hours		

Learning Resources	
1.	J. Wilson and J F B Hawkes " Optoelectronics- An Introduction", 3rd Edition, Pearson Education Taiwan Ltd, 2010.
2.	Pallab Bhattacharya "Semiconductor Optoelectronic Devices", 2nd Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2009.
3.	Jasprit Singh "Optoelectronics- An Introduction to Materials and Devices", Mc Graw Hill Education India, 2014.
4.	S C Gupta "Optoelectronic Devices and Systems", 2nd Edition, Prentice Hall of India, 2015.
5.	S O Kasap "Optoelectronics and Photonics: Principles and practices", 2nd Edition, Pearson Education International, 2012.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15EC223E	Electronic Testing			L	T	P	C
				3	0	0	3
Co-requisite:	Nil						
Prerequisite:	Nil						
Data Book / Codes/Standards	Nil						
Course Category	**P**	**Professional Elective**	**Electronics**				
Course designed by	Department of Electronics and Communication						
Approval	30th Academic Council Meeting, 24th March 2016						

Purpose	To attain comprehensive knowledge of various testing methods in Electronics			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Gain knowledge on the basics of testing and the testing equipments	e	i	
2.	Emphasize the needs of fault modeling and simulation	e		
3.	Interpret different testing methods of combinational and sequential circuits	e	f	i
4.	Explore the delay test and I_{DDQ} test	e	i	

H: high correlation, **M:** medium correlation **L:** low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Testing Process and Fault Modeling	**9**			
1.	Test process and automatic test equipment	3	C	1	1
2.	Test economics and product quality	1	C	1	1
3.	Fault modeling : Defects, Errors, and Faults, Functional Versus Structural Testing, Levels of Fault Models, Single Stuck-at Fault	5	C	2	1, 3
4.	**Unit-II: Fault Simulation and Testability Measures**	**9**			
5.	Simulation for Design Verification	1	C	2	1
6.	Simulation for Test Evaluation	1	C	2	1
7.	Modeling Circuits for Simulation	2	C	2	1
8.	Algorithms for True-Value Simulation	1	C	2	1
9.	Algorithms for Fault Simulation	2	C	2	1
10.	SCOAP Controllability and Observability	2	C	2	1
11.	**Unit-III: Testing and Testability of Combinational Circuits**	**9**			
12.	Test Generation Techniques: One dimensional path sensitization, Boolean Difference, D-Algorithm, PODEM, FAN, Delay Fault Detection	4	C	3	1, 2
13.	Detection of multiple faults	1	C	3	2
14.	The Reed-Muller Expansion Technique	1	C	3	2
15.	Three level OR-AND-OR Design	1	C	3	2
16.	Automatic Synthesis of Testable Logic	1	C	3	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
17.	Testable PLA Design	1	C	3	2
18.	**Unit-IV: Testing and Testability of Sequential Circuits**	**9**			
19.	Testing of sequential circuits as iterative combinational circuits	1	C	3	2
20.	State Table Verification	2	C	3	2
21.	Test Generation based on Circuit Structure	2	C	3	2
22.	Ad Hoc Design Rules	1	C	3	1, 2
23.	Scan Path Technique	1	C	3	1, 2
24.	Partial Scan and Boundary Scan	2	C	3	1, 2
25.	**Unit-V : Delay Test and I_{DDQ} Test**	**9**			
26.	Delay Test Problem	1	C	4	1, 3
27.	Path-Delay Test	2	C	4	1, 3
28.	Faults Detected by I_{DDQ} Tests	1	C	4	1
29.	I_{DDQ} Testing Methods	2	C	4	1
30.	Limitations of I_{DDQ} Testing	1	C	4	1
31.	I_{DDQ} Built-In Current Testing	1	C	4	1
32.	I_{DDQ} Design for Testability	1	C	4	1
	Total contact hours	**45**	Exclusive of Assessment hours		

Learning Resources	
1.	Michael L. Bushnell and Vishwani D. Agarwal, “Essentials of Electronic Testing for Digital, Memory & Mixed-Signal VLSI Circuits”, Springer, 2006.
2.	P. K. Lala, “Digital Circuit Testing and Testability”, Academic Press, 2002.
3.	Dimitris Gizopouilos, “Advances in Electronic Testing”, Springer 2006.

Course nature					**Theory**		
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC224E	Electronics Packaging	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	**P**	**Professional Elective**	**Electronics**		
Course designed by	Department of Electronics and Communication				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	To introduce the basics and design considerations involved in Electronics Packaging			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		H	M	L
1.	Understand the basics of electronic packaging, processing technologies and materials used.	a	i	
2.	Acquire knowledge on electrical, thermal and mechanical design consideration in electronic packaging.	d	a	i
3.	Comprehend the steps involved in electronic package assembly.	d	i	
4.	Explore the concepts of Multichip packaging.	h	f	

H-High Correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Microelectronic Packaging and Processing Technologies	**9**			
1.	Functions of an Electronic Package	1	C	1	1, 2
2.	Packaging Hierarchy	1	C	1	1
3.	Brief History of Microelectronic Packaging Technology	1	C	1	1, 2
4.	Driving Forces on Packaging Technology	1	C	1	1
5.	Thin-Film Deposition	3	C	1	1
6.	Patterning	1	C	1	1
7.	Metal-to-Metal Joining	1	C	1	1
	Unit-II: Materials and Electrical Considerations	**9**			
8.	Packaging Material Properties	1	C	1	1
9.	Ceramics in Packaging	1	C	1	1
10.	Polymers in Packaging: Fundamentals of Polymers, Primary Classes of Polymers Used in Microelectronics and First-Level Packaging Applications of Polymers	1	C	1	1
11.	Metals in Packaging	1	C	1	1
12.	Electrical Fundamentals	1	C	2	1, 2
13.	Signal Integrity and Modeling	1	C	2	1, 2
14.	Crosstalk, Power and Ground	2	C	2	1, 2
15.	Overall Packaged IC Models and Simulation	1	C	2	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-III: Thermal and Mechanical Design Considerations	**9**			
16.	Heat Sources, Approaches to Heat Removal and Failure Modes	1	C	2	1, 3
17.	Heat Transfer Fundamentals: Heat Transfer Rate Equations, Transient Thermal Response of Components, Conduction in Various Shapes and Overall Resistance	2	C	2	1, 3
18.	Air Cooling and Liquid Cooling	1	C	2	1, 3
19.	Stress, Deformation and Strain	1	C	2	1
20.	Constitutive Relations: Elastic Material, Plastic Material and Creep	1	C	2	1
21.	Failure Theories	1	C	2	1
22.	Analytical Determination of Stress	2	C	2	1
	Unit-IV: Electronic Package Assembly	**9**			
23.	Facilities and Component Handling	1	C	3	1
24.	Surface-Mount Technology (SMT) Assembly	1	C	3	1,3
25.	Wafer Preparation	1	C	3	1
26.	Die Attachment	1	C	3	1
27.	Wire bonding	1	C	3	1
28.	Flip-Chip	1	C	3	1
29.	Package Sealing/Encapsulation/Coating	1	C	3	1
30.	Package-Level Processes	1	C	3	1
31.	State-of-the-Art Technologies	1	C	3	1
	Unit-V: Design Considerations and Multichip Packaging	**9**			
32.	Packaging and the Electronic System	1	C	4	1
33.	Trade-Offs Among Packaging Functions	1	C	4	1
34.	Traditional and Modified Product Cycles, Market Analysis and Product Specification	1	C	4	1
35.	Design Concepts	1	C	4	1
36.	History and Motivations of Multichip Packaging	1	C	4	1, 2
37.	Packaging Hierarchy and Taxonomy	1	C	4	1, 2
38.	Three-Dimensional Systems	1	C	4	1, 2
39.	Options in Multichip Packaging	2	C	4	1, 2
	Total contact hours	**45**	Exclusive of Assessment hours		

Learning Resources	
1.	William D. Brown, “Advanced Electronic Packaging”,2nd Edition, A John Wiley & Sons, Inc., Publication, 2006
2.	Tummala, Rao R.,” Fundamentals of Microsystems Packaging”, 1st Edition, McGraw Hill Education, 2001
3.	Glenn R Blackwell, “The electronic packaging handbook”, CRC Press LLC, 2000

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC225E	Electronic Measurements and Instrumentation			L	T	P	C
				3	0	0	3
Co-requisite:	Nil						
Prerequisite:	Nil						
Data Book / Codes/Standards	Nil						
Course Category	**P**	**Professional Elective**	**Application**				
Course designed by	Department of Electronics and Communication Engineering						
Approval	30th Academic Council Meeting 24th March, 2016						

Purpose	This course introduces the learner on various types of measurement technique, equipments and advanced instruments used in electronic measurement.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, learners will be able to		**H**	**M**	**L**
1.	Understand various types of errors encountered during measurement and able to analyze the system response.	e	c	
2.	Obtain knowledge on the various analog and digital measuring instruments	c	e	
3.	Recognize on the architecture of various signal generation equipments.	e		c
4.	Familiarize with the principle and operation of advanced measuring instruments.		e	
5.	Acquire knowledge on computer based test system and the application based on VNA	c	e	

H-High Correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Measurements and Errors	**9**			
1.	Accuracy, Precision, Significant Figures, Types of Errors, Statistical Analysis, Limiting Errors	3	C	1	1
2.	Bridge Measurements (AC and DC bridges), Bourdon Tube, Pressure Gauge, and Measurement of Flow.	3	C,D	1	1,4
3.	Analysis of Linear Systems: Time Domain Response, Zero order and First order time domain system, First Order response for Step Input, Ramp Input &Impulse Input	3	C,D	1	1,4
	Unit-II: Electromechanical and Digital Indicating Instruments	**9**			
4.	PMMC Mechanism, DC Ammeters and Voltmeters, Series and Shunt Type Ohmmeter	3	C,D	2	1
5.	Alternating Current Indicating Instruments (Moving Iron instruments, electrodynamometer instrument)	3	C	2	1
6.	D/A and A/D Converters Digital Voltmeters, Vector Voltmeter, Guarding Techniques, Automation in Voltmeter	3	C	2	1,5
	Unit-III: Signal Generation and Analysis	**9**			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
7.	Sine Wave Generator, Sweep Frequency Generator, Pulse and Square wave Generator	3	C	3	1
8.	Function Generator Analyzer, Wave Analyzer, Distortion Analyzer	3	C	3	1
9.	Harmonic Distortion Analyzer, Spectrum Analyzer, Logic Analyzer.	3	C	3	1
	Unit-IV: Oscilloscopes and Advanced Instruments	**9**			
10.	Simple CRO, Dual Beam, Dual Trace Sampling Oscilloscope. Analog and Digital Storage Oscilloscope	3	C	4	4
11.	Scanning Probe Microscope-Atomic Force Microscope-Magnetic Force Microscope-Scanning Tunneling Microscope	3	C	4	4
12.	Data Acquisition Systems(DAS)- Single channel, Multi channel, Computer based DAS	3	C	4	4
	Unit-V: Computer Controlled Test Systems	**9**			
13.	Testing an Audio Amplifier, Testing a Radio Receiver, Instruments used in Computer Controlled Instrumentation, Microprocessor based System and Measurement case studies	4	C	5	1
14.	Interfacing transducers to Electronic control and measuring system	1	C	5	1
15.	Vector network analyzer(VNA),VNA based testing and measurement systems Antenna and Filter characteristic study	4	C,D,I	5	6,7,8
	Total contact hours	**45**	Exclusive of Assessment hours		

Learning Resources	
1.	Albert.D. Helfrick and William. D. Cooper, “Modern Electronic Instrumentation and Measurement Techniques”, PHI.Learning Private Limited 2010.
2.	H. S. Kalsi, “Electronic Instrumentation”, Tata McGraw Hill Publishing Company Ltd., 2010, 3rd edition.
3.	Earnest .O Doeblin, “Measurement Systems Application and Design”, McGraw Hill International editions, 5th edition, 2009.
4.	A.K. Sawhney, “A course in electrical and electronic measurements and instrumentation”, Dhanapat Rai & Sons, 2000.
5.	A.J. Bouwens, “Digital Instrumentation”, McGraw Hill, 1986.
6.	Fundamentals of Vector Network Analysis Primer, Accessed on April 6 2016, [Online] https://cas.web.cern.ch/cas/Denmark-2010/Caspers/anritsuVNAprimer%202009%20for%20CAS2010.pdf
7.	Basic RF Technic and Laboratory Manual - Vector Network Analyzer Measurement. Dr. Haim Matzner & Shimshon Levy. August, 2008. http://www.hit.ac.il/.upload/engineering/microwave_-_experiment_1_-_revision-network_analyzer.pdf
8.	Network Analyzer for Anritsu RF and Microwave Handheld Instruments- Measurement Guide, 2015. https://dl.cdn-anritsu.com/en-us/test-measurement/files/Manuals/Measurement-Guide/10580-00289H.pdf

Learning Resources	
9.	Ludwig Reimer, “Scanning Electron Microscopy: Physics of Image Formation and Microanalysis”, Springer science media, 2013.
10.	Gustaaf Van Tendeloo, Dirk Van Dyck, Stephen J. Pennycook, “Handbook of Nanoscopy: Vol. 1”, Wiley Publishers, 2012.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC226E	Sensors and Transducers	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**		**Application**	
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	To impart knowledge on various types of sensors and transducers used in industrial automation.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learners will be able to		**H**	**M**	**L**
	Obtain knowledge on the basic concepts of various sensors and transducers.	a	b	d
2.	Acquire knowledge in mechanical and electromechanical sensors.	a	b	d
3.	Understand the working principle of capacitive inductive sensor and transducers.	a	b	d
4.	Know the principle and operation of piezoelectric and electro chemical sensors.	a	b	d
5.	Familiarize on the application of sensor and transducers	a	b	d

H-High Correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Sensors and Transducers Characteristics	**9**			
1.	Definition, classification, Characterization, Electrical, mechanical, thermal, optical, biological and chemical	3	C	1	1,2,3,4
2.	Classification of errors, Error analysis	3	C	1	1,2,3,4
3.	Static and dynamic characteristics of transducers	2	C	1	1,2,3,4
4.	Performance measures of sensors	1	C	1	1,2,3,4
	Unit-II: Mechanical and Electromechanical Sensors	**9**			
5.	Resistive sensors: Potentiometer, strain gauge and electrode elements	4	C,D	2	1,2,3,4
6.	Magnetic sensors: Types, Principle, Requirement and Advantages	3	C,D	2	1,2,3,4
7.	Magneto resistive sensors: Hall Effect sensor, Eddy current sensors	2	C,D	2	1,2,3,4
	Unit-III: Capacitive, Inductive Sensors and Transducers	**9**			
8.	Capacitive sensors: Capacitance circuitry, Feedback type condenser microphone, Frequency modulating oscillator circuit, Dynamic capacitance variation.	3	C,D	3	1,2,3,4
9.	Applications: Proximity, Microphone, Pressure, Displacement	3	C,D	3	1,2,3,4
10.	Inductive transducers: LVDT, RVDT, Synchro, Microsync	3	C,D	3	1,2,3,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Applications: Pressure, Position, Angle and Acceleration				
	Unit-IV: Piezoelectric, Radiation, Electrochemical Sensors and transducers	**9**			
11.	Piezoelectric Materials and properties, Modes of deformation, Multimorphs, Environmental effects. Application: Accelerometer	4	C,D	4	1,2,3
12.	Radiation sensors: Photo conductive cell, Photo voltaic, Photo resistive, Fiber optic sensors, X-ray and Nuclear radiation sensors	3	C,D	4	1,2,3
13.	Electro Chemical sensors: Electrochemical cell, Polarization, sensor Electrodes	2	C,D	4	1,2,3
	Unit-V: Application of Sensors and Transducers	**9**			
14.	Film sensors, Micro scale sensors, Particle measuring systems	3	C,D	5	5,6
15.	Applications and case studies of sensors and transducers in Automobile: Fuel Injection System, Aeronautics: Tire Pressure Monitoring Systems, Machine tools and Manufacturing process: Diagnostics of machine tool linear axes, Home automation	6	C	5	5,6
	Total contact hours	**45**	Exclusive of Assessment hours		

Learning Resources	
1.	Ernest O. Doeblin, "Measurement System, Application and Design", Tata McGraw Hill Publishing Company Ltd., 5th Edition, 2008.
2.	Patranabis D, "Sensor and Actuators", Prentice Hall of India (Pvt) Ltd., 2006
3.	Ian Sinclair, "Sensor and Transducers", Elsevier India Pvt Ltd, 3rdEdtion, 2011.
4.	H. S. Kalsi, "Electronic Instrumentation", Tata McGraw Hill Publishing Company Ltd., 2010, 3rd edition.
5.	Sawhney.A.K, Puneethsawhney, "A Course in Electrical and Electronic Measurements and Instrumentation", DhanpatRai Publications, 2012.
6.	Web resources: http://lit.ie/News/News%20Documents/ETTA-ENGINEERING-TOPIC-2015-student.pdf http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6089941 http://www.phmsociety.org/sites/phmsociety.org/files/phm_submission/2015/phmc_15_036.pdf

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

Level-3 Elective Courses

15EC321E	Electromagnetic Interference and Electromagnetic Compatibility	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Electronics**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	To understand the basics of Electromagnetic Interference and Compatibility in System Design.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learners will be able to		**H**	**M**	**L**
1.	Acquire the knowledge of EMI/EMC Fundamentals and EMI coupling principles	a	f	h
2.	Understand the EMI Measuring Instruments and their usages	a	f	h, e
3.	Know about EMC standards, frequency assignment and spectrum conservation techniques	a	f	h
4.	Attain the knowledge of EMI control techniques	a	f	h
5.	To understand the concepts of EMC PCB design and interconnection techniques	a	f, b	h

H– High Correlation, **M-** Medium Correlation, **L-** Low Correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: EMI/EMC Concepts	**9**			
1.	Concepts of EMI and EMC and Definitions	1	C	1	1,2 ,4
2.	Classification of EMI/EMC - CE, RE, CS, RS, Units of Parameters	1	C	1	1
3.	Examples of EMI, Sources of EMI	2	C	1	1,2,3,4,5
4.	EMC between and within systems, Radiation Hazards	1	C	1	1,5
5.	ESD phenomena and effects	2	C	1	1,2,5
6.	Transient phenomena and suppression	1	C	1	1
7.	EMI coupling modes - CM and DM.	1	C	1	1,3
	Unit-II: EMI Measurements	**9**			
8.	Open Area Test sites	1	C	1	1,3
9.	Radiated interference measurements:Anechoic chamber, TEM cell, reverberating chamber, GTEM cell	2	C	1	1,3
10.	Conducted interference measurements: Characterization of conduction currents / voltages, conducted EM noise and power supply line, conducted EMI from equipment, immunity to conducted EMI	3	C	1	1
11.	LISN	1	C	1	1,2,3,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
12.	Antennas	1	C	1	2,3,5
13.	EMC analyzer	1	C	1	2,3,5
	Unit-III: EMC Standards	**9**			
14.	Need for standards, National and international standards	1	C	2	1,3,4,5
15.	MIL-STD-461/462, DO-160/ED-14, CENELEC and ETSI	1	C	2	1,3,4,5
16.	CISPR/IEC,FCC regulations, British Standards	1	C	2	1,3,4,5
17.	VDE standards, EURO norms	2	C	2	1,4
18.	EMI/EMC Standards in Japan, comparisons	1	C	2	1,4
19.	Frequency allocation and frequency assignment	1	C	2	1
20.	Spectrum conversation	2	C	2	1
	Unit-IV: EMI Control Techniques	**9**			
21.	Grounding, Shielding	3	C	3	1,2,3,5
22.	Electrical bonding	1	C	3	1,3
23.	CM Filter-DM Filter	1	C	3	1,3
24.	Power line filter design	1	C	3	1,2
25.	EMC connectors, EMC Gaskets	2	C	3	1,5
26.	Opto-Isolators, Isolation transformer	1	C	3	1
	Unit-V: EMC Design of PCBs	**9**			
27.	Cables and Connectors	1	C	5	2,3,5,6
28.	Digital and analogue circuit design	1	C,D	5	2,3,5
29.	Component selection and mounting	1	C	5	2,3
30.	PCB layout stackup, PCB trace impedance, trace Routing, and Grounding	3	C,D	5	2,3,5,6
31.	Cross talk control and Impedance control	1	C	5	2,3,5,6
32.	Decoupling and Zoning	2	C	5	2,3,6
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1	Prasad Kodali, “Engineering Electromagnetic Compatibility–Principles, Measurements, and Technologies”, IEEE press, 2001.
2	Clayton R.Paul, “Introduction to Electromagnetic Compatibility”, Wiley & Sons, 2nd Edition,2006
3	Henry W. Ott, “Noise Reduction Techniques in Electronic Systems”, John Wiley & Sons, 2009
4	BernharoQ’Keiser, “Principles of Electromagnetic Compatibility”, Artech house, 3rd Edition, 1986.
5	Tim Williams,“EMC for Product Designers”,Newnes, 4th Edition, 2007.
6	Mark I.Montrose, “Printed Circuit Board Design Techniques for EMC Compliance: A Handbook for Designers”, Wiley-IEEE Press, 2nd edition, 2000.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15EC322E	Fundamentals of MEMS			L	T	P	C
				3	0	0	3
Co-requisite:	Nil						
Prerequisite:	Nil						
Data Book / Codes/Standards	Nil						
Course Category	**P**	**Professional Elective**	**Electronics**				
Course designed by	Department of Electronics and Communication Engineering						
Approval	30th Academic Council Meeting , 24th March 2016						

Purpose	The learners will gain basic knowledge on MEMS (Micro Electro Mechanical System), various fabrication techniques and to design, analyze, fabricate and test the MEMS based components.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, learner will be able to		**H**	**M**	**L**
1.	Acquire the knowledge of MEMS and micro fabrication.	a	d	
2.	Understand` the essential electrical and mechanical concepts of MEMS.	a	d	
3.	Understand the electrostatic and thermal sensing principles and actuating technique.	a	d	b,j
4.	Attain the knowledge of piezoresistive, piezoelectric and magnetic sensing and actuating technique.	a	d	b,j
5.	Understand the concepts of polymer on optical MEMS.	a	d	j

H: high correlation, **M:** medium correlation **L:** low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Introduction to MEMS and Micro Fabrication	**9**			
1.	History of MEMS Development, Characteristics of MEMS: Miniaturization	2	C	1	1,4
2.	Micro electronics integration , Mass fabrication with precision	1	C	1	1,4
3.	Sensors and Actuators, Energy domain	1	C	1	1,2,4
4.	Micro fabrication process	1	C	1	1
5.	Silicon based MEMS processes- processing Anisotropic wet etching and Isotropic wet etching, Dry etching of silicon and Deep reactive ion etching (DRIE)	2	C,D	1	1,2,4
6.	New material and fabrication processing- points of consideration for processing	1	C	1	1,2,4
7.	Surface micromachining process- structural and sacrificial material.	1	C,D	1	1,4
	Unit-II: Electrical and Mechanical Concepts of MEMS	**9**			
8.	Conductivity of semiconductors , Crystal planes and orientations	2	C	2	1,3,4
9.	Stress and strain: definition, Relationship between	2	C,D	2	1,2,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	tensile stress and strain, Mechanical properties of Silicon and thin films				
10.	Flexural beam bending analysis under single loading conditions: Types of beam, longitudinal strain under pure bending, deflection of beam, Spring constant	2	C,D	2	1,2
11.	Torsional deflection, intrinsic stress, Resonance and quality factor	3	C,D	2	1,2
	Unit-III: Electrostatic and Thermal Principle Sensing and Actuation	**9**			
12.	Electrostatic sensing and actuation	1	C	3	1,4
13.	Parallel plate capacitor , Application: Inertial, pressure and tactile sensor, parallel plate actuator	2	C,D	3	1,4
14.	comb drive	1	C		
15.	Thermal sensing and Actuations: Thermal sensors, Actuators	2	C	3	1,4
16.	Applications: Inertial, flow and infrared sensors	3	C,D	3	1,3
	Unit-IV: Piezoresistive, Piezoelectric and Magnetic Principle Sensors and Actuator	**9**			
17.	Piezoresistive sensors : piezoresistive sensor material	2	C	4	1,4
18.	Stress in flexural cantilever and membrane	1	C	4	1
19.	Application of Piezoresistive sensors	1	C,D	4	1,4
20.	Piezoelectric sensing and actuation: piezoelectric materials properties, quartz, PZT, PVDF, ZnO, Applications	3	C,D	4	1,3,4
21.	Magnetic actuation: Principles, Deposition of magnetic materials, Design and fabrication of magnetic coil	2	C,D	4	1,3,4
	Unit-V: Polymer and Optical MEMS	**9**			
22.	Polymers in MEMS: polymide,SU-8, Liquid Crystal Polymer (LCP) , PDMS, PMMA , Parylene ,Fluorocarbon	3	C	5	1,3,4
23.	Polymer MEMS Applications	2	C,D	5	1
24.	Optical MEMS: passive MEMS optical components, lenses, mirrors	2	C,D	5	1,3
25.	Actuation for active optical MEMS.	1	C,D	5	1
26.	RF MEMS- Cases study	1	C,D	5	1
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	Chang Liu, “Foundations of MEMS”, Second Edition, Pearson , 2012
2.	Gaberiel M. Rebiz, “RF MEMS Theory,Design and Technology”,John Wiley & Sons, 2010.
3.	Charles P. Poole and Frank J. Owens, “Introduction to Nanotechnology”, John Wiley & Sons,2009.
4.	Julian W.Gardner and Vijay K Varadhan, “Microsensors, MEMS and Smart Devices”, John Wiley & sons, 2013.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC323E	Embedded System Design	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**		**Computers**	
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	This course presents fundamental concepts of Embedded system design and programming, Real time operating system.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Understand the basics of embedded system development tools and Atmel RISC Processors	e	a	
2.	Write C programs for Microcontrollers	e	a	
3.	Familiarize with the concepts of RTOS	e		d

H-High Correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
Unit-I: ATMEL RISC Processors and Development Tools		**9**			
1.	Introduction, Basics of developing for embedded systems	2	C	1	1
2.	Embedded system Initialization	2	C	1	1
3.	Atmel RISC Processors Architecture, Memory, Reset and interrupt functions	1	C	1	2,3
4.	Parallel I/O ports, Timer/Counters, Serial communication using UART, SPI, Analog Interfaces	3	C	1	2,3
5.	AVR RISC Assembly language instruction set	1	C	1	2,3
Unit-II:Elements of C Programming and Preprocessor Functions		**9**			
6.	Variables and constants, I/O operations, Operators and Expressions	2	C	2	2
7.	Control statements	1	C	2	2
8.	Functions, Pointers and Arrays, Structure and Unions, Memory types	3	C	2	2
9.	Real time methods	2	C,D	2	2
10.	Standard I/O and Preprocessor functions	1	C	2	2
Unit-III: IDE and Project Development		**9**			
11.	Code Vision AVR C Compiler and IDE: IDE Operation, C Compiler Options	3	C	1	2
12.	Compile and Make Projects, Program the target device, AVR code generator, Atmel AVR Studio debugger	2	C	1	2
13.	Project development: Process steps	1	C,D	1	2
14.	Example Projects	3	C,D	1	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
Unit-IV: RTOS Internals		**9**			
15.	Introduction to RTOS: scheduler, objects, services, key characteristics	2	C	3	1
16.	Tasks	2	C	3	1
17.	Semaphores	2	C	3	1
18.	Message queues	1	C	3	1
19.	Pipes, Event Registers, Signals, Condition variables	2	C	3	1
Unit-V:RTOS Services		**9**			
20.	Other RTOS services	1	C	3	1
21.	Exceptions and Interrupts	2	C	3	1
22.	Timer and timer services	2	C	3	1
23.	I/O subsystem	1	C	3	1
24.	Memory management	1	C	3	1
25.	Modularizing an application for concurrency	1	C	3	1
26.	Common design problems	1	C	3	1
	Total Contact Hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	Qing Li with Caroline Yao “Real-Time Concepts for Embedded Systems ” CMP books 2011
2.	Barnett, Cox, &O’Cull “Embedded C Programming and the Atmel AVR” Thomson Delmar learning 2006
3.	www.Atmel.com

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15EC324E	Introduction to Multimedia Communications			L	T	P	C
				3	0	0	3
Co-requisite:	Nil						
Prerequisite:	Nil						
Data Book / Codes/Standards	Nil						
Course Category	**P**	**Professional Elective**	**Communications**				
Course designed by	Department of Electronics and Communication Engineering						
Approval	30th Academic Council Meeting, 24th March 2016						

Purpose	To understand the multimedia communications and to know how communications and computing technologies bring new user experiences.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Understand the basic need of multimedia and components of multimedia	i	j, h	
2.	Implement the human communication through multimedia technology	j	f	k
3.	Understand the various multimedia standards	e	j	
4.	Employ the MPEG video compression techniques	a, j		
5.	Understand the functioning of streaming	a, j	h	

H-High Correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I:Multimedia Information Representation	**9**			
1.	Text, Unformatted text, Formatted text, hypertext	2	C, D	1	2
2.	Images, Graphics, Digitized documents, digitized pictures	2	C, D	1	2
3.	Audio, PCM speech, CD quality audio, Synthesized audio	2	C, D	1	2
4.	Video, Broadcast television, Digital video, Video content	3	C, D	1	2
	Unit-II:Multimedia Communications	**9**			
5.	Human Communication Model, Physical System, Symbol Encoding, Feeling, Memory, Cognitive System	3	C	1,2	1
6.	Evolution and convergence	2	C	1,2	1
7.	Technology Framework, Multimedia Technologies, Multimedia Networking, Multimedia Conferencing, Multicasting, Technologies for e-Content	2	C	1,2	1
8.	Standardization Framework, Research and Regulation, Technology and Education, Convergence and Regulatory Issues, Manufacturing and Marketing	2	C	1,2	1
	Unit-III:Frameworks for Multimedia Standardization	**9**			
9.	Standardization Activities	3	C	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Standards to Build a New Global Information Infrastructure (GII)				
10.	Standardization Processes on Multimedia Communications	2	C	3	1
11.	ITU-T Mediacom 2004 Framework for Multimedia Communications	2	C	3	1
12.	ISO/IEC MPEG-21 Multimedia Framework, IETF Multimedia Internet Standards	2	C	3	1
	Unit-IV:Applications Layer - MPEG	**9**			
13.	MPEG Applications, Digital TV and Storage Media	3	C	2, 4	1,3,4
14.	Multimedia Conferencing, Streaming Media, and Interactive Broadcasting	2	C	2, 4	1
15.	Media Description, Searching, and Retrieval	2	C	2, 4	1
16.	Media Distribution and Consumption	2	C	2, 4	1,3,4
	Unit-V:Middleware Layer - Media Streaming	**9**			
17.	Media Streaming , MPEG-4 Delivery Framework	2	C	5	1
18.	Streaming Video Over the Internet	3	C	5	1
19.	Challenges for Transporting Real-Time Video Over the Internet, End-to-End Architecture for Transporting MPEG-4 Video Over the Internet	2	C	5	1,3
20.	Broadband Access, Quality of Service Framework	2	C	5	1
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	K. R. Rao, Zoran S. Bojkovic and Dragorad A. Milovanovic, “Introduction To Multimedia Communications: Applications, Middleware, Networking”, Wiley Interscience, 1st edition, 2006.
2.	Fred Halsall, “Multimedia Communications: Applications, Networks, Protocols And Standards,” Pearson education, 4th edition, 2009.
3.	Chen, Chang Wen, Li, Zhu, Lian, Shiguo, “Intelligent Multimedia Communication: Techniques and Applications”, Springer-Verlag,2010.
4.	John William Woods, Multidimensional Signal, “Image, and Video Processing and Coding”, 2nd edition, Academic Press, 2012.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC325E	Digital Logic Design with PLDs and VHDL	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Electronics**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	Learning design of digital circuits is a fundamental necessity for designing practical systems. To develop standard design practices for digital circuits at a higher level of abstraction, a hardware description language is useful. This course provides necessary instruments to achieve that goal.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, leaner will be able to		**H**	**M**	**L**
1.	Apply advanced theorems to simplify the design aspects of various practical circuits.	b	c	k
2.	Design State Machines.	b	c	d
3.	Implement various digital circuits using Programmable Logic Devices.	b	e	k
4.	Implement combinational and sequential circuits using VHDL.	b	d	e

H-High Correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
Unit-I: Advanced Topics in Boolean Algebra		**9**			
1.	Shannon's Expansion theorem and its application	2	C	1	1
2.	Consensus theorem	1	C	1	1
3.	Reed-Muller Expansion technique	1	C,D	1	1
4.	Multiplexer logic as function generators	1	C,D	1	1
5.	Implementation of Multiple output logic functions	1	C,D	1	1
6.	Static and Dynamic hazards	1	D	1	1
7.	Design of static hazard; free and dynamic hazard; free logic circuits	2	C	1	1
Unit-II: Sequential Circuit Design		**9**			
8.	Mealy and Moore machines	3	C,D	2	1,2
9.	Clocked synchronous sequential circuit design procedure; state diagrams; state table; state reduction; state assignment	3	C,D	1,2	1,2
10.	Incompletely Specified Sequential Machines	3	C	1	1,2
Unit-III: Design with Programmable Logic Devices		**9**			
11.	Basic concepts, PROM as PLD	1	C	1,3	1,2
12.	Programmable Array Logic (PAL)	2	C,D	3	1,2
13.	Programmable Logic Array (PLA)	1	C	3	1,2
14.	Design of combinational and sequential circuits using	1	D	3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	PLD's				
15	Complex PLD (CPLD)	1	C,D	3	1,2
16.	Introduction to Field Programmable Gate Arrays (FPGA)	1	C	1,3	1,2
17.	Xilinx FPGAs-Xilinx 3000 series and 4000 series FPGA	2	D	3	1,2
Unit-IV: Introduction to VHDL		**9**			
18.	VHDL Description of combination circuits	1	C	1,4	3
19.	VHDL Modules; Entity and Architecture description	1	C	4	3
20.	Sequential statements and VHDL processes	1	C	4	3
21.	VHDL Data types and Operators	1	C	4	3
22.	Concurrent and Sequential Assignment Statements (All types)	1	C	4	3
23.	Different types of Modeling in VHDL; Behavioral, dataflow and structural modeling	2	C,D	4	3
24.	Variables, Signals and Constants in VHDL	1	C	4	3
25.	Package in VHDL	1	C,D	4	3
Unit-V: Digital Design with VHDL		**9**			
26.	Combinational Circuit Design using Structural, behavioral and data flow modeling (Circuits like Arithmetic circuits, decoders, encoders, multiplexers, demultiplexers, code converters, 4-bit binary adders, BCD adder, comparator, ALU etc.,)	4	C,D	1,4	3
27.	Design of Sequential Elements	2	C,D	2,4	3
28.	Registers	1	C	4	3
29.	Counters and Synchronous Sequential Circuits using VHDL	2	C,D	1,4	3
	Total Conduct Hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	Charles H. Roth, Jr. University of Texas at Austin. Larry L. Kinney, "Fundamentals of Logic Design", 7th edition, Cengage Learning, 2012
2.	Jayaram Bhasker, "A VHDL Primer", 3rd edition, Prentice Hall, 2011.
3.	Richard S. Sandige, Michal L. Sandige, "Fundamentals of digital and computer design with VHDL", MGH, Edition 2014

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC326E	Embedded C	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Computers**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting 24th March 2016				

Purpose	To explore embedded systems architecture hardware and firmware. This course uses a bottom-up approach in gradually building and optimizing embedded software. This course emphasis on C program for AVR microcontroller and several interfacing concepts.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Obtain in-depth knowledge about microcontroller architecture and its design principles.	a,b	e	k
2.	Gain knowledge in embedded C programming and its Optimization techniques.	b	k,i	a
3.	Acquire skills on AVR microcontroller architecture programming on Interfacing concepts.	d	b ,c	j

H-High Correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
Unit-I : Architecture and Design		**9**			
1.	Benefits of C in Embedded Systems	1	C	1	1
2.	Problem Specification: Product Requirements, Hardware Engineering, Software Architecture, Pseudocode, Flowchart, StateDiagram, Resource Management	2	C	1	1
3.	Microcontroller Architecture and features: The Central Processing Unit (CPU), Memory Addressing and Types	2	C	1	1
4.	Timers, Interrupt Circuitry, I/O Ports	2	C	1	1
5.	Design Process: Product Functionality, Hardware Design,Software Design, Resource Management, Testing Choices	2	D	1	1
Unit-II : Embedded C Programming		**9**			
6.	C for Embedded Systems	1	C	1	1
7.	Data Types and Variables	5	C	1	1
8.	Data Type Modifiers		C	1	1
9.	Storage Class Modifiers		C	1	1
10.	C Statements, Structures, and Operations	2	C	1	1
11.	Libraries	1	C	1	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
Unit-III: Optimizing and Testing Embedded C Programs		**9**			
12.	Code Optimization Technique	4	C	2	1
13.	Profiling and Cycle Counting	1	C	2	2
14.	Instruction Scheduling	1	C	2	2
15.	Register Allocation	1	C	2	2
16.	Endianness	1	C	2	2
17.	Portability Issues.	1	C	2	2
Unit-IV: C Programming for AVR microcontroller		**9**			
18.	C data types	2	C	3	3
19.	I/O Programming in C	1	C	3	3
20.	Logic Operations in C	1	C	3	3
21.	Data Conversion Programs in C	1	C	3	3
22.	Data Serialization in C	1	C	3	3
23.	AVR hardware connection: ATMEGA 32 Pin connection	1	C	3	3
24.	AVR fuse bits	1	C	3	3
25.	Loading HEX file into AVR microcontroller	1	C	3	3
Unit-V: Interfacing with AVR and PWM programming in AVR		**9**			
26.	Interfacing an Optoisolator	1	C	3	3
27.	Stepper motor interfacing	2	C	3	3
28.	LCD interfacing	1	C	3	3
29.	ADC interfacing	1	C	3	3
30.	DC motor interfacing and PWM design issues: DC motor interfacing and PWM	2	C	3	3
31.	DC motor control using PWM	1	C	3	3
32.	DS1307 RTC interfacing	1	C	3	3
	Total Conduct Hours	**45**	Exclusive of assessment hours		

LEARNING RESOURCES	
1.	Kirk Zurell, “C Programming for Embedded Systems”, Illustrated Edition, Taylor & Francis, 2000.
2.	Andrew Sloss, Dominic Symes, Chris Wright, “ARM System Developer's Guide: Designing and Optimizing System Software”, Morgan Kaufmann, 2004.
3.	Muhammad Ali Mazidi, “The AVR microcontroller and Embedded system using assembly and C”, Pearson education, 2011.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC327E	ASIC Design	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Electronics**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting 24th March, 2016				

Purpose	The purpose of this course is to introduce the students the basics of designing and using ASIC's. The operation of tools used in the design is also explained.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the leaner will be able to		**H**	**M**	**L**
1.	Achieve basic knowledge of ASIC internals.	a	c	d
2.	Achieve impart knowledge on ASIC types and tools used	c	d	i
3.	Attain basic understanding of necessary tools.	d	i	j

H-High Correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
Unit-I: Introduction to ASICs		**9**			
1.	Introduction to ASICs; Types of ASIC	1	C	1	1
2.	ASIC design flow	1	C	1	1
3.	ASIC cell libraries	1	C	1	1
4.	CMOS logic: CMOS fabrication process	1,4	C	1	1
5.	CMOS transistors	1,4	C,D	1	1
6.	CMOS process theory	1,4	C	1	1
7.	CMOS design rules	1,4	D	1	1
8.	Combinational logic design	1,4	D	1	1
9.	Sequential logic design	1,4	D	1	1
Unit-II: Programmable ASICs		**9**			
10.	Programmable ASICs: Anti fuse	1	C	2	1
11.	Static RAM	1	C	1,2	1
12.	EPROM and technology	1	C	1,2	1
13.	Programmable ASIC logic cell: Altera flex	1	C,D	2	1
14.	I/O cells: DC output, AC output, Clock input	2	C	2	1
15.	Interconnects: Actel ACT & Xilinx LCA	2	C,D	2	1
16.	Low level design entry: Hierarchical design entry.	1	C	1,2	1
Unit-III: Simulation and Synthesis		**9**			
17.	Logic synthesis: A comparator MUX	2	C	2	1
18.	Inside a logic synthesizer	1	C	2	1
19.	VHDL and logic synthesis	2	C,D	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
20.	FSM synthesis	1	C,D	3	1
21.	Memory synthesis	1	C	2,3	1
22.	Simulation: Types of simulation; logic systems	1	C	2,3	1
23.	Static timing analysis	1	C,D	2	1
Unit-IV: ASIC Testing		**9**			
24.	Boundary scan test	2	C	2	1
25.	Faults	2	C	2	1
26.	Fault simulation	1	C	2,3	1
27.	Automatic Test Pattern Generation algorithm: D-algorithm	1	C,D	2,3	1
28.	PODEM	1	D	2	1
29.	Built in self test	1	D	2	1
30.	A simple test example	1	D	1,2	1
Unit-V: ASIC Construction		**9**			
31.	System partitioning	1	C,D	2,3	1
32.	Power dissipation	1	C	2	1
33.	Partitioning method: KL algorithm	1	C,D	3	1
34.	Simple iterative & constructive partitioning algorithm	1	C,D	3	1
35.	Floor planning: measurement of delay, Placement: goals and objectives; min-cut algorithm, Iterative placement improvement	2	C,D	3	1
36.	MRST algorithm	2	C	3	1
37.	Routing: Global, detailed, and special routing	1	C	2,3	1
	Total Contact Hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	Smith.M.J.S, “Application Specific Integrated Circuits”, Addison Wesley Longman Inc., 1996. (Pearson Education Reprint 2006).
2.	Sarafzadeh.M. and Wong.C.K, “An Introduction to VLSI Physical Design”, McGraw Hill, 2nd Edition, 1996.
3.	Design manuals of Altera, Xilinx and Actel.
4.	Jan M. Rabaey. AnanthaChandrakasan, Borivoje Nikolic, “Digital Integrated Circuits”, Prentice-Hall Publication, 2nd Edition, 2002.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15EC328E	CMOS Analog IC Design	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Electronics**		
Course designed by	Department of Electronics and Communication				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	The purpose of the course is to introduce the design methods for op-amps, CMOS, BiCMOS, CMOS comparator and analog multiplier.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, learner will be able to		**H**	**M**	**L**
1.	Design MOSFET amplifiers	c	e	
2.	Analyse and design bipolar op-amp, CMOS	c	e	a
3.	Analyse and design 741 op-amp, BiCMOS	c	e	a
4.	Understand and design RAM and ROM memories	c	e	
5.	Analyse and design the nonlinear analog circuits such as CMOS comparator and analog multiplier	c	e	a

H-High Correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I : Overview of MOSFET: Device Operation, Characteristics and Analysis	**9**			
1.	MOS structure, N-channel enhancement mode MOSFET	1	C	1	1-5
2.	Current-voltage characteristics, MOSFET DC circuit analysis	3	C	1	1-5
3.	Graphical analysis, Load lines, Small-signal parameters and equivalent circuits	1	C	1	1-5
4.	Small-signal analysis of MOS differential pairs with resistive load and active load	2	C,D	1	1-5
5.	Small-signal analysis of BJT differential pairs with resistive load and active load	2	C,D	1	1-5
	Unit-II: Op-Amp Circuit Design-I	**9**			
6.	Bipolar op-amp circuit: Circuit diagram, DC analysis, Small-signal analysis, Frequency response,	4	C,D	2	1
7.	CMOS op-amp circuit: MC14573 CMOS op-amp circuit, Folded cascode op-amp circuit, CMOS current-mirror op-amp circuit, CMOS cascode current-mirror op-amp circuit	5	C,D	2	3,4,5
	Unit-III : Op-Amp Circuit Design-II	**9**			
8.	741 op-amp circuit: Circuit diagram, DC analysis, Small-signal analysis, Gain, Frequency response and slew rate	5	C,D	3	5
9.	BiCMOS op-amp circuit: BiCMOS folded cascode op-amp circuit, DC analysis, Small-signal analysis	4	C,D	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-IV : Memories	**9**			
10.	Latches, Flip-flops, Registers-its CMOS implementation	1	C,D	4	1,5
11.	Classification of memories, Basic memory architecture	1	C,D	4	1,5
12.	RAM memory cells : Static RAM, Dynamic RAM	2	C,D	4	1,5
13.	Memory peripheral circuits: Sense amplifier, Row-adder decoder, Column-adder decoder, Pulse generation circuits	3	C,D	4	1,5
14.	ROM memory cells: Mask programmable ROM, User programmable ROM, EPROM	2	C,D	4	1,5
	Unit-V: Non-Linear Analog Circuits	**9**			
15.	CMOS comparator: Basic CMOS comparator design, Comparator characteristics, Amplifier based comparator, Comparator using charge-balancing techniques, Latched comparators	6	C,D	5	1,2,3,4
16.	Analog multipliers: Multiplying quad, Multiplier design using squaring circuits	3	C,D	5	1,2
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	R. Jacob Baker, "CMOS: Circuit Design, Layout, and Simulation", 3rd edition, Wiley, 2010.
2.	TertulienNdjountche, "CMOS Analog Integrated Circuits: High-Speed and Power-Efficient Design", CRC Press, 2011.
3.	Tony Chan Carusone, David A. Johns, Kenneth W. Martin, "Analog Integrated Circuit Design", Wiley, 2012.
4.	Phillip E. Allen, Douglas R. Holberg, "CMOS Analog Circuit Design", 3rd edition, Oxford University Press, 2012.
5.	Adel S. Sedra, Kenneth C. Smith, "Microelectronic Circuits: Theory and Applications", Oxford University Press, 2014.

Course nature				**Theory**			
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC329E	Communication Switching Techniques	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**		**Communication**	
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	To study the fundamental concepts of switching, signaling, and traffic management in the context of telecommunication networks.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Design the basic switching systems in Telecommunication network	a	e	
2.	Solve problems in single-stage networks, strict-sense non-blocking networks, and sectionalized switching networks in Grade of Service.	a	e	c
3.	Gain the Knowledge on statistical methods for estimating the traffic in various systems and be able to solve the congestion problems.	a	e	
4.	Understand the types of switch fabrics for high speed applications.	a		e
5.	Analyze the concept of IP switching techniques and broadband networks.	c		

H-High correlation **M** –Medium correlation **L-** Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I:Basic Switching Systems for Telecommunication	**9**			
1.	Crossbar switching	1	C	1	1
2.	Electronic space division switching	1	C	1	1
3.	Time division switching	1	C,D	1	2
4.	n-stage combination switching (2,3,5,7 stages)	4	C,D	1	2
5.	Hybrid time and space division multiplexes	2	C,D	1	2
	Unit-II: Switching Networks	**9**			
6.	Single-stage networks , Gradings , Link systems	3	C,D	2	1
7.	Grades of service of link systems (2,3,5,7 stages) , Grades of service of Time division switching networks	3	C,D	2	1
8.	Strict-sense non-blocking networks, Sectionalized switching networks.	2	C,D	2	1
9.	Call packing , Re-arrangeable Clos networks	1	C,D	2	1
	Unit-III:Traffic Engineering	**9**			
10.	Congestion , Network traffic load and Parameters	1	C,D	3	1
11.	Traffic measurement	1	C	3	1
12.	Modeling switching systems	1	C,D	3	1
13.	Lost-call system	1	C,D	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
14.	Grade of Service and Blocking probability	1	C,D	3	1
15.	Incoming traffic and service time characterization	1	C	3	1
16.	Queuing systems	3	C,D	3	1
	Unit-IV:Switching Architectures	**9**			
17.	Issues and Performance analysis	2	C	4	3
18.	Banyan and Knockout switches	2	C,D	4	3
19.	Single and Multistage networks	3	C,D	4	3
20.	Shuffle switch tandem banyan	2	C	4	3
	Unit-V: Broadband Network and IP Switching	**9**			
21.	Local and wide area network, Large scale networks, Broadband networks.	3	C	5	1
22.	Integrated services digital network (ISDN)	2	C	5	1
23.	ATM Standard ,IP over ATM	2	C	5	4
24.	IP protocol and MPLS protocol	2	C	5	4
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	Flood.J.E, “Telecommunications Switching, Traffic and Networks”, Pearson Education Ltd., 2012
2.	ThiagarajanViswanathan, “Telecommunication Switching Systems and Networks”, Prentice Hall of India Pvt. Ltd, Second edition, 38th Reprint, 2015
3.	AchillePattavina, “Switching Theory Architectures and performance in Broadband ATM networks”, John wiley& sons Ltd,New York, 1998.
4.	Christopher Y Metz, “IP Switching Protocols & Architectures”, McGraw Hill Professional Publishing, New York, 1999

Course nature					**Theory**		
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC330E	RADAR and Navigational Aids	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Communication**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March, 2016				

PURPOSE	To understand the basic concepts in the field of RADAR Communication and to learn about radar signal detection and propagation.			
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**		
At the end of the course, learner will be able to		**H**	**M**	**L**
1.	Gain knowledge about RADAR theory and equations.	a	e	
2.	Understand different types of RADAR and their working principles.	a	e	b
3.	Gain knowledge on RADAR signal detection methods.	b		
4.	Understand about radio navigation techniques.	a	e	
5.	Acquire information about RADAR transmitters and receivers	c		

Session	Description of Topic	Contact hours	C-D-I-O	IOs	References
	Unit-I: Basics of RADAR	**9**			
1.	RADAR block diagram, Operation & Applications	2	C	1	1,3,4
2.	RADAR frequencies, RADAR range equation, Detection of signals in noise	2	C	1	1,3,4
3.	RADAR cross section of targets, RADAR cross section fluctuations,Transmitter power	2	C	1	1,3,4
4.	Pulse repetition frequency, System losses and Propagation effects	3	C	1	1,3,4
	Unit-II: Moving Target Indicator (MTI) and Pulse Doppler RADAR	**9**			
5.	Introduction to Doppler & MTI RADAR, Delay Line canceller	2	C	2	1
6.	Non-Coherent MTI, CW RADAR	3	C	2	1
7.	FMCW RADAR, Tracking RADAR: Monopulse Tracking, Conical Scan and Sequential Lobing	4	C	2	1
	Unit-III: RADAR Signal Detection & Propagation	**9**			
8.	Detection criteria : Automatic detection	2	C	3	1,3
9.	Constant false alarm rate receiver, Ambiguity diagram, Linear FM pulse compression	4	C	3	1,3
10.	Introduction to clutter, Surface clutter RADAR equation, Anomalous propagation	3	C	3	1,3
	Unit-IV: Radio Navigation	**9**			
11.	Adcock directional finder, Automatic directional finder	2	C	4	2,5
12.	Radio Compass, Decca Navigation System	2	C	4	2,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	References
13.	Tactical Air Navigation ,Instrument Landing System	2	C	4	2,5
14.	Ground Controlled approach , Microwave Landing System	3	C	4	2,5
	Unit-V: RADAR Transmitter and Receiver	**9**			
15.	RADAR Transmitter, Linear beam power tubes, Solid state RF power sources, solid state devices used in RADAR	2	C	5	1,6
16.	Magnetron- crossed field amplifiers – other aspects of radar transmitter	2	C	5	1,6
17.	RADAR Receiver, Receiver noise figure, Super heterodyne receiver	3	C	5	1,6
18.	Dynamic range – RADAR Displays	2	C	5	1,6
	Total contact hours	**45**	Exclusive of contact hours		

Learning Resources	
1.	Skolnik.M.I, “Introduction to RADAR systems”, Mc-Graw Hill, 3rd Edition, 2001.
2.	Nagaraja.N.S. “Elements of Electronic Navigation”, Tata Mc-Graw Hill, 2nd Edition, 2009.
3.	Mark, Richards.A, “Fundamentals of radar signal processing”, Mc-Graw Hill, Electronic Engineering, 1st Edition, 2005.
4.	Brookner, “RADAR Technology”, Artech House, 1st edition, 1986.
5.	Bagad.V.S, “Radar Systems”, Technical publications, 1st edition,2008.
6.	NadavLevanon, “RADAR Principles”, John Wiley and Sons, 3rd Edition,1989.

Course nature					**Theory**		
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC331E	Advanced Digital Signal Processing	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	**P**	**Professional Elective**	**Signal Processing**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting 24th March , 2016				

Purpose	To enable the students to understand advanced digital signal processing techniques.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, learner will be able to		**H**	**M**	**L**
1	Estimate power spectrum using non parametric and parametric methods.	a	e	
2	Gain knowledge on adaptive filtering techniques using LMS algorithm, applications and RLS method	a	e	
3	Acquire knowledge on multirate signal processing techniques and applications	a	e	
4	Understand the design of Lattice and Weiner filters.	a	e	b
5	Understand digital model, time domain model for speech signals and Linear predictive coding technique	a	e	

H-High correlation **M** –Medium correlation **L**- Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I:Non-Parametric and Parametric Methods for Power Spectrum Estimation	**9**			
1.	Non parametric methods: Barlett method, Welch method, Black man and Tukey method	2	C,D	1	1
2.	Relationship between the auto correlation and the model parameters	1	C	1	1
3.	The Yule – Walker method for the AR Model Parameters	2	C,D	1	1
4.	The Burg Method for the AR Model parameters	1	C,D	1	1
5.	Unconstrained least-squares method for the AR Model parameters	1	C,D	1	1
6.	Sequential estimation methods for the AR Model parameters	1	C,D	1	1
7.	Selection of AR Model order	1	C,D	1	1
	Unit-II: Adaptive Signal Processing	**9**			
8.	MMSE criterion – LMS algorithm – properties of LMS algorithms	2	C	2	1
9.	Application: noise cancellation – channel equalization - Echo cancellation	2	C,D	2	1
10.	Linear predictive coding of speech signals-	3	C,D	2	1
11.	Adaptive direct form filters-RLS algorithm.	2	C,D	2	1
	Unit-III: Multirate Signal Processing	**9**			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
12.	Decimation by a factor D	1	C,D	3	1,4
13.	Interpolation by a factor I	1	C,D	3	1,4
14.	Sampling rate conversion rate by rational factor I/D	1	C,D	3	1,4
15.	Filter design and Implementation of sampling rate conversion	2	C,D	3	1,4
16.	Multi stage implementation of sampling rate conversion	2	C,D	3	1,4
17.	Applications of multi rate signal processing.	2	C	3	1,4
	Unit-IV: Lattice and Weiner Filters	**9**			
18.	FIR Lattice filter	2	C,D	4	2
19.	IIR Lattice filter	2	C,D	4	2
20.	FIR Weiner filter	3	C,D	4	2
21.	IIR Weiner filter	2	C,D	4	2
	Unit-V: Speech Signal Processing	**9**			
22.	Digital models for speech signal : Mechanism of speech production – model for vocal tract, radiation and excitation– complete model	3	C	5	3
23.	Time domain processing of speech signal:- Pitch period estimation – using autocorrelation function	3	C,D	5	3
24.	Linear predictive Coding: Basic Principles – autocorrelation method – Durbin recursive solution	3	C,D	5	3
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	John G.Proakis, DimitrisG.Manolakis, “Digital Signal Processing, Principles, Algorithms and Applications”, Fourth edition, Pearson Education, 2014.
2.	Monson H.Hayes, “Statistical Digital Signal Processing and Modeling, John Wiley &Sons,Inc, 2008.
3.	L.R.Rabiner and R.W.Schafer, Digital Processing of Speech Signals, Pearson Education, 2009.
4.	Roberto Cristi, “Modern Digital Signal Processing”, Illustrated Edition, Thomson/ Brooks/Cole, 2004.

Course nature					**Theory**		
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15EC332E	Advanced Microcontrollers	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**		**Computers**	
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March , 2016				

Purpose	To introduce the advanced features of Microcontrollers and learn the design aspects of RISC and MSP430.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, learner will be able to		**H**	**M**	**L**
1.	Understand fundamental operating concepts behind microcontrollers.	a	b	c
2.	Understand the advantages in using RISC architecture in engineering applications.	a	b	d
3.	Familiarize the instruction set of ARM processor and its programming	c	b	a
4.	Design microcontroller based solutions to real time problems.	c	b	a
5.	Apply this knowledge to more advanced structures like MSP430 microcontroller.	c	b	d

H: High Correlation, M: Medium Correlation, L: Low Correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: ARM Processor Fundamentals	9			
1.	Registers,CPU,Pipeline	2	C	1	1,2
2.	Exceptions, Interrupts, Vector table	2	C	1	1,2
3.	Core extensions	1	C	1	1,2
4.	ARM architecture, Architecture revisions	2	C	1	1,2
5.	ARM organization, ARM Processor families	2	C	2	1,2
	Unit-II: High Performance RISC Architecture and Programming	9			
6.	Data Process instruction	1	C	3	1,2
7.	Branch and Load instruction	1	C	3	1,2
8.	Software interrupts	1	C	3	1,2
9.	Thumb instruction set, Thumb register usage	2	C	3	1,2
10.	ARM thumb network	1	C	3	1,2
11.	Stack instructions	1	C	3	1,2
12.	Basic ARM Assembly language programs,Binary sorting	2	D	4	1,2
	Unit-III: Memory Management	**9**			
13.	Memory Hierarchy	1	C	2	1,2
14.	Coprocessor and Cache memory	2	C	2	1,2
15.	Memory management	2	C	2	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
16.	ARM CPU cores	1	C	2	1,2
17.	NuvoTon Cortex M0(Nu-LB-NUC140) Architecture and supporting tools	3	D	4	5
	Unit–IV: MSP430 Microcontroller Overview	**9**			
18.	Functional Block diagram of MSP430F2003-Memory Mapped	2	C	5	3,4
19.	CPU, Exceptions, Architecture of MSP430 Processor	3	C	5	3,4
20.	A simple tour of MSP430- Light LED in C and Assembly Language	3	D	4,5	3,4
21.	Read input from switch	1	C	5	3,4
	Unit-V: Instruction Set and Addressing Modes of MSP430	**9**			
22.	Addressing Modes of MSP430	2	C,D	4,5	3,4
23.	Instruction Set, Function	2	C,D	4,5	3,4
24.	Interrupts, Digital in-outs	2	C	5	3,4
25.	Timer, Communication	3	C	5	3,4
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	K. M. Bhurchandi and A. K. Ray, "*Advanced Microprocessors and Peripherals-with ARM and an Introduction to Microcontrollers and Interfacing* ", Tata McGraw Hill, 3rd edition 2015.
2.	Andrew N. Sloss, Dominic Symes, Chris Wright and John Rayfield, *"ARM System Developer's Guide, Designing and Optimizing System Software"*, Elsevier, 2004.
3.	John H. Davies, *"MSP430 Microcontroller Basics"*, Elsevier, 2008.
4.	Manuel Jimenez, Rogelio Palomera, IsidoroConvertier, "*Introduction to Embedded systems using Microcontrollers and the MSP430",* Springer 2014.
5.	Nuvoton Lab Manual (www.nuvoton.com)

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC333E	Communication Network Protocols	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**		**Computers**	
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March, 2016				

Purpose	To introduce the emerging areas in internetworking and to acquire knowledge of different components involved in the seamless working of the internet.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Understand the need for internetworking, different network technologies and network models.	c	i	
2.	Apply the Engineering concepts that describe the internet addressing and packet formats.	k	c	i
3.	Understand the routing architecture and algorithms.	k	c	i
4.	Gain knowledge about the client server model.	k	i	
5.	Understand the internet security and firewalls.	k	i	

H: High Correlation, M: Medium Correlation, L: Low Correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Review of Underlying Network Technologies	**9**			
1.	Motivation for Internetworking- Internet Services , Network communication approaches- Wide and LAN	2	C	1	1,4
2.	Network Models and Network Architectures, Protocol Design Issues, Network Building Blocks: Transmission, Multiplexing and Switching	4	C	1	1,4
3.	Protocol Layering and Protocol Framework (SP3), Link Level Protocols, IETF and the Internet Standards Process	3	C	1	1,4
	Unit-II: Internet Addresses	**9**			
4.	LAN Protocols, LAN Design and Implementation, Ethernet Switching, Wireless Networks, 802.11	3	C	2	2
5.	Internet Protocol (IP) Design, Internet Addressing Internetworking and Routing, VLANs Classful Internet Addresses , Subnetting and Supernetting	2	C	2	2
6.	IPv6 Protocol Design, IPv6 Addressing	4	C	2	2
	Unit-III: Routing	**9**			
7.	Transport Layer Protocol Design, TCP and UDP Internet Protocol, Connectionless Datagram Delivery	2	C	3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
8.	TCP Congestion Control, Connection Management, Network Address Translation (NAT)IPV4 data grams , Packet format, Forwarding IP Datagrams	3	C	3	1,2
9.	Routing Architecture –Core , Peers and Algorithms, Routing between peers- Border Gateway Protocol (BGP)	2	C, D	3	1,2
10.	Routing within Autonomous systems-Routing , Information Protocol- RIP- OSPF	2	C	3	1,2
	Unit-IV: Client Server Model and Socket Interface	**9**			
11.	The client server model , UDP echo server, Time and date service -Socket abstraction	3	C,D	4	1,4
12.	Specifying local and destination addresses, Sending and Receiving data-Handling multiple services	3	C	4	1,4
13.	Domain name system – Distribution of name space, DNS resolution, DNS messages and records	3	C	4	1,4
	Unit-V: Internet Security and IPV6	**9**			
14.	Protecting resources – IPSec, Authentication Header-Encapsulating security payload	3	C	5	1,4
15.	Secure sockets-Secure Socket Layer (SSL), Firewalls and Internet access, Packet filter firewall, Proxy firewall	3	C	5	1,4
16.	IPv6-Features and packet format- IPV6 Source routing types, Comparison between IPV4 and IPV6	3	C	5	1,4
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	Douglas E. Comer, “Internetworking with TCP/IP”, Principles, Protocols and Architectures”, Pearson Education, Vol. I, 6th Edition, 2014.
2.	Behrouz A. Forouzan, “TCP/IP protocol suite”, Tata McGraw Hill, 4th Edition, 2010.
3.	Peterson (David. M.), “TCP/IP Networking”, Tata McGraw Hill, 5th Edition, 2011.
4.	Douglas E. Comer, M.S.Narayanan, “Computer Networks with internet applications”, Addison Wesley, 4th Edition, 2010.

Course nature							**Theory**
Assessment Method – Theory Component (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC334E	Communication for Micro / Nano Robots	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**		**Application**	
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting ,24th March 2016				

Purpose	To explore advancements in the field of robotics and its communication.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Learn the basics of robotics.	d		a
2.	Understand the concept of miniaturization in robotics.	d	c	a
3.	Familiarize with the concept of communication in micro robots.	d	a	
4.	Enhance expertise in designing robots.	c,d	a	
5.	Perform robotics based projects.	a,d	c	

H: High Correlation, M: Medium Correlation, L: Low Correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Introduction	**9**			
1.	Micro/nano robotic system components, products.	1	C	1,2	1,2
2.	Scaling effects at micro-nano scales, Kinematics and Dynamics of Robot.	1	C	1,2	1,2,5,6
3.	micro/nano robotic system: examples around the world: wall climbing micro robots, micromechanical flying robots.	2	C	2	1,2
4.	Design, fabrication, characterization of micro gripper. Micro/nanofabrication techniques-Photo lithography, electron beam, X-ray, Ion beam lithography, LIGA process.	3	C,D	1,2,4,5	1,2,5,6
5.	Introduction to nano manipulation, control and applications, bottom up and top down approach.	2	C,D	1,2	1,2,5,6
	Unit-II: Micro / Nano Sensors	**10**			
6.	Nanoscale sensor: bio sensor, Imaging sensors.	2	C	4,5	1,2
7.	Position sensors, Encoder, resolver, LVDT-Capacitive sensors.	2	C	4,5	1,2
8.	Interferometric sensors, STM Tips based sensor, force and pressure sensor	2	C	4,5	1,2
9.	Strain gauge, Thermal sensor, AFM: Visual force sensing	2	C	4,5	1,2
10.	Accelerometers, Gyroscopes, chemical sensors,	2	C	4,5	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	flow sensors.				
	Unit-III: Visible Light Communication for micro/ Nano Robots	**9**			
11.	IR based perception, Implementation, open issues, RF via IR.	3	C	3,5	2
12.	Influence of ambient light on communication/reflection, Recognition of communication signals by hardware .interruption.	3	C	3,5	2
13.	Problems of hardware related protocols, appearance of communication dead zones, non linear radiation patterns, Importance of synchronization of channels.	3	C	3,5	1,2
	Unit-IV: RF Communication for Micro/Nano Robots	**7**			
14.	Communication between robots:point to point radio communication.	2	C, D	3,5	7,8
15.	Wireless networking, Zigbee technology in robotics.	2	C,D	3,5	7,8
16	Adhoc communication architecture. Robot swarm communication networks: Architectures, Protocols and Applications.	3	C,D	3,5	7,8
	Unit-V: Applications of Micro Robots	**10**			
17	Biologically inspired miniature space robots and performance models of nano and bio robots.	3	C	2,4,5	3,4
18	Medical nano robots feasibility, nano robots in nano medicine, protein based nano motors and nano robots.	3	C	4,5	3,4
19	Micro scale locomotion in fluids, Actuation methods for swimming micro robots, fabrication of helical micro structures, swam control in biomedical applications.	2	C	4,5	3,4
20	Surgical micro robots, nano robots in drug delivery system.	2	C	4,5	3,4
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	Elwenspoek.M and Wiegerink.R, “Mechanical Microsensors”, Illustrated Edition, Springer Science & Business Media, 2012 .
2.	Tai–Ran Hsu, “MEMS and Microsystem: Design and Manufacture and Nanoscale Engineering”, Illustrated Edition, John Wiley & Sons, 2008.
3.	Katherine E peyer, Li Zhang and Bradely J. Nelson, “Bio-inspired magnetic swimming micro robots for biomedical applications”, Nanoscale, 2013,5, 1259-1272, DOI: 10.1039/C2NR32554C
4.	SoichiroTottori, LiZhang, FaminQiu, Krawczyk, Alfredo Franco-obregon and Bradley J.Nelson, “Magnetic Helical Micromachines: Fabrication, controlled swimming and cargo transport”, Wiley, 2012.
5.	Jake J.Abbott, Zoltan Nagy, Felix Beyeller and Bradley J.Nelson, “Robotics in small”, IEEE Robotics &Automation Magazine, 2007.

Learning Resources	
6.	Michel Wautelet, “Scaling laws in the macro-micro- and nanoworlds”, European Journal of physics, 2001.
7.	S. Kornienko, S. Kornienko, “IR-based communication and perception in microrobotic Swarms”, Workshop on collective and swarm robotics, University of Stuttgart, Germany, 2010.
8.	Ming Li, KejieLu, Min Chen, Shiwen Mao, “Robot Swarm communication Networks: Architecture, Protocols, Applications”, IEEE, 2008.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC335E	Fundamentals of RF System Design	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Communication**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	To familiarize with the modelling of RF system design in the field of communication system.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Design and analyze various RF filters and basic Resonators.	c	a	b
2.	Design impedance matching networks for RF integrated circuits.	c	e	
3.	Design and analyze the RF transistor amplifier and to understand the operation of Oscillator and Mixer models.	c	a	b
4.	Explore the RF view of Wireless standards and Architecture	a	j	

H-High Correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I:Filters & Resonators	**9**			
1.	Filter parameters, Filter configurations: LPF,HPF	2	C	1	1,2,4
2.	BPF, BRF	1	C,D	1	1,2,4
3.	Special filter realizations	2	C,D	1	1,2,4
4.	Resonator parameters, Cavity resonators	2	C	1	4
5.	Planar Microstrip Resonant structures	2	C	1	4
	Unit-II: Impedance Matching	**9**			
6.	Necessity of impedance matching networks and parameters	2	C	2	1
7.	Impedance matching using discrete components	1	C	2	1
8.	L section matching network	1	C,D	2	1
9.	Two component matching network	1	C,D	2	1
10.	T and Pi matching network	2	C,D	2	1
11.	Microstrip line matching network- Discrete components to Microstrip lines	1	C	2	1
12.	Single stub matching networks	1	C,D	2	1
	Unit-III: Characteristics of Amplifiers	**9**			
13.	Characteristics of amplifier	1	C	3	1,2
14.	Amplifier power relations and problems	2	C	3	1,2
15.	Stability consideration –Significance of Stability circles	1	C	3	1,2
16.	Stabilization methods for BJT	1	C	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
17.	Broadband Amplifier	2	C,D	3	1
18.	High power amplifier	1	C	3	1
19.	Multistage amplifiers	1	C,D	3	1
	Unit-IV: Basicoscillator& Mixer Model	**9**			
20.	Basic oscillator model : Design steps and Classifications	2	C,D	3	1,2
21.	High frequency oscillator configuration	1	C,D	3	1,2
22.	Types of oscillators	2	C,D	3	1,2
23.	Basic characteristics of Mixer	1	C	3	1,2
24.	Frequency domain considerations	1	C	3	1,2
25.	Single ended mixer design	1	C,D	3	1,2
26.	Single and Double balanced mixer	1	C	3	1,2
	Unit-V: RF Perspective of Wireless Standards and Architectures	**9**			
27.	RF perspective of Wireless standards: GSM,IS-95 CDMA	1	C	4	3
28.	Wideband CDMA, Bluetooth, IEEE 802.11 a/b/g	2	C	4	3
29.	General consideration of transceiver architecture,OOK transceivers	1	C	4	3
30.	Heterodyne receiver architectures	2	C	4	3
31.	Direct conversion receiver architecture	1	C	4	3
32.	Direct conversion and Heterodyne transmitter architectures	2	C	4	3
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	Reinhold Ludwig, Pavel Bretchko , ‘RF circuit design : Theory and applications’, 2nd Edition, Pearson, 2009.
2.	David M. Pozar, "Microwave Engineering", 4th edition, John Wiley & Sons, 2011.
3.	BehzadRazavi, *“RF Microelectronics”,* 2nd edition, Prentice Hall , 2011
4.	Bahil and P. Bhartia, "Microwave Solid State Circuit Design", 2nd edition, Wiley-Interscience, 2003.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC336E	Adhocand Sensor Networks	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Communication**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30h Academic Council Meeting, 24th March 2016				

Purpose	To gain knowledge in concepts related to Adhoc and Sensor Networks			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Understand and gain complete knowledge about Adhoc Networks and the various routing protocols used in Adhoc networks.	h,c	a	
2.	Emphasis knowledge in various functional areas such as MAC Layer and QOS	h,c	a	
3.	Understand and gain complete knowledge about energy management Adhoc Networks	j,h		e
4.	Emphasis knowledge in Mesh networks and routing configuration	h		j
5.	Understand and gain complete knowledge about application of Sensor network	j	h	

H: High Correlation, M: Medium Correlation, L: Low Correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Multicast Routing	**9**			
1	Cellular and Ad hoc wireless networks	2	C	1-4	1,3
2	Issues of MAC layer	1	C	1-4	1,3
3	Routing : Proactive, Reactive and Hybrid Routing protocols	2	C,D	1	1,3
4	Multicast Routing – Tree based and Mesh based protocols	2	C,D	1	1,3
5	Multicast with Quality of Service Provision	2	C	1	1,3
	Unit II: Quality of Service	**9**			
6	Real-time traffic support	1	C	2,4	1,3
7	Issues and challenges in providing QoS , Classification of QoS Solutions	2	C	2,4	1,3
8	QoS Aware	2	C	2,4	1
9	MAC layer classifications	2	C	2,4	1
10	Routing Protocols –Ticket based and Predictive location based Qos Routing Protocols	2	C,D	2,4	1
	Unit-III: Energy Management Adhoc Networks	**9**			
11	Need for Energy Management	1	C	3,4	1
12	Classification of Energy Management Schemes , Battery Management and Transmission Power	2	C	3,4	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Management Schemes				
13	Network Layer solutions	2	C	3,4	1,3
14	Data Link Layer Solutions	2	C	3,4	1,3
15	System power Management schemes	2	C	3,4	1,3
	Unit-IV: Mesh Networks	**9**			
16	Necessity for Mesh Networks	1	C	4	3
17	MAC enhancements	2	C	2,4	3
18	IEEE 802.11s Architecture	3	C	2,4	3
19	Opportunistic Routing , Self Configuration and Auto Configuration	3	C	4	3
	Unit-V: Sensor Networks	**9**			
20	Introduction – Sensor Network architecture	2	C	1,4	3,4
21	Data Dissemination, Data Gathering	2	C	1,4	3
22	MAC Protocols for sensor Networks, Location discovery	2	C	1,4	3,4
23	Quality of Sensor Networks, Evolving Standards	2	C	1,4	3
24	Recent trends in Sensor Networks	1	C	1,4	3
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	Siva Ram Murthy C. and Manoj B.S, *"Ad hoc Wireless Networks – Architectures and Protocols"*, Pearson Education, 2nd edition, 2004.
2.	Feng Zhao and Leonidas Guibas, "Wireless Sensor Networks", Morgan Kaufman Publishers, 1st edition, 2004.
3.	C.K.Toh, "Adhoc Mobile Wireless Networks", Pearson Education, 7th edition, 2002.
4.	Thomas Brag and SebastinBuettrich, 'Wireless Mesh Networking', O'Reilly Publishers, 3rd edition, 2007.

Course nature					**Theory**		
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

Level-4 Elective Courses

15EC421E	Multigate Transistors	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Electronics**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting 24th March , 2016				

Purpose	This course describes the evolution of the SOI MOSFET from single-gate structures to multi-gate structures to improve the electrostatic control by the gate and hence, reduces short-channel effects.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, learner will be able to		**H**	**M**	**L**
1.	Expose to the advantages of multi-gate FETs and the challenges posed by the appearance of novel effects.	a	c	
2.	Realize the issues associated with multi-gate FET manufacturing.	a	c	
3.	Analyze the behavior of electron mobility in different multi-gate structures	a	c	
4.	Familiarize with the applications of multi-gate device in regard to digital and analog circuits for modern IC design.	a	c	j

H: high correlation, **M:** medium correlation, **L:** low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I : Structures of Multigate Devices	**9**			
1	Principle operation of FlexFET, Independent Double Gated FlexFET	3	C	1	1,2,4
2	Principle operation of FinFET, Pi-gate, Tri-gate	3	C	1	1,2,4
3	Principle operation of Ω-gate, GAA transistor	2	C	1	1,2,4
4	Comparison of Multigate devices with CMOS	1	C	1	1,2,4
	Unit- II : Multi-Gate MOSFET Technology	**9**			
5	Quantum effects, Volume inversion	3	C	1,2	1
6	Mobility, Threshold voltage	3	C	1,2	1
7	Inter subband scattering, multigate technology, Mobility, Gate stack	3	C	1,2	1
	Unit-III : Physics of the Multigate MOS Systems	**9**			
8	MOS Electrostatics : 1D, 2D MOS Electrostatics	2	C	1,3	1
9	Modeling assumptions, Gate voltage effect	3	C	1,3	1
10	Semiconductor thickness effect , Asymmetry effect	2	C	1,3	1
11	Oxide thickness effect , Electron tunnel current	2	C	1,3	1
	Unit-III : Circuit Design using Multigate Devices	**9**			
12	Digital circuits, Impact of device performance on digital circuits	3	C	4	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
13	Leakage performance trade off	2	C	4	1,3
14	Multi V_T devices and circuit	2	C	4	1,3
15	SRAM design	2	C	4	1,3
	Unit-V : Analog Circuit Design using Multi-Gate Transistor	**9**			
16	Introduction to Analog circuit design: design issues, Transconductance	1	C	4	1,5
17	Intrinsic transistors gain , Matching behavior, Flicker noise	3	C	4	1
18	Transit and maximum oscillation frequency ,Self heating, Charge trapping in high K dielectric	3	C	4	1
19	RF circuit design	2	C	4	1,5
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	Jean-Pierre Colinge, "FinFETs and Other Multi-GateTransistors", Springer Science+Business Media LLC, ISBN 978-0-387-71751-7, e-ISBN 978-0-387-71752-4, 2008.
2.	Hiroshi Iwai, "Future of Nano CMOS technology", Solid-State Electronics, Elsevier, pp.56-67, 2015.
3.	Prateek Mishra, Anish Muttreja, and Niraj K. Jha, "FinFET Circuit Design", Nanoelectronic Circuit Design, Springer Science+ Business Media LLC, pp. 23-54, 2011.
4.	J.P. Colinge, "Multi-gate SOI MOSFETs", Microelectronic Engineering, Elsevier, pp. 2071-2076,2007.
5.	D. Lederer, "FinFET analogue characterization from DC to 110 GHz", Solid-State Electronics, Elsevier, pp. 1488–1496, 2005.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC422E	Design of Microwave Integrated Circuits			L	T	P	C
				3	0	0	3
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	**P**	**Professional Elective**		**Communication**			
Course designed by	Department of Electronics and Communication Engineering						
Approval	30th Academic Council Meeting, 24th March, 2016						

Purpose	To attain in depth knowledge used in MIC techniques and operation of many microwave devices will be understandable.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Understand the different types of MICs and different transmission lines to be used in MICs	i		
2.	Explore the concept of microstrip line and its interpretation in the analysis and design of microstrip line	a,e		i
3.	Apply the design of Passive and active microstrip line	a,e		i
4.	Apply the design of non-reciprocal components, active devices, filters circuits	a,e		i
5.	Understand Micro fabrication of MIC devices will be covered in order to understand the major MIC fabrication techniques and how they interact with system design strategies.	I	e	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Ref.
	Unit-I: Analysis of MIC	**9**			
1.	Introduction, types of MICs and their technology, Propagating models.	2	C,D	1-4	3
2.	Strip Line and Microstrip Line	2	C,D	1-2	1
3.	Hybrid mode analysis and Analysis of MIC by conformal transformation	3	C,D	1-2	1
4.	Losses in microstrip, Introduction to slot line and coplanar waveguide.	2	C,D	1-2	1
	Unit-II: Couplers and Lumped Elements in MIC	**9**			
5.	Introduction to coupled microstrip	2	C	1-2	1
6.	Even and odd mode analysis, Branch line couplers,	3	C,D	1-2	1,3
7.	Design and fabrication of lumped elements for MICs	3	C,D	1-2	2,3
8.	Comparison with distributed circuits.	1	C	1-2	1,3
	Unit-III: Passive and Active Components in MIC	**9**			
9.	Ferrimagnetic substrates and inserts	2	C	2-4	3
10.	Microstrip circulators, Phase shifters	2	C,D	2-4	1
11.	Microwave transistors, Parametric diodes and amplifiers	3	C,D	2-4	1
12.	Microstrip Isolator	2	C,D	2-4	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Ref.
	Unit-IV: MIC Circuits and its Applications	**9**			
13.	Introduction, Impedance transformers-Quarter wave transforms, Binominal transforms and Chepy-Shev transforms	4	C,D	3,4	2
14.	Design of Filters	3	C,D	3,4	2
15.	MICs in Radar and satellite	2	C	3,4	2
	Unit-V: Fabrication Process	**9**			
16.	Fabrication process of MMIC, Hybrid MICs	2	C	1,5	1
17.	Dielectric substances	1	C	1,5	1
18.	Thick film and thin film technology and materials	2	C	1,5	1
19.	Testing methods, Encapsulation	2	C	1,5	1
20.	Mounting of devices	2	C	1,5	1
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	Leo G. Maloratsky, "Passive RF and Microwave Integrated circuits", Elsevier, 2nd edition,2004.
2.	David M. Pozar, "Microwave Engineering", 2nd edition.
3.	Gupta K.C and Amarjit Singh, "Microwave Integrated Circuits", John Wiley, New York, 2nd edition, 1975.
4.	Hoffman R.K., "Hand Book of Microwave Integrated Ciruits", Artech House, Boston, 2nd edition, 1987.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC423E	Advanced Mobile Communication Systems	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Communication**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	To acquire knowledge in concepts related to advanced mobile communication and standards			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	apply the architecture and functionalities of 3G and 4G systems	j	e	
2.	understand the concepts of OFDM and it issues	a,e	j	
3.	understand the MIMO communication systems	a	e	
4.	understand the principle of Cognitive Radio Techniques	a,e		j
5.	acquire the concept of millimeter wave communication	a	e	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: 3G and 4G Standards	**9**			
1.	Overview of the legacy 3GPP cellular systems	2	C	1,5	1
2.	WiMAX systems: Architecture	2	C	1,5	1
3.	WiMAX systems :Frame structure and its applications	2	C	1,5	1
4.	LTE systems: Architecture	2	C	1,5	1
5.	LTE systems: Frame structure and its applications	1	C	1,5	1
	UNIT-II: OFDM Communication	**9**			
6.	Introduction to OFDM	1	C	2,3	1
7.	Multicarrier Modulation and Cyclic Prefix	2	C	2,3	1
8.	Channel model and SNR performance	2	C	2,3	1
9.	OFDM Issues :PAPR	2	C	2,3	1
10.	Frequency and timing offset issues	2	C	2,3	1
	UNIT-III: Wireless MIMO Communication	**9**			
11.	Introduction to MIMO, MIMO Channel Capacity	2	C	2,3	1,4
12.	MIMO Channel Estimation	2	C	2,3	1,4
13.	MIMO Spatial Multiplexing :V- BLAST	2	C	2,3	1,4
14.	MIMO Diversity: Alamouti, OSTBC	2	C	2,3	1,4
15.	MIMO:OFDM system	1	C	2,3	1,3
	Unit-IV: Cognitive Radio	**9**			
16.	Cognitive transceiver architecture	1	C	4	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
17.	Principle of interweaving	2	C	4	1
18.	Spectrum sensing	2	C	4	1
19.	Spectrum sharing	2	C	4	1
20.	Spectrum management	2	C	4	1
	Unit-V: Millimeter Wave Communication	**9**			
21.	Millimeter Wave Characteristics; Channel Performance at Mm wave communication	2	C	1,5	3
22.	Modulation for Millimeter Wave communication	2	C	1,5	3
23.	Millimeter wave transceiver , receiver and Antenna	3	C	1,5	3
24.	Emerging applications of Mm wave Communications	1	C	1,5	3
25.	Development of Millimeter Wave Standards	1	C	1,5	3
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	Andrea Molisch, “Wireless Communication”, Cambridge University Press, 2nd edition, 2013.
2.	Theodre Rappaport, “Wireless Communication: Principle and Practice”, Prentice Hall, 2nd edition, 2014.
3.	Kao-Cheng Huang, Zhaocheng Wang, “Millimeter Wave Communication System”, Wiley-IEEE Press, 2nd edition, 2011.
4.	EzioBigleri, “MIMO Wireless Communications”, Cambridge University Press, 1st edition, 2007.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15EC424E	Indoor Radio Planning	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Communication**		
Course designed by	Department of Electronics and communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	To provide solid understanding of how to design and plan high quality radio networks.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		H	M	L
1.	Understand Basics and functionalities of cellular systems	c	b	
2.	RF Planning for Different Technologies	c	b	j
3.	Design a different types of distributed antenna systems for MIMO application	c	b	
4.	Identify the issues and achieve high quality data rate Radio networks	e	j	f
5.	Optimize the Radio Networks	k	i	j

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I:Introduction to Cellular Systems and Network Planning	**9**			
1.	Mobile Telephony, Introduction to GSM, Universal Mobile Telecommunication System	2	C	1	1,2,3
2.	Introduction to HSPA, Advanced Antenna Systems for HSPA and LTE	2	C	1	1,2,3
3.	Short Introduction to LTE	1	C	1	1,2,3
4.	Future trends towards a service driven network management	1	C	1	1,2,3
5.	Wireless Local Area Networks (WLANs)	2	C	1	1,2,3
6.	Next-generation Mobile Communication	1	C	1	1,2,3
	Unit-II:Indoor Radio Planning	**9**			
7.	Indoor Coverage from the Macro Layer	2	C	1,2	1,2,4
8.	The Indoor UMTS/HSPA Challenge	2	C	1,2	1,2,4
9.	Common UMTS Rollout Mistakes	2	C	1,2	1,2,4
10.	The Basics of Indoor RF Planning	3	C	1,2	1,2,4
	Unit-III:Distributed Antenna Systems	**9**			
11.	Type of Distributed Antenna , The Passive DAS System, Passive Components	2	C,D	3	1,2
12.	Active DAS, Hybrid Active DAS Solutions	2	C,D	3	1,2
13.	Indoor DAS for MIMO Application Using Repeaters for Indoor DAS Coverage	2	C,D	3	1,2
14.	Repeaters for Rail Solutions, Designing with Pico and	2	C,D	3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Femto cells				
15.	Active DAS Data, Electromagnetic Radiation, EMR	1	C,D	3	1,2
	Unit-IV:Radio Resource Utilization	**9**			
16.	Introduction to Radio Resource Management	1	C,D	4	1,2,4
17.	Power Control, Handover Control	2	C,D	4	1,2,4
18.	Congestion Control , UMTS system and radio network planning	1	C,D	4,5	1,2,4
19.	UMTS introduction, UMTS configuration planning , UMTS coverage and capacity enhancements	1	C,D	4,5	1,2,4
20.	UMTS topology planning, UMTS radio resource management and functionality	2	C,D	4,5	1,2,4
21.	System improvements towards higher packet data rate services	1	C,D	4,5	1,2,4
22.	HSDPA, HSUPA, LTE system , LTE performance	1	C,D	4,5	1,2,4
	Unit-V:Radio Network Optimization Process	**9**			
23.	Introduction to Radio Network Optimization Requirements, Introduction to the Telecom Management Network Mode	2	C,D	5	1,2,4
24.	Tools in Optimization	2	C,D	5	1,2,4
25.	Advanced Analysis Methods and Radio Access Network, Auto tuning	2	C,D	5	1,2,4
26.	Advanced Analysis Methods for Cellular Networks	2	C,D	5	1,2,4
27.	Automatic Optimization	1	C,D	5	1,2,4
Total contact hours		**45**	Exclusive of assessment hours		

Learning Resources	
1.	Morten Tolstrup, “Indoor Radio Planning: A Practical Guide for GSM, DCS, UMTS and HSPA”, John Wiley, 2012.
2.	JaanaLaiho, Achim Wacker & Tomas Novosad, “Radio Network Planning and Optimisation for UMTS”, John Wiley & Sons Ltd, 2006.
3.	Ajay R. Mishra, “Advanced Cellular Network Planning and Optimisation”, Wiley Publication, 2006.
4.	J. I. Agbinya, “Planning and Optimization of 3G and 4G Wireless Networks”, River Publishers, 2010.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15EC425E	Telecommunications ManagementNetwork	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Communication**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	To acquire knowledge in Telecommunication Networks and its Management.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Understand basic concepts of network management	h	j	f
2.	Understand the standards, architecture of telecommunication management network	h	j	f
3.	Gain knowledge in various applications of network management	h	j	f
4.	Understand timing issues, network synchronization, control and management	h	j	a
5.	Understand telecommunication traffic and mathematical modeling to measure traffic performance	a	h	j

H-High correlation M –Medium correlation L- Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I:Introduction	**9**			
1.	Overview of Data Communication and Network Management : Goals, Organization and Functions	2	C	1	1
2.	Network Management : Architecture and Organization	2	C	1	1
3.	Network Management Perspectives	2	C	1	1
4.	Current Status and Future of Network Management.	1	C	1	1
5.	Network Topology, Network Node Components, Transmission Technology.	2	C	1	1
	Unit-II: Telecommunications Management Network	**9**			
6.	TMN Conceptual Model, TMN Standards	2	C	2	1
7.	TMN Architecture, TMN Management Service Architecture	2	C	2	1
8.	TMN Integrated View	2	C	2	1
9.	TMN Implementation	3	C	2	1
	Unit-III: Network Management Applications	**9**			
10.	Configuration Management, Fault Management	2	C	3	1
11.	Performance Management, Security Management, Service Level Management	3	C	3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
12.	Accounting Management, Report Management	2	C	3	1
13.	Policy- Based Management.	2	C	3	1
	Unit-IV Control and Network Synchronization Management	**9**			
14.	Timing Recovery:Phase locked loop,Clock instability	2	C	4	2
15.	Jitter measurements, Systematic jitter	2	C	4	2
16.	Timing Inaccuracies: Slips, Asynchronous Multiplexing, waiting time jitter , Network Synchronization	3	C	4	2
17.	Network Control, Network Management	2	C	4	2
	Unit-V: Telecommunications Traffic	**9**			
18.	Introduction: Unit of Traffic, Congestion, Traffic Measurement	3	C	5	3
19.	A Mathematical model, Lost Call systems: theory, traffic performance, loss systems in tandem	3	C	5	3
20.	Queuing systems: The second Erlang distribution, probability of delay, finite queue capacity, system with single server-queues in tandem, applications of delay formulaetandem	3	C	5	3
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	Mani Subramanian "*Network Management – Principles and Practice*", Pearson, 2nd Edition, 2010.
2.	John C. Bellamy , "Digital Telephony", John Wiley &Sons, Inc., 4th edition,2010,
3.	J.E.Flood , " Telecommunications Switching Traffic and Networks", Pearson Education Pvt.Ltd, 2007.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC426E	Satellite Communication and Broadcasting	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Communication**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	To make the learner understand the basic concept in the field of satellite communication. This course gives the learner an opportunity to know how to place a satellite in an orbit. The learners are taught about the earth and space subsystems. The satellite services like broadcasting are dealt thoroughly.

Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Understand the principles, concepts and operation of satellite communication systems	k	a, e	
2.	Gain the knowledge of Satellite orbits and launching, link design, link availability and perform interference calculations	k	a, e	c
3.	Analyze the concepts of Satellite systems in relation to other terrestrial systems.	k		
4.	Evaluate the performance of various channel access schemes	k	j	c
5.	Familiarize with applications of satellites and compression standards.	k	j	c, e

H-High correlation **M** –Medium correlation **L**- Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Satellite Orbit	**9**			
1.	Kepler's law	1	C,D	1,2	1,3
2.	Earth - Orbiting satellites terms	1	C	1,2	1,3,
3.	Orbital elements ,Orbit Perturbations	2	C	1,2	1,3
4.	Inclined Orbits , Sun synchronous orbit	1	C	1,2	1
5.	Constellation:Geo stationary satellites, Non geostationary constellation	2	C	1,2	2
6.	Launching of Geostationary satellites	1	C	1,2	2
7.	Antenna Look angles- problems, Sun transit outage	1	C,D	1,2	1
	Unit-II: Link Design	**9**			
8.	EIRP, Transmission Losses	2	C	1,2	1,3
9.	Link Power Budget equation	1	C,D	1,2	1,3
10.	System Noise, Carrier to noise ratio	2	C,D	1,2	1,3
11.	Uplink, Downlink	2	C	1,2	1,3
12.	Effects of rain	1	C	1,2	1,3
13.	Inter modulation Noise	1	C	1,2	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-III: Space and Earth Segment	**9**			
14.	Basic concept of space segment**,** Power Supply	1	C	1,3	1,2
15.	Altitude control	1	C	1,3	1,3
16.	Station keeping,Thermal Control	1	C	1,3	1,3
17.	TT&C Subsystems, Antenna subsystem	1	C	1,3	1,3
18.	Transponders,Wideband Receiver	2	C	1,3	1
19.	Basic concept of Earth segment	1	C	1,3	1
20.	Receive only home TV system	1	C	1,3	1
21.	Community antenna TV system	1	C	1,3	1
	Unit-IV: Multiple Access Techniques for Satellite Communication	**9**			
22.	Concepts of Multiple Access techniques, types, Single Access	1	C	4	1
23.	Pre assigned FDMA	1	C	4	1
24.	Demand Assigned FDMA, SPADE system	1	C	4	1
25.	TWT amplifier operation,Downlink analysis	1	C	4	1
26.	TDMA	1	C	4	1
27.	Reference bursts, Preamble, Postamble	1	C	4	1,2
28.	Carrier recovery, Network synchronization	1	C	4	1,2
29.	Pre assigned TDMA , Demand assigned TDMA	1	C	4	1,2
30.	CDMA , Direct Sequence Spread Spectrum , CDMA throughput	1	C	4	1,3
	Unit-V: Broadcast and Services	**9**			
31.	Concept of Broadcasting satellites , Direct Broadcasting Satellite	1	C	5	1
32.	Orbital Spacing, Power ratings	1	C	5	1
33.	Frequency and Polarization, Transponder Capacity,Bit rate	1	C	5	1
34.	MPEG,Forward Error Correction	2	C	5	1
35.	Outdoor Unit, Indoor Unit	2	C	5	1
36.	Downlink Analysis,Uplink	1	C,D	5	1
37.	Satellite Mobile services,VSAT, GPS	1	C	5	1
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	Dennis Roddy, *"Satellite Communications",* Tata Mc-Graw Hill Publications, 4th Edition, 13th Reprint, 2014.
2.	MadhavendraRichharia, Leslie David, *"Satellite Systems for Personal Applications Concepts and Technology",* Wiley-Blackwell, 1st Edition, 2010.
3.	Louis J. IppolitoJr, "*Satellite Communications Systems Engineering*", John Wiley and Sons , Ltd, Publication, 1st Edition, 2008

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC430E	Cryptography and Network Security			L	T	P	C
				3	0	0	3
Co-requisite:	Nil						
Prerequisite:	Nil						
Data Book / Codes/Standards	Nil						
2Course Category	**P**	**Professional Elective**		**Computers**			
Course designed by	Department of Electronics and Communication Engineering						
Approval	30th Academic Council Meeting, 24th March 2016						

Purpose	To study various aspects of Network Security Attacks, Services and Mechanisms.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		**H**	**M**	**L**
1.	Understand various methods of Encryption and Authentication.	h	a	e
2.	Familiarize with the concepts of Number theory, Key generation standards and Digital Signature algorithm.	h	a	e
3.	Gain the knowledge of Authentication Protocols and Email Security	h	c	
4.	Evaluate the performance of internet security and application specific security Protocols and standards.	h		c
5.	Analyze the concepts of Intrusion and filtering analysis.	h	c	

H-High correlation **M** –Medium correlation **L**- Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Conventional and Modern Encryption & Block Ciphers	**9**			
1.	Security Services Mechanisms and Attacks	1	C	1	1
2.	Network Security Model, Classical Encryption Techniques, Steganography	2	C,D	1	1
3.	Data Encryption Standard (DES), Overview of Advanced Encryption Standard (AES)	2	C	1	1
4.	Block cipher modes operation	1	C	1	1
5.	Overview of IDEA, Blowfish, RC5, CAST-128	2	C	1	3
6.	Characteristics of advanced symmetric Block ciphers, Key Distribution	1	C	1	1
	Unit-II: Public Key Encryption and Hash & MAC Algorithms	**9**			
7.	Number Theory, Modular arithmetic, Multiplicative Inverse, Extended Euclidean algorithm, Fermet's and Euler's theorem	2	C,D	2	1,2
8.	Principle of Public key Cryptosystems	1	C	2	1,2
9.	RSA algorithm	1	C,D	2	1,2
10.	Diffie - Hellmen Key Exchange	1	C,D	2	1,2
11.	Elliptic Curve Cryptography	1	C,D	2	1
12.	Message Authentication and Hash Functions, Hash and MAC Algorithms	2	C	2	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
13.	Digital Signatures and Digital Signature Standard.	1	C	2	1
	Unit-III:Authentication Protocols and Email Security	**9**			
14.	Kerberos version 4 and 5	3	C	3	1
15.	X.509 Directory Service, X.509 Public Key Certificate format	2	C	3	1
16.	Pretty Good Privacy	2	C	3	1
17.	Secure Multipurpose Internet Mail extension	2	C	3	1
	Unit-IV: IP Security and Web Security	**9**			
18.	IP Security Overview, IP Security Architecture, Authentication Header, Encapsulating Security Payload,Security Associations	3	C	4	1,2
19.	IP security Key Management	2	C	4	1,2
20.	Web Security Requirements, Secure Sockets Layer, Transport Layer Security	2	C	4	1,2
21.	Secure Electronic Transaction	2	C	4	1
	Unit-V: System Security	**9**			
22.	Intruders, Intrusion Detection	2	C	5	1
23.	Password management	1	C	5	1
24.	Malicious software	1	C	5	1
25.	Viruses and counter measures	2	C	5	1
26.	Firewall Types and Configurations	2	C	5	1
27.	Trusted System	1	C	5	1
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	William Stallings, *"Cryptography and Network Security",* Pearson Education, 6th Edition, New Delhi, 2014.
2.	Forouzan.B.A. and Mukhopadhyay.D, *"Cryptography and Network Security",* Tata Mc-Graw Hill, 2nd Edition, 2012.
3.	William Stallings, *"Cryptography and Network Security",* PHI, New Delhi, 2nd Edition, 1999.

Course nature					**Theory**		
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC431E	Photonics and Optical Networks	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Communication**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting ,24th March 2016				

Purpose	To understand the fundamental concepts in photonics and optical communication networks.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learners will be able to		**H**	**M**	**L**
1	Understand the interaction of photons and matter, the propagation of light in waveguides and optical fibers, the operation principles of light emitting diodes, semiconductor lasers, detectors amplifiers and network Components.	a		c
2.	Explore the operating principles of optical communication systems including wavelength division multiplexing, Time division multiplexing and code division multiplexing concepts.	a	b	
3.	Design simple optical communication link.	b		c
4.	Understand the main types of architectures, protocols and standards governing modern optical networks.	a	b	

H-High correlation **M** –Medium correlation **L**- Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Introduction to Photonics and Optical Fiber	**9**			
1.	Review of wave nature and particle nature of light	1	C	1	2,3
2.	Interaction of light with matter-emission and absorption of radiation	1	C	1	2,3
3.	Review of optics, Reflection and refraction of plane waves	2	C,D	1	3,5
4.	Fresnel's formulas, Interference and interferometers	1	C,D	1	3,5
5.	Diffraction, Optical coherence	1	C,D	1	3,5
6.	Polarization of light	1	C	1	2,3
7.	Material and Waveguide Dispersion	1	C,D	1	2,3
8.	Dispersion shifted fiber, Signal Attenuation.	1	C,D		2,3
	Unit-II:Optical Fiber Waveguides, Sources and Detectors	**9**			
9.	The propagation of light in optical waveguides	1	C	1	2,3
10.	Classification of optical fibers, Single mode fiber	1	C	1	3,4
11.	Introduction to Nonlinear fiber optics	1	C	1	1,3
12.	Laser Fundamentals, Stimulated and spontaneous Emission	1	C	1	2,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
13.	Optical feedback, threshold condition	1	C,D	1	2,3
14.	Injection Laser Diode (ILD), Quantum well, DFB, Laser Modes	1	C,D	1	2,3
15.	Photo detection, PIN and Avalanche Photo diode (APD)	1	C	1	2,3
16.	Quantum Efficiency, Responsivity and Speed of Response	1	D	1	2,3
17.	Noise mechanism in photo detectors.	1	C,D	1	2,3
	Unit-III: Optical Components and System Design	**9**			
18.	Principle and Operation of couplers/splitters	1	C	2	1,2
19.	WDM MUX/DEMUX	1	C	2	1,2
20.	Isolators, Circulators, Fabry Perot Filters	1	C	2	1,2
21.	Mach-Zehnder Interferometer, optical switches	1	C	2	1,2
22.	EDFA	1	C	1	3,5
23.	Semiconductor Optical Amplifier	1	C	1	3,5
24.	Optical Link Design, Powerpenalty -Point- to- point links	1	D	3	3,6
25.	System considerations, Link Power budget	1	D	3	3,6
26.	Rise time budget	1	D	3	3,6
	Unit-IV: Optical Networks Architecture	**9**			
27.	Optical network concepts	1	C	4	1,2
28.	Topology, Metropolitan ,Area Networks	2	C	4	1,2
29.	SONET/SDH	2	C	4	1,3
30.	Optical specifications, SONET frame structure	1	C	4	1,3
31.	Optical transport network	1	C	4	1,2
32.	Broadcast and Select networks.	2	C	4	1,2
	Unit-V: WDM Network Design	**9**			
33.	WDM network elements	2	C	4	1,2
34.	WDM network design	2	D	4	1,2
35.	Cost tradeoffs	1	D	4	1,2
36.	Virtual Topology design	1	D	4	1,2
37.	Routing and wavelength assignment	2	D	4	1,2
38.	Statistical dimensioning models	1	C,D	4	1,2
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	Rajiv Ramaswamy, Kumar N. Sivaranjan and Galen H. Sasaki, “OpticalNetworks – A practical perspective”, 3rd edition, Elsevier, 2010.
2.	John M. Senior, “Optical Fiber Communications –Principles and Practice”,Pearson Education, 2009.
3.	Keiser, “Optical Fiber Communication Systems”, 4th edition, TataMcGraw Hill, Edition, 2010.
4.	Joseph C.Palais “Fiber Optic Communications”, Fifth edition, Seventhimpression, Pearson, 2012.
5.	Djafar.K. Mynbaev Lowell and Scheiner, “Fiber Optic CommunicationTechnology”, Sixth impression, Pearson Education Asia, 9th impression,2011.
6.	John Powers, “An Introduction to Fiber optic Systems”, 2nd edition, Tata-McGraw Hill, 2010.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

Courses offered to other departments

15EC251J	Introduction to Electronic Devices and Circuits			L	T	P	C
				3	0	2	4
Co-requisite:	Nil						
Prerequisite:	15EC101						
Data Book / Codes/Standards	Nil						
Course Category	P	**Professional Core**	**Electronics**				
Course designed by	Department of Biomedical Engineering						
Approval	30th Academic Council Meeting held on 24th March 2016						

Purpose	The purpose of learning this course introduction to electronic devices and circuits for biomedical engineering student is to provide knowledge about the working, characteristics, operation and limitations of semiconductor and optoelectronic devices			
Instructional Objectives		**Student Outcomes**		
At the end of the course on introduction to electronic devices and circuits, student will be able to		**H**	**M**	**L**
1.	Explain the physical construction, working and operational characteristics of Semiconductor devices.	a	b	
2.	Analyze the operation of power supply circuits built using filters, rectifiers and voltage regulators	a		
3.	Describe the various types of rectifiers and power supply circuits	a		
4.	Illustrate the various transistor amplifier configurations	a		
5.	Analyze multi-vibrators, oscillators and wave shaping circuits.	a		

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Diodes and DC Power Supplies	**9**			
1.	Semiconductor diodes:Formation of PN junction , working principle, VI characteristics,voltage breakdown in diodes	2	C	1	1,2,3
2.	Semiconductor diodes:Zener diode – working principle, VI characteristics, applications	1	C	1	1,2,3
3.	Rectifiers and Filters : Block diagram of a typical DC power supply, HWR, FWR	1	C,D	1	1,2,3
4.	Rectifiers and Filters : full-wave bridge rectifier, power supply filters	1	C,D	1	1,2,3
5.	Filters : Bleeder resistor and voltage dividers	1	C	1	1,2,3
6.	Voltage regulators: Voltage regulation, Zener diode shunt regulator	1	C	1	1,2,3
7.	Voltage regulators: Transistor series regulator, transistor shunt regulator	1	C	1	1,2,3
8.	Voltage regulators: switching regulators	1	I	1	1,2,3
	Unit-II: Bipolar Transistors and FET	**9**			
9.	Bipolar Transistors: Construction and working NPN and PNP configuration	2	C	2	1,2,3
10.	Bipolar Transistors: Transistor currents , transistor configurations	1	C	2	

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
11.	Bipolar Transistors: Input-output characteristics,Applications	1	C	2	1,2,3
12.	Field-Effect Transistors:Construction, working and VI characteristics, Comparison of BJT and JFET	3	C,D	2	1,2,3
13.	Field-Effect Transistors :MOSFET Construction and working principle	2	C,D	2	1,2,3
	Unit-III: Amplifiers	**9**			
14.	Basic Amplifier configuration: CE, CC, CB amplifiers	1	C,D	3	3,4,5,6
15.	Cascade connections and Darlington connections	2	C	3	3,4,5,6
16.	Differential amplifiers:Common mode analysis, Differential mode analysis, DC and AC analysis	2	C	3	3,4,5,6
17.	Power amplifiers: Definitions and amplifier types, Class A amplifier, Class B and Class AB amplifiers	2	C	3	3,4,5,6
18.	Power amplifiers: push-pull amplifiers , Class C amplifiers	1	C	3	3,4,5,6
19.	Tuned amplifiers: Need for tuned circuits, single tuned, double tuned amplifiers	1	I	3	3,4,5,6
	Unit-IV: Feedback Amplifiers and Oscillators	**9**			
20.	Feedback Amplifiers: Basic concepts of feedback, four types of negative feedback	2	C	4	3,4,5,6
21.	Feedback Amplifiers: Effect of feedback on input resistance, output resistance	2	C	4	3,4,5,6
22.	Feedback Amplifiers: voltage gain and current gain, Advantages of negative feedback.	1	C	4	3,4,5,6
23.	Oscillator: Classification, Barkhausen criterion	1	C,I	4	3,4,5,6
24.	Oscillator:Wien bridge and Hartley oscillator	1	C,I	4	3,4,5,6
25.	Oscillator: Colpitts and Crystal oscillator, biomedical applications	2	C,I	4	3,4,5,6
	Unit-V: Solid State Switching Circuits	**9**			
26.	Types of waveforms, transistor switching times	2	C	5	3,4,5,6
27.	Multivibrators: Astablemultivibrator	2	C,I	5	3,4,5,6
28.	Monostablemultivibrator	2	C,I	5	3,4,5,6
29.	Bistablemultivibrator	2	C,I	5	3,4,5,6
30.	Schmitt trigger	1	C,I	5	3,4,5,6
	Total contact hours	45 (Exclusive of Assessment hours)			

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1	V I characteristics of PN junction and Zener diode.	2	D,I	1	7

2	Working of half wave and full wave rectifiers	2	D,I	1	7
3	Frequency Response of CE amplifier with self-bias	2	D,I	2	7
4	Frequency response of BJT & FET feedback amplifiers	2	D,I	3	7
5	Frequency response of Single Tuned Amplifier using multisim software	4	D,I	3	7
6	Realization of Hartley and Colpitt Oscillators using multisim software	4	D,I	4	7
7	Realization of R- C Phase shift oscillator using multisim software	4	D,I	4	7
8	Wave shaping using Schmitt triggerusing multisim software	4	D,I	4	7
9	Design of Multi-vibrator circuitsusing multisim software	6	D,I,O	3	7
	Total contact hours	30			

Learning Resources	
1.	Robert L. Boylestad and Louis Nashelsky, *"Electronic devices and circuit theory"*, Pearson Education, 9th edition, 2009.
2.	Jacob Millman, Christos C Halkias, SatyabrataJit, *"Electron devices and circuits"*, Tata McGraw Hill, 6th edition, 2010.
3.	Somanathan Nair B, *"Electronic devices and applications"*, PHI, 4th edition,2006.
4.	David A Bell, *"Fundamentals of electronic devices and circuits"*, Oxford Press, 5th edition, 2009.
5.	Godse A.P, .Bakshi U.A, *"Electronics devices and circuits"*,Techinical Publications, Pune, 1st edition, 2009.
6.	Nagrath I.J, *"Electronic devices and circuits"*, Prentice Hall of India Pvt Ltd, 2nd edition, 2007.
7.	"Introduction to Electronic Devices",Lab Manual.

Course nature							**Theory + Practical**
Assessment Method – Theory Component (Weightage 50%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**
Assessment Method – Practical Component (Weightage 50%)							
In-semester	**Assessment tool**	Experiments	Record	MCQ/Quiz/Viva Voce	Model examination		**Total**
	Weightage	**40%**	**5%**	**5%**	**10%**		**60%**
						End semester examination Weightage :	**40%**

15EC252	**Principles of Communication Systems** *(Common to IT, CSE, EEE)*	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**		**Communication**	
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March , 2016				

Purpose	To gain the knowledge on basic concepts of conventional analog and digital communication systems and to get knowledge on the importance of radio communication systems.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learner will be able to		H	M	L
1.	Understand the concepts of analog communication techniques.	e		
2.	Know different types of radio transmitters and receivers	e	a	
3.	Understand the concept of Pulse and data communication system	e		
4.	Gain knowledge on different digital communication techniques.	e	a	b
5.	Understand the fundamentals of various radio communication systems.	e		

H-High Correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: Analog Communication	**9**			
1.	Introduction to Communication Systems: Modulation ,Need for Modulation ,Types of modulation, Principles of Amplitude Modulation, Types of Amplitude Modulation	3	C	1	1,2,3
2.	Generation of AM waves, Linear Modulation, Switching modulator, Collector Modulation method, Non-linear Modulation, Balanced Modulator	3	C	1	1
3.	Angle modulation, FM and PM waveforms, Phase deviation and Modulation index , Frequency deviation and Percent modulation, FM modulators, Direct Method, Varactor diode modulator, Indirect method, Comparison between AM and FM	3	C	1	1,2,3
	Unit-II: Radio Transmitters and Receivers	**9**			
4.	Demodulation of AM waves, Linear diode detector, AM Transmitters, Low power level and High power level transmitters, AM Receivers, TRF receiver, super heterodyne receiver	4	C	2	1
5.	FM Demodulators, Slope detector, Foster seely discriminator	3	C	2	1
6.	FM Transmitters, Direct and indirect FM transmitters, FM super heterodyne receiver	2	C	2	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-III: Pulse and Data Communication	**9**			
7.	Pulse Communication: Pulse Amplitude Modulation (PAM), Pulse Time Modulation (PTM)	3	C	3	1,3
8.	Pulse code Modulation (PCM),Comparison of various Pulse Communication System (PAM,PTM,PCM)	2	C	3	1,3
9.	Data Communication: Standards Organizations for Data Communications, Data Communication Circuits, Data Communication Codes, Error Detection and Correction Techniques.	4	C	3	1
	Unit-IV:Digital Communication	**9**			
10.	Digital Pass band Transmission and Reception: Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK),Binary Phase Shift Keying(BPSK)	3	C	4	1,2
11.	Quadrature Phase Shift Keying (QPSK), 8-PSK, Quadrature Amplitude Modulation (QAM), 8-QAM	4	C	4	1,2
12.	Bandwidth efficiency, Comparison of various Digital Communication System	2	C	4	1,2
	Unit-V: Radio Communication Systems (Elementary Treatment Only)	**9**			
13.	Microwave Communication: Introduction to microwave transmission, Advantages and disadvantages of microwave radio, Analog versus digital microwave, Frequency modulated microwave radio system	2	C	5	2,4
14.	Fiber optical communication: Elements of an optical fiber, Principles of light transmission in a fiber, Modes in optical fiber waveguides, Advances in optical fiber communication	3	C	5	1
15.	Mobile communication: Cellular Concept and Frequency Reuse, Channel Assignment and Hand off, A Basic cellular network, GSM,GPRS, UMTS	4	C	5	1,5
	Total contact hours	**45**	Exclusive of assessment hours		

Learning Resources	
1.	R.P.Singh, S.D.Sapre, “Communication Systems, Analog and Digital”, Tata McGraw Hill 5th Reprint 2015.
2.	Wayne Tomasi, “Electronic Communications Systems Fundamentals Through Advanced”, Pearson Education Asia, 5th Edition, 2009.
3.	Simon Haykin, “Communication Systems”, John Wiley and Sons, Inc., 4th Edition, 2001.
4.	Samuel Y. Liao, “Microwave Devices and Circuits”, 3rd edition, Pearson education, 2011 reprint.
5.	Jochen Schiller, “Mobile Communications”, 2nd edition, Pearson education Ltd, United Kingdom 2012.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
End semester examination Weightage :							**50%**

15EC352E	**Introduction to VLSI Design** *(Common to CSE, EEE)*	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Elective**	**Electronics**		
Course designed by	Department of Electronics and Communication Engineering.				
Approval	30th Academic Council Meeting, 24th March -2016				

Purpose	To get expose on the technology, design concepts, electrical properties and modeling of Very Large Scale Integrated Circuits			
Instructional Objectives At the end of this course, the learner will be able to		**Correlates to Student Outcomes**		
		H	**M**	**L**
1.	Understand the basic MOS Technology and its non-ideal effects	a		e
2.	Understand the MOS Process Technology	c,a	e	
3.	Gain the knowledge in concepts of modeling a digital system using Hardware Description Language.	c,b	a	

H: high correlation, **M**: medium correlation, **L**: low correlation

S.No	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I: CMOS Logic Design	**9**			
1	Introduction to VLSI Design	1	C	1	1,2
2	Review of MOS Transistor Theory: nMOS, pMOS Transistor, Enhancement and depletion transistors.	2	C	1	1,2
3	Ideal I-V characteristics	2	C	1	1,2
4	Non-ideal I-V effects	2	C	1	1,2
5	CMOS logic: Basic gates, logic functions	2	C,D	1	1,2
	Unit-II: Electrical Properties of MOS and Performance Estimation	**9**			
6	Pass transistor and transmission logic (Design of gates, multiplexer)	2	C	1	1,2
7	nMOS inverter	1	C	1	1,2
8	Pull up to Pull down ratio (Driven by another nMOS inverter, Driven by one or more pass transistor)	2	C	1	1,2
9	DC characteristics of CMOS Inverter	1	C	1	1,2
10	Interconnect: Resistance, Capacitance	3	C	1	1,2
	Unit-III: MOS Technology	**9**			
11	Introduction to IC Technology	1	C	2	1,2
12	nMOS Fabrication	1	C	2	1,2

S.No	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
13	CMOS Fabrication-Pwell, nwell and twintub fabrication process	4	C	2	1,2
14	Latch up in CMOS	1	C	2	1,2
15	Layout Design rules	1	C	2	1,2
16	Stick diagram	1	C,D	2	1,2
	Unit-IV: Introduction to Verilog HDL	**9**			
15	Basic concepts, modules and ports	2	C	3	3
16	Gate-level modeling	2	C,D	3	3
17	Dataflow modeling	2	C,D	3	3
18	Behavioural modeling	2	C,D	3	3
19	Switch-level modeling	1	C, D	3	3
	Unit-V: CMOS Subsystem Design	**9**			
20	Design of Adder: Carry select - carry look ahead - carry skips adder	4	C, D	3	1
21	Design of multiplier - Braun array	2	C, D	3	1
22	Baugh wooley multiplier	2	C, D	3	1
23	Wallace tree Multiplier	1	C, D	3	1
	Total contact hours	**45**	Excluding assessment hours		

Learning resources	
1.	DouglesA.Pucknell, "*Basic VLSI Design",* Prentice Hall of India, 3rd Edition, reprint 2008.
2.	Neil H.E.Westie,David Harris, *"CMOS VLSI Design",* Pearson,3rd Edition, 2006.
3.	Samir Palnitker, *"Verilog HDL Guide to Digital Design and synthesis"*,Pearson Education-2nd Edition, 2003.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**

15EC353	Digital Signal Processing Techniques	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	**P**	**Professional Core**	**Signal Processing**		
Course designed by	Department of Electronics and Communication Engineering				
Approval	30th Academic Council Meeting, 24th March 2016				

Purpose	To provide the fundamentals of continuous and discrete time signals, systems and modern digital processing as well as applications.			
Instructional Objectives		**Student Outcomes**		
At the end of the course, the learners will be able to		**H**	**M**	**L**
1.	Classify, analyze continuous and discrete signals and systems	a	e	c
2.	Know about Frequency domain analysis using Z-Transform and using DFT	e	a	
3.	Design of Finite and Infinite Response filters.	a	e	
4.	Understand the finite world length effects that arise in digital signal processing	e	a	b
5.	Acquire knowledge about the architecture of DSP processors and applications of DSP	e	c	k

H-High Correlation, **M**-Medium Correlation, **L**-Low correlation

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Unit-I:Classification of Signals and Systems	**9**			
1.	**Classification of Signals:** Continuous time signals - Discrete time signals	1	C	1	1-2
2.	Periodic and Aperiodic signals – Even and odd signals	1	C	1	1-2
3.	Energy and power signals	1	C	1	1-2
4.	Deterministic and random signals –Complex exponential and Sinusoidal signals	1	C	1	1-2
5.	Unit step, Unit ramp, Unit impulse – Representation of signals in terms of unit impulse.	1	C	1	1-2
6.	**Classification of Systems:** Continuous time systems- Discrete time systems –staticsystem- causal system – Stable system	1	C	1	1-2
7.	Linear system – Time Invariant system -Linear Convolution	2	C	1	1-2
8.	Matlab Exercises	1	C,D,I	1	1-2
	Unit–II:Frequency Transformations	**9**			
9	z- transforms-ROC- Properties of Z transform	1	C	2	1-4
10	Inverse Z transform: Power series expansion - Partial fraction methods	1	C,D	2	1-4
11	Analysis and characterization of LTI system using Z transform-	2	C,D	2	1-4
12	DTFT-Sampling of DTFT-DFT and its inverse-	2	C	2	1-4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	properties of DFT-circular symmetry property				
13	N- point DFT Decimation-in-Time Radix-2 FFT Algorithms	1	C,D	2	1-4
14	N- point DFT Decimation-in-Frequency Radix-2 FFT Algorithms	1	C,D	2	1-4
15	Linear convolution using the DFT- Fast Fourier Transform	1	C,D	2	1-4
	Unit-III: Design of FIR Filters	**9**			
16	Design of Finite Impulse Response Filters-Symmetric and Antisymmetric FIR filters	2	C,D	3	3,4
17	Design of Linear- Phase FIR filters Fourier Series Method	1	C,D	3	3,4
18	Design of Linear- Phase FIR filters Using Rectangular Hamming Window	1	C	3	3,4
19	Design of Linear- Phase FIR filters Using Hanning Window (LPF,HPF,BPF,BSF)	2	C,D	3	3,4
20	Design of Linear- Phase FIR filters Using Blackman Window (LPF,HPF,BPF,BSF)	1	C,D	3	3,4
21	Design of Linear- Phase FIR filters Using Hanning Window (LPF,HPF,BPF,BSF)	1	C	3	3,4
22	MATLAB program for FIR filters	1	C	3	3,4
	Unit–IV:Design of IIR Filters from Analog Filters	**9**			
23	Frequency Response and Characteristics of Analog Filters	1	C,D	3	3,4
24	Analog to Digital transformations techniques	1	C,D	3	3,4
25	Design of Butterworth filter(LPF) using Bilinear Transformation and Impulse Invariance methods	2	C,D	3	3,4
26	Chebyshev Filter (LPF)Designs based on the Bilinear Transformation and Impulse Invariance methods	2	C,D	3	3,4
27	Finite word length effects in digital Filters: Errors-Quantization of Filter Coefficients	1	C,D	4	3,4
28	Limit Cycle oscillations	1	C,D	4	3,4
29	MATLAB programs for IIR Filters	1	C,D,I	3	3,4
	Unit-V: DSP Processor and Applications	**9**			
30	Super Harvard architecture –Data path- multiple access memory -pipelining	2	C	5	5
31	Architecture of TMS320C5X family of DSP processors	2	C	5	5
33	Addressing Modes of TMS320C5X	2	C	5	5
34	Instruction Set of TMS320C5X	1	C	5	5
35	Applications on digital signal processing	2	C	5	5
	Total contact Hours	**45**	Exclusive of assessment hours		

Learning Resources	
1	Alan V Oppenheim, Ronald W. Schafer "Signals & Systems", Pearson Education, 1997.
2	Simon Haykin and Barry Van Veen, "Signals and Systems", John Wiley & Sons Inc, 2nd Edition, 2007.
3	John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing, Principles, Algorithms and Applications", Pearson Education, 4th edition, 2007
4	Alan V. Opoenheim, Ronald W. Schafer, John R. Buck, "Discrete Time Signal Processing", Pearson Education, 8th edition, 2011
5	Venkataramani B, Bhaskar M, "Digital Signal Processors, Architecture, Programming and Application", Tata McGraw Hill, New Delhi, 2003.

Course nature							**Theory**
Assessment Method (Weightage 100%)							
In-semester	**Assessment tool**	Cycle test I	Cycle test II	Cycle Test III	Surprise Test	Quiz	**Total**
	Weightage	**10%**	**15%**	**15%**	**5%**	**5%**	**50%**
						End semester examination Weightage :	**50%**