FACULTY OF ENGINEERING AND TECHNOLOGY

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 : **ELECTRICAL AND ELECTRONICS ENGINEERING**

Offering Department : **ELECTRICAL AND ELECTRONICS ENGINEERING**

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

CONTENTS

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-long learning

(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 INITIATIVE

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.

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**
Dept.	--	**Department of Civil Engineering**
E with course code	--	**Elective Courses**
E	--	**Courses under Engineering Sciences**
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	--	**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 Multi Disciplinary 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**

FACULTY OF ENGINEERING AND TECHNOLOGY, SRM UNIVERSITY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

B.TECH ELECTRICAL AND ELECTRONICS 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	21.67%	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	15MA206	Numerical Methods	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																		
	39		Total	11	1	4	14		Total	7	1	2	9		Total	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	38.33%							15EE103	Analysis of Electric Circuits	3	0	0	3	15EE204	Electrical Machines-1	3	0	0	3	15EE210	Electrical Machines II	3	0	0	3
								15EE103L	Electric Circuits Laboratory	0	0	2	1	15EE204L	Electrical Machines Laboratory I	0	0	3	2	15EE210L	Electrical Machines Laboratory II	0	0	3	2
														15EE205	Electromagnetic Theory	3	0	0	3	15EE211	Control Systems	3	0	0	3
														15EE206	Digital System Design	3	0	0	3	15EE212L	Measurements and Control systems Laboratory	0	0	2	1
														15EE207	Electrical and Electronic Measurements and Instruentation	3	0	0	3	15EC204 J	Linear Integrated Circuits	3	0	2	4
														15EE208	Electron Devices and circuits	3	0	0	3	15EE213	Generation, Transmission and Distribution	3	0	0	3
														15EE209L	Analog and Digital Circuits Laboratory	0	0	3	2						
	69		Total	0	0	0	0		Total	3	0	2	4		Total	15	0	6	19		Total	12	0	7	16
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%																								
	18		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**			**22**	**1**	**6**	**26**			**22**	**1**	**7**	**26**
			Contact hours	**32**					**Contact hours**	**28**					**Total contact hours**	**29**					**Total Contact hours**	**30**			

FACULTY OF ENGINEERING AND TECHNOLOGY, SRM UNIVERSITY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

B.TECH ELECTRICAL AND ELECTRONICS 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	15MA301	Probability and Statistics	4	0	0	4												
	Total	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		Total	0	0	0	0		Total	0	0	0	0		Total	0	0	0	0
15EE301J	Power Electronics	3	0	2	4	15EE304	Power System Analysis	3	0	0	3	15EE401	Solid State Drives	3	0	0	3						
15EE302	Power System Protection	3	0	0	3	15EE305J	Microcontrollers	3	0	2	4	15EE401L	Electric Drives Laboratory	0	0	3	2						
15EE303	Discrete Transforms And Signal Processing	3	0	0	3	15EE306M	Multi Disciplinary Design	2	2	0	3	15EE402	Power System Operation And Control	3	0	0	3						
												15EE403L	Power System Laboratory	0	0	3	2						
	Total	9	0	2	10		Total	8	2	2	10		Total	6	0	6	10		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
15EE375L / 15EE380L / 15EE385L / 15EE490L	Minor Project I / Seminar I / Massive Open Online Courses (MOOCS) I / Industry Module I	0	0	3	2	15EE376L / 15EE381L / 15EE386L / 15EE491L	Minor Project II / Seminar II / Massive Open Online Courses (MOOCS) II / Industry Module II	0	0	3	2							15EE496L	Major Project	0	0	24	12
15EE390L	Industrial Training I (To be done after IV semester)	0	0	3	2																		
	Total	0	0	6	4		Total	0	0	3	2		Total	0	0	0	0		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
		20	**1**	**8**	**25**			**22**	**3**	**5**	**26**			**12**	**0**	**6**	**16**			**0**	**0**	**24**	**12**
	Total Contact hours	**29**					**Total contact hours**	**30**					**Total contact hours**	**18**					**Total contact hours**	**24**			

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

FACULTY OF ENGINEERING AND TECHNOLOGY, SRM UNIVERSITY

DEPARTMENT ELECTIVES FOR B.Tech EEE DEGREE PROGRAMME UNDER CHOICE BASED FLEXIBLE CREDIT SYSTEM (CBFCS)

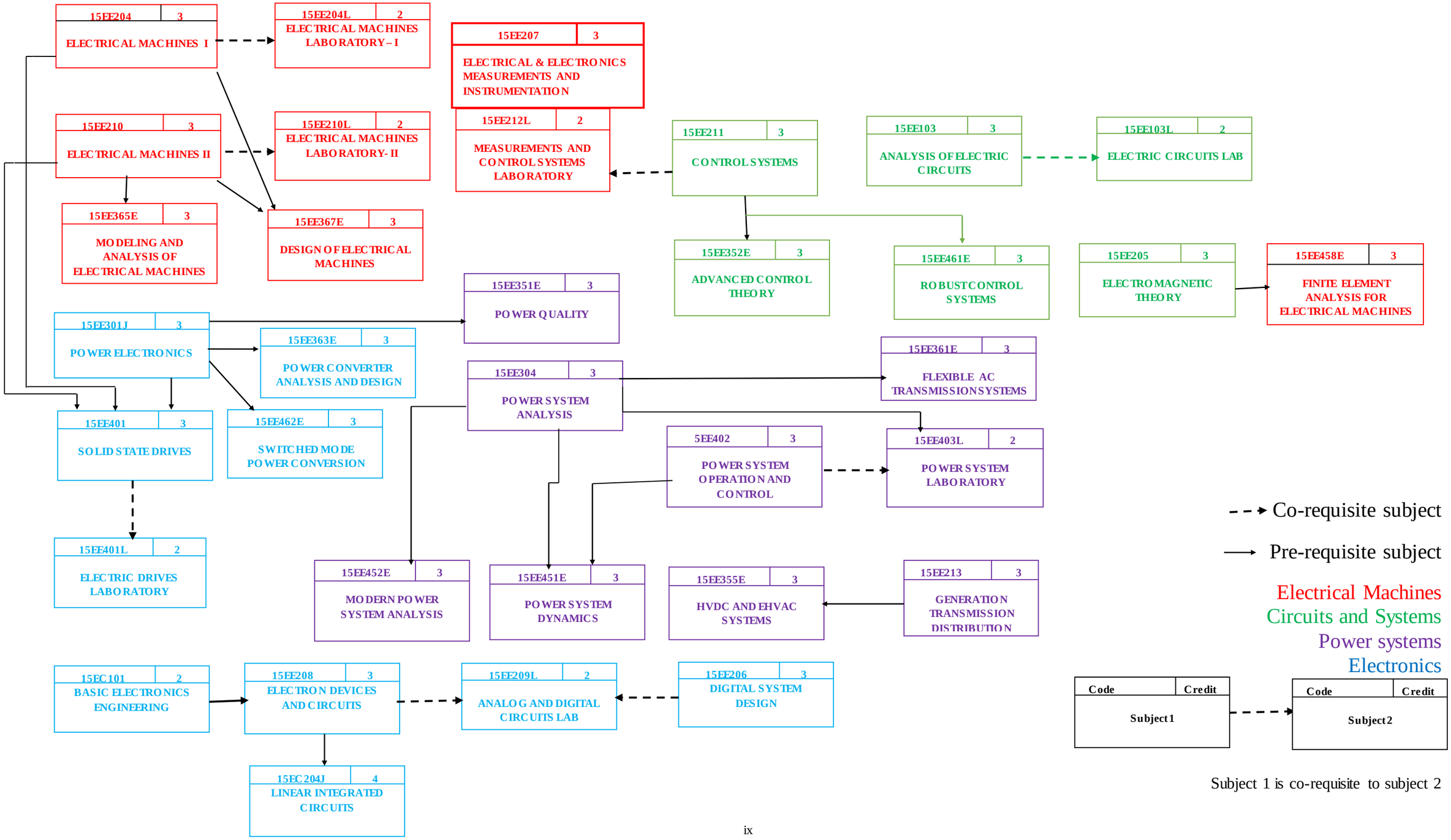
CODE	COURSE TITLE	L	T	P	C	CODE	COURSE TITLE	L	T	P	C	CODE	COURSE TITLE	L	T	P	C
15EE254E	Instrumentation Systems	3	0	0	3	15EE354E	Special Electrical Machines	3	0	0	3	15EE458E	Finite Element Analysis For Electrical Machines	3	0	0	3
15BM324E	Principles Of Biomedical Instrumentation	3	0	0	3	15EE365E	Modeling And Analysis Of Electrical Machines	3	0	0	3	15EE457E	Hybrid Electric Vehicles	3	0	0	3
15EC226E	Sensors And Transducers	3	0	0	3	15EE367E	Design Of Electrical Machines	3	0	0	3	15MH301	Fundamendals Of Robotics	3	0	0	3
15EE251E	Sustainable Energy	3	0	0	3	15EE352E	Advanced Control Theory	3	0	0	3	15EE463E	Embedded Systems	3	0	0	3
15EE252E	Electrical Power Utilization And Illumination	3	0	0	3	15EC252	Principles Of Communication Systems	3	0	0	3	15EE461E	Robust Control Systems	3	0	0	3
15EE253E	Advanced Topics In Electrical Insulation	3	0	0	3	15EE356E	Photonics	3	0	0	3	15EE459E	Solar Photovoltaic Systems	3	0	0	3
15SE251E	Principles Of Object Oriented Programming	3	0	0	3	15EE358E	Advanced CMOS Devices And Technology	3	0	0	3	15EE454E	Distributed Energy Resources	3	0	0	3
						15EE363E	Power Converter Analysis And Design	3	0	0	3	15EE462E	Switched Mode Power Conversion	3	0	0	3
						15EE357E	Power System Harmonics	3	0	0	3	15EC352E	Introduction To VLSI Design	3	0	0	3
						15EE359E	Industrial Power Systems	3	0	0	3	15MH322E	Micro Electro Mechanical Systems	3	0	0	3
						15EE355E	HVDC And EHVAC Systems	3	0	0	3	15BM421E	Medical Electronics	3	0	0	3
						15EE361E	Flexible AC Transmission Systems	3	0	0	3	15EE451E	Power System Dynamics	3	0	0	3
						15EE362E	High Voltage Engineering	3	0	0	3	15EE452E	Modern Power System Analysis	3	0	0	3
						15EE351E	Power Quality	3	0	0	3	15EE453E	Power System Deregulation	3	0	0	3
						15EE353E	Modern Optimization Techniques	3	0	0	3	15EE455E	Smart Grid	3	0	0	3
						15CS251E	Fundamendals To Data Structures	3	0	0	3	15EE456E	Energy Management System And SCADA	3	0	0	3
						15CS203	Computer System Architecture	3	0	0	3	15EE460E	Vehicular Power Systems	3	0	0	3
						15CS322	Neuro Fuzzy And Genetic Programming	3	0	0	3	15IT470E	Fundamentals Of Big Data Analytics	3	0	0	3
						15CS401	Artificial Intelligence	3	0	0	3	15IT370E	Fundamentals Of Cloud Computing	3	0	0	3
						15IT371E	Computer Networking	3	0	0	3	15CS325E	Digital Image Processing	3	0	0	3

COURSES CUSTOMIZED TO OTHER DEPARTMENT

CODE	COURSE TITLE	L	T	P	C	Course offered to
15EE232	Electrical Engineering And Control Systems	3	0	0	3	CSE
15EE231	Electrical Machines	3	0	0	3	E&I
15EE231L	Electrical Machines Laboratory	0	0	3	2	E&I
15EE234J	Fundamentals Of Circuits And Networks	3	0	2	4	BME

Department of Electrical and Electronics Engineering			
B. Tech Electrical and Electronics Engineering			
Course Code	**Course Title**	**Prerequisite course**	**Co requisite courses**
15EE103L	ELECTRIC CIRCUIT LABORATORY		15EE103
15EE204L	ELECTRICAL MACHINES LABORATORY – I		15EE204
15EE208	ELECTRON DEVICES AND CIRCUITS	15EC101	
15EC204J	LINEAR INTEGRATED CIRCUITS	15EE208	
15EE209L	ANALOG AND DIGITAL CIRCUITS LAB		15EE208,15EE206
15EE210L	ELECTRICAL MACHINES LABORATORY- II		15EE210
15EE212L	MEASUREMENTS AND CONTROL SYSTEMS LABORATORY		15EE207,15EE211
15EE352E	ADVANCED CONTROL THEORY	15EE211	
15EE355E	HVDC AND EHVAC SYSTEMS	15EE213	
15EE361E	FLEXIBLE AC TRANSMISSION SYSTEMS	15EE304	
15EE363E	POWER CONVERTER ANALYSIS AND DESIGN	15EE301J	
15EE365E	MODELING AND ANALYSIS OF ELECTRICAL MACHINES	15EE210	
15EE367E	DESIGN OF ELECTRICAL MACHINES	15EE204,15EE210	
15EE401L	ELECTRIC DRIVES LABORATORY		15EE401
15EE401	SOLID STATE DRIVES	15EE204, 15EE210, 15EE301J	
15EE403L	POWER SYSTEMS LABORATORY	15EE304	15EE402
15EE451E	POWER SYSTEM DYNAMICS	15EE304,15EE402	
15EE452E	MODERN POWER SYSTEM ANALYSIS	15EE304	
15EE458E	FINITE ELEMENT ANALYSIS FOR ELECTRICAL MACHINES	15EE205	
15EE461E	ROBUST CONTROL SYSTEMS	15EE211	
15EE462E	SWITCHED MODE POWER CONVERSION	15EE301J	
15EE351E	POWER QUALITY	15EE301J	

Faculty of Engineering and Technology
Department of Electrical and Electronics Engineering
B.Tech EEE Curriculum 2015-16, Pre-requisites and Co-requisites flowchart



DEPARTMENT OF EEE
CURRICULUM 2015 REGULATION

LEVEL 1 SEMESTER I						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
15LE101	G	English	2	0	0	2
15PD101	B	Soft Skills – I	1	1	0	1
15MA101	B	Calculus and Solid Geometry	3	1	0	4
15PY101	B	Physics	3	0	0	3
15PY101L	B	Physics Laboratory	0	0	2	1
15CY101	B	Chemistry	3	0	0	3
15CY101L	B	Chemistry Laboratory	0	0	2	1
15BT101	B	Biology for Engineers	2	0	0	2
15CE101	B	Basic Civil Engineering	2	0	0	2
15ME105L	B	Engineering Graphics	1	0	4	3
15CS101L	B	Programming Laboratory	0	0	3	2
15EE101	B	Basic Electrical Engineering	2	0	0	2
		TOTAL	**19**	**2**	**11**	**26**
		TOTAL CREDITS	**26**			

LEVEL 1 SEMESTER II						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
15LE102	G	Value Education	2	0	0	2
15PD102	B	Soft Skills – II	1	1	0	1
15NS101/ 15NC101/ 15SP101/ 15YG101	G	NSS / NCC / NSO/ YOGA	0	0	2	1
15MA102	B	Advanced Calculus and complex Analysis	3	1	0	4
15PY102L	B	Materials Science	2	0	2	3
15CY102	B	Principles of Environmental Science	2	0	0	2
15EC101	B	Basic Electronics Engineering	2	0	0	2
15EC102L	B	Electronics Engineering Practices	0	0	2	1
15EE102L	B	Electrical Engineering Practices	0	0	2	1
15ME101	B	Basic Mechanical Engineering	2	0	0	2
15EE103	P	Analysis of Electric Circuits	3	0	0	3
15EE103L	P	Electric Circuits Laboratory	0	0	2	1
		TOTAL	**17**	**2**	**8**	**23**
		TOTAL CREDITS	**23**			

LEVEL 2 SEMESTER I						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
15LE201E/ 15LE202E/ 15LE203E/ 15LE204E/ 15LE205E	B	German Language I / French Language I / Japanese Language I / Korean Language I / Chinese Language I	2	0	0	2
15PD201	B	Quantitative aptitude and logical reasoning-I	1	1	0	1
15MA201	B	Transforms and Boundary Value Problems	4	0	0	4
15EE204	P	Electrical Machines-1	3	0	0	3
15EE204L	P	Electrical Machines Lab I	0	0	3	2
15EE205	P	Electromagnetic Theory	3	0	0	3
15EE206	P	Digital System Design	3	0	0	3
15EE207	P	Electrical And Electronics Measurements And Instrumentation	3	0	0	3
15EE208	P	Electron Devices And Circuits	3	0	0	3
15EE209L	P	Analog And Digital Circuits Laboratory	0	0	3	2
		TOTAL	**22**	**1**	**6**	**26**
		TOTAL CREDITS	**26**			

LEVEL 2 SEMESTER II						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
15LE207E/ 15LE208E/ 15LE209E/ 15LE210E/ 15LE211E	B	German Language II/ French Language II/ Japanese Language II/ Korean Language II/ Chinese Language II	2	0	0	2
15PD202	B	Verbal Aptitude	1	1	0	1
15MA206	B	Numerical Methods	4	0	0	4
15EE210	P	Electrical Machines II	3	0	0	3
15EE210L	P	Electrical Machines Laboratory II	0	0	3	2
15EE211	P	Control Systems	3	0	0	3
15EE212L	P	Measurements And Control Systems Laboratory	0	0	2	1
15EC204J	P	Linear Integrated Circuits	3	0	2	4
15EE213	P	Generation, Transmission And Distribution	3	0	0	3
		Department Elective - I	3	0	0	3
		TOTAL	**22**	**1**	**7**	**26**
		TOTAL CREDITS	**26**			

LEVEL 3 SEMESTER I						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
15PD301	B	Communication & Reasoning Skills	1	1	0	1
15MA302	B	Discrete Mathematics	4	0	0	4
15EE301J	P	Power Electronics	3	0	2	4
15EE302	P	Power System Protection	3	0	0	3
15EE303	P	Discrete Transforms And Signal Processing	3	0	0	3
	P	Department Elective II	3	0	0	3
	P	Open Elective I	3	0	0	3
15EE375L/ 15EE380L/ 15EE385L/ 15EE490L	P	Minor Project I/ Seminar I/ Massive Open Online Courses (MOOCs) I/ Industry Module I	0	0	3	2
15EE390L	P	Industrial Training I (to be undergone at the end of II year)	0	0	3	2
		TOTAL	**20**	**1**	**8**	**25**
		TOTAL CREDITS	**25**			

LEVEL 3 SEMESTER II						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
15PD302	B	Quantitative Aptitude And Logical Reasoning – II	1	1	0	1
15MA301	B	Probability And Stastistics	4	0	0	4
15EE304	P	Power System Analysis	3	0	0	3
15EE305J	P	Microcontrollers	3	0	2	4
15EE306M	P	Multi Disciplinary Design	2	2	0	3
		Department Elective III	3	0	0	3
		Department Elective IV	3	0	0	3
		Open Elective II	3	0	0	3
15EE376L/ 15EE381L/ 15EE386L/ 15EE491L	P	Minor Project II/ Seminar II / Massive Open Online Courses (MOOCs) II/ Industry Module II	0	0	3	2
		TOTAL	**22**	**3**	**5**	**26**
		TOTAL CREDITS	**26**			

LEVEL 4 SEMESTER I						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
15EE401	P	Solid State Drives	3	0	0	3
15EE401L	P	Electric Drives Laboratory	0	0	3	2
15EE402	P	Power System Operation And Control	3	0	0	3
15EE403L	P	Power System Laboratory	0	0	3	2
		Department Elective V	3	0	0	3
		Department Elective VI	3	0	0	3
		TOTAL	**12**	**0**	**6**	**16**
		TOTAL CREDITS	**16**			

LEVEL 4 SEMESTER II						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
15EE496L	P	Major Project /Practice School	0	0	24	12
TOTAL			**0**	**0**	**24**	**12**
TOTAL CREDITS			**12**			

LEVEL 2 ELECTIVE						
DEPARTMENT ELECTIVE I						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
15EE254E	P	Instrumentation Systems	3	0	0	3
15BM324E	P	Principles of Biomedical Instrumentation	3	0	0	3
15EC226E	P	Sensors And Transducers	3	0	0	3
15EE251E	P	Sustainable Energy	3	0	0	3
15EE252E	P	Electrical Power Utilization And Illumination	3	0	0	3
15EE253E	P	Advanced Topics In Electrical Insulation	3	0	0	3
15SE251E	P	Principles of Object Oriented Programming	3	0	0	3

LEVEL 3 ELECTIVE						
DEPARTMENT ELECTIVE II / DEPARTMENT ELECTIVE III / DEPARTMENT ELECTIVE IV						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
15EE354E	P	Special Electrical Machines	3	0	0	3
15EE365E	P	Modeling And Analysis Of Electrical Machines	3	0	0	3
15EE367E	P	Design Of Electrical Machines	3	0	0	3
15EE352E	P	Advanced Control Theory	3	0	0	3
15EC252	P	Principles Of Communication Systems	3	0	0	3
15EE356E	P	Photonics	3	0	0	3
15EE358E	P	Advanced CMOS Devices And Technology	3	0	0	3
15EE363E	P	Power Converter Analysis And Design	3	0	0	3
15EE357E	P	Power System Harmonics	3	0	0	3
15EE359E	P	Industrial Power Systems	3	0	0	3
15EE355E	P	HVDC And EHVAC Systems	3	0	0	3
15EE361E	P	Flexible Ac Transmission Systems	3	0	0	3
15EE362E	P	High Voltage Engineering	3	0	0	3
15EE351E	P	Power Quality	3	0	0	3
15EE353E	P	Modern Optimization Techniques	3	0	0	3
15CS251E	P	Introduction to Data Structures	3	0	0	3
15CS203	P	Computer System Architecture	3	0	0	3
15CS322	P	Neuro Fuzzy And Genetic Programming	3	0	0	3
15CS401	P	Artificial Intelligence	3	0	0	3
15IT371E	P	Computer Networking	3	0	0	3

LEVEL 4 ELECTIVE						
DEPARTMENT ELECTIVE V & DEPARTMENT ELECTIVE VI						
Course Code	**Category**	**Course Name**	**L**	**T**	**P**	**C**
15EE458E	P	Finite Element Analysis For Electrical Machines	3	0	0	3
15EE457E	P	Hybrid Electric Vehicles	3	0	0	3
15MH301	P	Fundamendals of Robotics	3	0	0	3
15EE463E	P	Embedded Systems	3	0	0	3
15EE461E	P	Robust Control Systems	3	0	0	3
15EE459E	P	Solar Photovoltaic Systems	3	0	0	3
15EE454E	P	Distributed Energy Resources	3	0	0	3
15EE462E	P	Switched Mode Power Conversion	3	0	0	3
15EC352E	P	Introduction To VLSI Design	3	0	0	3
15MH322E	P	Micro Electro Mechanical Systems	3	0	0	3
15BM421E	P	Medical Electronics	3	0	0	3
15EE451E	P	Power System Dynamics	3	0	0	3
15EE452E	P	Modern Power System Analysis	3	0	0	3
15EE453E	P	Power System Deregulation	3	0	0	3
15EE455E	P	Smart Grid	3	0	0	3
15EE456E	P	Energy Management System And SCADA	3	0	0	3
15EE460E	P	Vehicular Power Systems	3	0	0	3
15IT470E	P	Fundamentals of Big Data Analytics	3	0	0	3
15IT370E	P	Fundamentals of Cloud Computing	3	0	0	3
15CS325E	P	Digital Image Processing	3	0	0	3

Level / Semester	**No. of Credits**	**Cumulative Credits**	**Category**			
			H / SS	**B**	**E**	**P**
Level 1 / Semester I	26	**26**	3	14	9	4
Level 1 / Semester II	23	**49**	4	9	6	-
Level 2 / Semester I	26	**75**	3	4	-	19
Level 2 / Semester II	26	**100**	3	4	-	19
Level 3 / Semester I	25	**126**	1	4	-	20
Level 3 / Semester II	26	**152**	1	4	-	21
Level 4 / Semester I	16	**168**	-	-	-	16
Level 4 / Semester II	12	**180**	-	-	-	12
Total	**180**		**15**	**39**	**15**	**111**

COURSES OFFERED TO OTHER DEPARTMENTS

Course Code	**Department**	**Course Name**	**L**	**T**	**P**	**C**
15EE232	CSE	Electrical Engineering And Control Systems	3	0	0	3
15EE231	E&I	Electrical Machines	3	0	0	3
15EE231L	E&I	Electrical Machines Laboratory	3	0	0	3
15EE234J	BME	Fundamentals of circuits And Networks	3	0	2	4

15EE101	Basic Electrical Engineering	L	T	P	C
		2	0	0	2
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE	CIRCUITS AND SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd, Academic Council Meeting, 2016				

PURPOSE	This course provides comprehensive idea about circuit analysis, working principles of machines and common measuring instruments

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Understand the basic concepts of magnetic circuits, AC and DC circuits.	a	e					
2.	Gain knowledge about the working principle, construction, applications of DC, AC machines and measuring instruments.	a						
3.	Understand the fundamentals of wiring and earthing.	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	**UNIT I : FUNDAMENTALS OF DC CIRCUITS**	**6**			
2.	Introduction to DC and AC circuits, Active and passive two terminal elements	1	C	1	1
3.	Ohms law, Voltage-Current relations for resistor, inductor, capacitor	1	C	1	1
4.	Kirchhoff's laws, Mesh analysis	2	C	1	1
5.	Nodal analysis	1	C	1	1
6.	Ideal sources –equivalent resistor, current division, voltage division	1	C	1	1
	UNIT II : MAGNETIC CIRCUITS	**6**			
7.	Introduction to magnetic circuits	1	C	1	1
8.	Simple magnetic circuits	2	C	1	1
9.	Faraday's laws	2	C	1	1
10.	Induced emf and inductances	1	C	1	1
	UNIT III : AC CIRCUITS	**6**			
11.	Sinusoids, Generation of AC, Average and RMS values, Form and peak factors	2	C	1	1
12.	Concept of phasor representation, J operator	1	C	1	1
13.	Analysis of R-L, R-C, R-L-C circuits	2	C	1	1
14.	Introduction to three phase systems - types of connections, relationship between line and phase values	1	C	1	1
	UNIT IV : ELECTRICAL MACHINES & MEASURING INSTRUMENTS	**6**			
15.	Working principle, construction and applications of DC machines	2	C	2	1
16.	Working principle, construction and applications of AC machines (1 - phase transformers, single phase induction motors: split phase, capacitor start and capacitor start and run motors)	2	C	2	1
17.	Basic principles and classification of instruments - Moving coil and moving iron instruments.	2	C	2	1
	UNIT V : ELECTRICAL SAFETY, WIRING AND INTRODUCTION TO POWER SYSTEM	**6**			
18.	Safety measures in electrical system- types of wiring	1	C	3	1
19.	Wiring accessories - staircase, fluorescent lamps and corridor wiring	2	C	3	1

20.	Basic principles of earthing-Types of earthing- Simple layout of generation, transmission and distribution of power	3	C	3	1
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Dash.S.S, Subramani.C, Vijayakumar.K, "*Basic Electrical Engineering*", First edition, Vijay Nicole Imprints Pvt.Ltd,2013
REFERENCE BOOKS/OTHER READING MATERIAL	
2.	Smarajt Ghosh, "*Fundamentals of Electrical & Electronics Engineering*", Second edition, PHI Learning, 2007
3.	Metha.V.K, Rohit Metha, "*Basic Electrical Engineering*", Fifth edition, Chand. S & Co, 2012
4.	Kothari.D.P and Nagrath.I.J, "*Basic Electrical Engineering*", Second edition, Tata McGraw - Hill, 2009
5.	Bhattacharya.S.K, "*Basic Electrical and Electronics Engineering"*, First edition, 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%**

15EE102L	Electrical 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	CIRCUITS AND SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To provide exposure to the students with hands on experience on various electrical engineering practices.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Learn the residential wiring and various types of wiring.	a						
2.	Measure the various electrical quantities.	a	b					
3.	Gain knowledge about the fundamentals of various electrical gadgets, their working and trouble shooting.	a						
4.	Design a prototype of a transformer.	a		c				
5.	Know the necessity and types of earthing and measurement of earth resistance.	a	b					

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Residential wiring (using Energy meter, fuses, switches, indicator, lamps, etc)	2	D,I,O	1	1,2,3
2.	Types of wiring (fluorescent lamp wiring, staircase wiring, godown wiring, etc)	2	D,I,O	1	1,2
3.	Measurement of electrical quantities (like voltage, current, power, power factor in RLC circuits)	2	D,I	2	1,2
4.	Measurement of energy (using single-phase and three-phase energy meter)	2	D,I	2	1,3
5.	Study of Earthing and Measurement of Earth resistance.	2	C	5	1
6.	Study of trouble shooting of electrical equipment (fan, iron box, mixer and grinder, etc)	2	C	3	1
7.	Study of various electrical gadgets (Induction motor, transformer, CFL, LED, PV cell, etc)	2	C	3	1
8.	Assembly of choke or small transformer.	2	D,I,O	4	1,2
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Subhransu Sekhar Dash & K.Vijayakumar, "*Electrical Engineering Practice Lab Manual".* Vijay Nicole Imprints Private Ltd., First Edition, 2013.
2.	Jeyachandran.K, Natarajan.S and Balasubramanian.S, " *A Primer on engineering practices laboratory*", Anuradha Publications, 2007.
3.	Jeyapoovan.T, Saravanapandian.M and Pranitha.S, "*Engineering practices lab manual*", Vikas Publishing House Pvt., Ltd., 2006.

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%**

15EE103	Analysis of Electric Circuits	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15EE101				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	CIRCUITS AND SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To enrich the students on the basics of circuit analysis, network theorems, concepts of AC circuits, transient analysis and synthesis of electrical networks.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Understand the circuit parameters, sources, analysis of circuits using Mesh current and Nodal voltage methods, network reduction, source transformation and star –delta transformation.	a	e					
2.	Gain knowledge on the solution methods of AC circuits including series and parallel resonance	a	e					
3.	Get an insight into solution of DC and AC circuits using network theorems.	a	e					
4.	Get an insight into the transient analysis of RLC circuits with and without source.	a	e					
5.	Gain knowledge on 3-phase circuits, coupled circuits, tuned circuits and network graphs.	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: ANALYSIS OF DC CIRCUITS	**9**			
1.	Introduction to DC circuits	2	C	1	1-4
2.	Mesh analysis; Presence of dependent sources; circuits with current sources	2	C	1	1-4
3.	Node analysis; presence of dependent sources, circuits with voltage sources	2	C	1	1-4
4.	Network reduction; source transformation; star-delta transformation	3	C	1	1-4
	UNIT II: ANALYSIS OF AC CIRCUITS	**9**			
5.	Introduction to AC circuit; phasors; Impedance and admittance	2	C	2	1-4
6.	Steady state analysis of RL, RC and RLC circuits; power and power factor	3	C	2	1-4
7.	Series and Parallel resonance	2	C	2	1,2
8.	Mesh impedance matrix and node admittance matrix; solving AC circuits using mesh and node analysis	2	C	2	1,2
	UNIT III: NETWORK THEOREMS	**9**			
9.	Use of superposition theorem and thevenin's theorem in solving DC and AC circuits	3	C	3	1-4
10.	Application of Norton's theorem, Maximum power transfer theorem in solving DC and AC circuits.	3	C	3	1-4
11.	Application of Millman's theorem and Reciprocity theorem in solving DC and AC circuits.	3	C	3	1-4
	UNIT IV: TRANSIENT ANALYSIS	**9**			
12.	Introduction; Exponentially increasing and decreasing functions; time constant; RC and RL source free and driven circuits;	3	C	4	1-4
13.	Transients in RC, RL and RLC circuit with DC excitation	3	C	4	1-4
14.	Laplace transforms; Transform impedance; Circuit transients using Laplace transform	3	C	4	1-4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT V: THREE PHASE CIRCUITS, TUNED CIRCUITS AND GRAPH THEORY	**9**			
15.	Analysis of balanced three-phase circuits and simple unbalanced three-phase circuits	2	C	5	1,2
16.	Two-wattmeter method of measuring three-phase power	2	C	5	1,2
17.	Analysis of coupled and tuned circuits	2	C	5	1,2
18.	Graph of a network; Trees, chords and branches; Tie-set and cut-set of a graph	3	C	5	1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Jegatheesan. R, "*Analysis of Electric Circuits*", McGraw Hill Education (India), 2014.
2.	Sudhakar.A and Shyam Mohan.S.P, "*Circuits and Networks Analysis and Synthesis*", Tata McGraw Hill Publishing Company Ltd., New Delhi, 4th edition, 2010.
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	Sukhija and Nagsarkar, "*Circuits and Networks*", Oxford University Press, Second edition, 2016
4.	William H Hayt, J E Kemmerly and Steven M Durbin, "*Engineering Circuit Analysis*", McGraw Hill, 7th Edition, 2007.
5.	Charles K. Alexander and Matthew N. Q. Sadiku, "*Fundamentals of Electric Circuits*", McGraw-Hill International Edition, 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%**

15EE103L	Electric Circuit Laboratory	L	T	P	C
		0	0	2	1
Co-requisite:	15EE103				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	CIRCUITS AND SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32 nd Academic Council Meeting, 2016				

PURPOSE	This laboratory course will give the student a thorough knowledge about the basics of circuit analysis.				
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**			
At the end of the course, student will be able to					
1.	Understand and gain knowledge about circuit laws and theorems.	a	b	e	
2.	Gain knowledge about time domain analysis of circuit transients.	a	b	e	
3.	Understand the concept of resonance in series and parallel circuits.	a	b	e	
4.	Learn how to use the PSpice software for simulating circuits.	a	b	e	k

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Verification of Kirchhoff's laws	4	D,I,O	1, 4	1, 2, 3,4
2.	Verification of Thevenin's and Norton's Theorem	6	D,I,O	1, 4	1, 2, 3,4
3.	Verification of Superposition and Reciprocity theorem	4	D,I,O	1, 4	1, 2, 3,4
4.	Verification of Maximum Power Transfer theorem	4	D,I,O	1, 4	1, 2, 3,4
5.	Time Domain analysis of RL, RC transient circuits	4	D,I,O	2, 4	1, 2, 3,4
6.	Series Resonance Circuit	4	D,I,O	3, 4	1, 2, 3,4
7.	Parallel Resonance Circuit	4	D,I,O	3, 4	1, 2, 3,4
Note: All the above experiments can be realized in simulation and hardware environment.					
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Department Lab Manual
2.	R.Jegatheesan, "Analyais of Electric Circuits", McGraw Hill Education (India) Edition 2015.
3.	Sudhakar.A and Shyam Mohan.S.P, "Circuits and Networks Analysis and Synthesis", Tata McGraw Hill Publishing Company Ltd., New Delhi, Fourth edition, 2010.
4.	Muhammed H Rashid, "SPICE for circuits and electronics using PSPICE", PHI, 2nd edition, 2011

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%**

15EE204	Electrical Machines -I	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE ELECTRICAL MACHINES				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32 ND Academic Council Meeting 2016				

PURPOSE	To acquire fair knowledge on the working of various DC machines & Transformers.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Model and Analyze the performance of different types of DC machines	a	e					
2.	Learn the applications of DC generators	a	e					
3.	Analyze the performance of different types of DC motors	a	e					
4.	Analyze the performance of different types of Transformer	a	e					
5.	Familiarize with the applications of DC machines and transformer	a		h				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I : DC GENERATOR	**10**			
1.	Electromechanical energy conversion concept	1	C	1	1,2
2.	Single and multiple excited systems	1	C,D	1	1,2
3.	Torque and force equations	1	C	1	1,2
4.	Introduction – electric generator- Constructional features- Principle of operation of DC generator	1	C	1	1,2
5.	EMF equation-circuit model - methods of excitation	1	C	1	1,2,3
6.	Losses in DC generator –power stages –condition for maximum efficiency	1	C	2	1,3
7.	armature reaction – compensating winding , commutation	2	C,D	2	1,2
8.	Operating Characteristics of DC generators	1	C,D	2	1,5
9.	Parallel operation of DC generators, Applications of DC generators	1	C,D	2	1,2
	UNIT II : DC MOTORS	**09**			
10.	Principle of operation of DC motors	1	C	3	1.2
11.	Back EMF	1	C	3	1,5
12.	Torque equation-quantitative analysis	2	C	3	2,5,6
13.	Types of DC motors- characteristics of DC motors	2	C	3	1,2
14.	Starting of DC motors: review of mechanical starter, electronic soft starters for DC motor with energy saving.	1	C	3	1,3
15.	Speed control: Field control, Armature control, voltage control, Thyristor control – efficiency	2	C	3	1,2
	UNIT III :TRANSFORMERS	**10**			
16.	Construction - principle of operation – transformer on no load	1	C	4	1,2
17.	Ideal transformer – equivalent circuit – phasor diagram – transformer losses	2	C	4	1,3
18.	Efficiency and voltage regulation-all day efficiency-per unit representation	2	C,D	4	1,2
19.	Three phase transformers-connections - Scott Connection - Phasing of transformer- parallel operation of three phase transformers	2	C	4	1,5
20.	Auto transformer - tap changing transformers-tertiary winding.	1	C	4	1,2
21.	Variable frequency transformer – audio frequency transformer	1	C	4	1
22.	Grounding transformer – welding transformer	1	C	4	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT IV : TESTING OF DC MACHINES & TRANSFORMERS	**09**			
23.	Losses and efficiency –Condition for maximum efficiency	2	C	5	1,2
24.	Testing of DC machines: Brake test , Swinburne's test,	2	C	5	1,2
25.	Retardation test, Hopkinson's test, Testing of transformer: polarity test, load test,	2	C,D	5	2,3
26.	Open circuit and short circuit test	1	C,D,	5	4,5
27.	Sumpner's test – All day efficiency.	2	C	5	1,2
	UNIT V : MODELING OF DC MACHINES	**07**			
28.	Basic two pole DC machine-analysis of DC machine using Primitive two axis machine equation	2	C,D	1	3,4
29.	Voltage and current relationship –torque equations	1	C,D	1	3,4
30.	Mathematical model of separately excited DC motor and Dc series motor in state variable form - transfer function	2	C,D	1	3,4
31.	Mathematical model of DC shunt motor and DC compound motor in state variable form - transfer function	2	C,D	1	3,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Nagrath I. J and Kothari D. P. ''*Electric Machines"*, Tata McGraw Hill Publishing Company Ltd, 4th Edition, 2010.
2.	Dr. Murugesh Kumar K. "*DC Machines and Transformers'',* Vikas Publishing House Pvt Ltd., 2010.
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	Fitzgerald. A.E., Charles Kingsely Jr, Stephen D.Umans, ''*Electric Machinery*'', 6th edition, Tata McGraw Hill Books Company, 2006.
4.	P.S. Bimbhra, "*Electrical Machinery''*, Khanna Publishers, 7th edition paper back, 2011.
5.	S.Sarma & K.Pathak "*Electric Machines*", Cengage Learning India (P) Ltd., Delhi, 2011.
6.	Syed A. Nasar, ''*Electric Machines and Power Systems: Volume I*'', Mcgraw-Hill College; International 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%**

15EE204L	Electrical Machines Laboratory – I	L	T	P	C
		0	0	3	2
Co-requisite:	15EE204				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	ELECTRICAL MACHINES			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting 2016				

PURPOSE	To acquire fair knowledge on the working of various DC machines and Transformers.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Rig up circuits for testing a given Electrical machine.	a	b	e				
2.	Obtain the performance characteristics of Electrical machines.	a	b	e				
3.	Simulate the circuits of DC machines.							

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Load test on DC motors (shunt, series, compound) using OPEN LAB SYS	6	I,O	1	1,2
2.	Speed Control of DC Motor: Field control, Armature control, Thyristorised control	3	I,O	1	1,2
3.	Load test on DC generators.	3	I,O	2	1,2
4.	Load test on single-phase and three phase-transformers	3	I,O	2	1,2
5.	Open circuit and Short circuit tests on single-phase transformer	3	I,O	2	1,2
6.	Open circuit and load characteristics of DC generator (Self and Separately Excited)	3	I,O	2	1,2
7.	Swinburne's test and separation of losses in DC Machine.	3	I,O	1	1,2
8.	Hopkinson's test	3	I,O	1	1,2
9.	Sumpner's test on single-phase transformers	3	I,O	1	1,2
10.	Three-phase transformer connections	3	I,O	1	1,2
11.	Three-phase to two-phase conversion of transformer	3	I,O	1	1,2
12.	Testing of DC machines by using OPEN LAB SYS	3	I,O	1	1,2
13.	DC motor speed control using MATLAB/SIMULINK	3	I,O	3	1,2
14.	Transfer function of DC machine.	3	I,O	3	1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
7.	Laboratory Manual
8.	Nagarath.I.J. and Kothari.D.P., "*Electric Machines*", T.M.H. Publishing CoLtd., New Delhi, 4thedition 2010.

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%**

15EE205	Electromagnetic Theory	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	CIRCUITS AND SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting 2016				

PURPOSE	To acquire fair knowledge about the theoretical concepts and problems in Electromagnetic Fields							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the concepts of Electrostatics and their applications	a	e					
2.	Familiarize with the concepts of Magnetostatics and their applications	a	e					
3.	Learn the concept of Electromagnetic Fields, waves and wave propagation.	a	e	h				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: BASIC CONCEPTS OF FIELD THEORY	**8**			
1.	Introduction to various Co-ordinate Systems- Sources and effects of electromagnetic fields.	1	C	1	1,2,3,4
2.	Divergence theorem-Strokes theorem- Field theory and circuit theory comparison- Electric field intensity	2	C	1	1,2,3,4
3.	Electric fields due to point, line, surface and volume charge distributions – Electric flux density- Coulomb's law	2	C	2	1,2,3,4
4.	Introduction to magnetic circuits – Magnetically induced EMF and Mechanical force, torque calculations	2	C	2	1,2,3,4
5.	Magnetic field in a rotating machine-generated voltage –induced EMF	1	C	2	1,2,4,3
	UNIT II: ELECTROSTATICS APPLICATIONS	**9**			
6.	Gauss's law and its applications – Electric potential – potential gradient	2	C	1	1,2,3,4
7.	Electric field in free space, conductors, dielectric -Dielectric polarization	2	C	1	1,2,3,4
8.	Dielectric strength - Electric field in multiple dielectrics	1	C	1	1,2,3,4
9.	Boundary conditions, Poisson's and Laplace's equations	2	C	1	1,2,3,4
10.	Determination of Capacitance- Energy density problems.	1	C,D	1	1,2,3,4
11.	Methods of images, graphical field mapping	1	C	1	1,2,3,4
	UNIT III: MAGNETOSTATICS APPLICATIONS	**10**			
12.	Magnetic field due to straight conductors, circular loop, infinite sheet of current using Ampere and Bio-Savart law	2	C,D	2	1,2,3,4
13.	Magnetic flux density (B) – B in free space, conductor, magnetic materials – Magnetization	2	C	2	1,2,3,4
14.	Magnetic field in multiple media – Boundary conditions	2	C	2	1,2,3,4
15.	Scalar and vector potential –Design of Inductance – Energy density	2	C,D	2	1,2,3,4
16.	Application of magnetic circuits –. Energy in magnetic systems	2	C	2	7

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT IV: TIME VARYING ELECTRIC AND MAGNETIC FIELD FIELDS	**8**			
17.	Faraday's laws – Transformer and motional EMF-continuity current equation–Displacement current-conduction current	2	C	1	1,2,3,4,5
18.	Energy in quasi-stationary Electromagnetic Fields	2	C	1,2	1,2,3,4,5
19.	Maxwell's equations (differential, integral forms and sinusoidal variation of field with time)	2	C,D	1,2	1,2,3,4,5
20.	Potential for time varying fields, flow of power in electromagnetic field-Poynting vector	2	C	1	1,2,3,4,5
	UNIT V: ELECTROMAGNETIC WAVES	**10**			
21.	Electro Magnetic Wave equations – Wave parameters- velocity, intrinsic impedance-quantitative analysis propagation constant	1	C	3	1,2,3,4,5
22.	Electromagnetic Wave equation for free space, lossy and lossless dielectrics	2	C	3	1,2,3,4,5
23.	Wave equation for conductors-skin depth	2	C	3	1,2,3,4,5
24.	Plane wave reflection and refraction –incidence of plane wave at the boundary between two region ratio	2	C	3	1,2,3,4,5
25.	Input impedances – Standing wave–critical angle of incidence-Brewster angle	2	C	3	1,2,3,4,5
26.	Applications of electromagnetic waves-Introduction of bioelectromagnetics	1	C	3	6,3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	William Hayt, "*Engineering Electromagnetics*", McGraw Hill, New York, 7th edition, 2014.
2.	Matthew. N.O. Sadiku, "*Elements of Electromagnetics*", Fourth Edition, Oxford University Press, 1st Indian Edition, 2010.
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	Ashutosh Pramanik, "*Electromagnetism – Theory and Applications"*, Prentice-Hall of India Private Limited, New Delhi, 2006.
4.	Gangadhar.K.A, "*Field theory*", Khanna Publishers, New Delhi, 15th edition, 2010.
5.	S C Mahapatra, "*Principles Of Electromagnetics*", McGraw Hill education private limited, 2011.
6.	John D. Kraus, *"Electromagnetics with application"* McGraw Hill, 5th edition,2011.
7.	Kothari D.P and Nagrath .I. J," *Electrical machines*", Tata McGraw Hill Publishing Co. Ltd, New Delhi, 5th 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%**

15EE206	Digital System Design			L	T	P	C
				3	0	0	3
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	ELECTRONICS				
Course designed by	Department of Electrical and Electronics Engineering						
Approval	32nd, Academic Council Meeting, 2016						

PURPOSE	To acquire an in-depth knowledge on Digital logic families, Combinational circuits and able to design and analyze sequential circuits.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Understand the concepts of digital logic circuits.	a						
2.	Design combinational and sequential logic circuits.	a	c	e	h	j		
3.	Learn the concepts of Memory devices, VHDL	a	h	j	k			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: BOOLEAN ALGEBRA AND COMBINATIONAL CIRCUITS	**10**			
1.	Boolean algebra: De-Morgan's theorem – switching functions	1	C	1	1,2
2.	Simplification of switching function using K maps	2	C,D	1,2	1,3
3.	Quine Mc-Cluskey method	2	C,D	1,2	1,3
4.	Design of adders, subtractors and comparators	1	C,D	1,2	1,2
5.	Design of code converters	2	C,D	2	2,9
6.	Encoders, decoders, multiplexers and de-multiplexers.	2	C,D	1,2	2,9
	UNIT II: SYNCHRONOUS SEQUENTIAL CIRCUITS	**9**			
7.	Flip flops - SR, D, JK and T	1	C	2	1,3,6
8.	Analysis of synchronous sequential circuits	2	C,D	2	1,3,7
9.	Design of synchronous sequential circuits	2	C,D	2	1,3
10.	Counters: Synchronous and Asynchronous	2	C,D,I	2	2,3,7
11.	State diagram-state reduction – state assignment	2	C,D	2	1,3
	UNIT III: ASYNCHRONOUS SEQUENCTIAL CIRCUIT	**8**			
12.	Analysis of asynchronous sequential machines	3	C,	2	2,3
13.	State reduction – state assignment	2	C,D	2	2,3
14.	Asynchronous design problem	3	D	2	2,3
	UNIT IV: PROGRAMMABLE LOGIC DEVICES, MEMORY AND LOGIC FAMILIES	**9**			
15.	Memories: ROM ,PROM ,EPROM	1	C	3	1
16.	Programmable Logic Devices(PLD) :Programmable Logic Array(PLA) , Programmable Array Logic(PAL)	3	C,D	3	2,5,6
17.	CPLD – FPGA	1	C	3	4,5,6
18.	Digital logic families: characteristics of Digital logic families	1	C	3	1,2
19.	TTL – ECL	2	C	3	1
20.	MOS families	1	C	3	1,2
	UNIT V: HDL AND RECENT TRENDS	**9**			
21.	RTL Design – combinational logic – Types – Operators	2	C	3	8
22.	Packages – Sequential circuit	2	C	3	8
23.	Sub-programs – Test benches.	2	C	3	8
24.	Example programs: adders, counters, flip-flops – FSM, Multiplexers / De-multiplexers, HDL code generation Techniques	3	D,I	3	8
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Morris. M. Mano and Michael.D.Ciletti, "*Digital Design"*, Pearson Education,Fifth edition, 2013
2.	Floyd and Jain, "*Digital Fundamentals"*, Pearson Education, Eleventh edition,2015.
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	John M.Yarbrough, "*Digital Logic Application & Design"*, West Publishing Company, Thomson,First edition, 2002.
4.	Raj Kamal, "*Digital systems-Principles and Design"*, Pearson education,Second edition, 2007
5.	Charles H.Roth, '*Fundamentals Logic Design*', Jaico Publishing, Seventh edition,2014.
6.	John F.Wakerly, "*Digital Design Principles and Practice*", Pearson Education, Third edition,2006.
7.	Roger L.Tokheim,"Digital Electronics: Principles and Applications", Mc Graw Hill Education,8th edition,2014
8.	Bhasker.J, "*A VHDL Primer*" PHI Learning, Third edition, 2009.
9.	G K Kharate, " *Digital Electronics*", Oxford University Press India ,1st Edition, 2010,
10.	David J Comer, "*Digital Logic and State Machine Design*", Oxford University Press India,3rd Edition, 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%**

15EE207	Electrical And Electronics 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 CORE	ELECTRICAL MACHINES			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32 nd Academic Council Meeting 2016				

PURPOSE	To acquire fair knowledge on construction, working of measuring instruments, bridges and display devices							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Learn the various types of DC and AC brides	a						
2.	Understand the working of analog meters for power and energy measurements	a	e					
3.	Learn the operation of different measuring and display devices	a						
4.	Comprehend the measurement of non- electrical quantities.	a						
5.	Understand the working of biomedical instruments and data acquisition system	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I : MEASUREMENT OF R, L,C AND MEASURING INSTRUMENTS	**7**			
1	Functional elements of instrument –static characteristic	1	C	1	1,2
2	Dynamic characteristic and Errors in measurement,	1	C	1	1,2
3	Measurement of R, L, C using Bridge circuits	2	C	1	1,2
4	Principle of operation, construction, Torque equation of Dynamometer type instruments	1	C	1	1,2
5	Ratio type instruments	1	C	1	1,2
6	Thermocouple and Rectifier type instruments.	1	C	1	1,2
	UNIT II : MEASUREMENT OF POWER AND ENERGY	**09**			
7	Current Transformer, Potential Transformer	1	C	2	1,2
9	Principle of operation, construction, Torque equation of induction type single and three phase energy meter	2	C	2	1,2
10	DIGITAL Energy meter, Bi-directional power flow meter, Net metering, Power measurements at high frequency	1	C	2	1,2
11	Creeping adjustments, testing of energy meters, Calibration of energy meter using direct and phantom loading	2	C,D	2	1,2
12	Measurement of reactive power using wattmeter in single phase and poly phase circuits, VArh meter, laser power meter	2	C,D	2	1,2
13	Maximum demand indicator,	1	C	2	1,2
	UNIT III : MEASUREMENT OF FREQUENCY, PHASE SEQUENCE AND DISPLAY DEVICES	**9**			
14	Frequency meters-Electrical resonance and Mechanical Resonance type-RFID reader	2	C	3	1,2
15	Principle of operation, construction, working of single phase and three phase power factor meter	2	C	3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
16	Construction and working of synchroscope – Western type,Nalder-Lipman type-Phase sequence indicator	2	C	3	1,2
17	Storage and display devices: Strip chart recorder- X-Y recorder	1	C	3	1,2
18	LED, LCD, dot matrix display, data loggers	2	C	3	1,2
	UNIT IV : MEASUREMENT OF NON ELECTRICAL QUANTITIES	**10**			
19	Pressure measurement-Basic methods of pressure measurements	2	C	4	1
20	Dead-weight gauges and manometers	1	C	4	1
21	Flow measurement- Flow visualization, velocity magnitude from pilot static tube.	2	C	4	1
22	Temperature measurements –Temperature standards -Bimetallic thermometers, Liquid in glass thermometers, Pressure thermometers	2	C	4	1
23	Motion measurement-Fundamentals standards - Potentiometer displacement transducer	2	C	4	1
24	Differential transformers, Tachometer Encoder-Laser based methods	1	C	4	1
	UNIT V: BIOMEDICAL MEASUREMENTS AND DATA ACQUISITION SYSTEM	**10**			
25	Over view of biomedical measurements	1	C	5	1-5
26	Sources of bio electric potentials, Electrodes	1	C	5	1-5
27	Electrocardiogram, Electrocardiograph	1	C	5	1,2,5
28	Measurement of blood pressure-direct methods, Pacemakers X ray instrumentation	2	C,D	5	1,2,4,5
29	Block diagram of data acquisition system	1	C,D	5	1,2,4,5
30	Signal conditioning, Telemetry	1	C,D	5	1,2,4,5
31	Interfacing instruments –GPIB, USB	2	C	5	1,2,4,5
32	Power quality analyzer	1	C	5	1,2,4,5
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Ernest O Doebelin and Dhanesh N Manik,"*Measurements systems Application and design*", McGraw Hill publication, 5th edition, 2015.
2.	Sawhney A.K, "*A course in Electrical and electronic Measurement and Instrumentation"*, Dhanpat Rai & Sons, New Delhi, 2008
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	Stout MB, "*Basic Electrical Measurements"*, Prentice Hall of India Pvt Ltd., 2007.
4.	Rajendra Prasad, "*Electrical Measurements & Measuring instruments"*, Khanna Publishers, 4th Edition, 2010.
5.	Albert D Halfride & William D Cooper, "*Modern Electronic instrumentation and measurement techniques"*, Prentice Hall of India 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%**

15EE208	Electron Devices And Circuits	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15EC101				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE ELECTRONICS				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To familiarize the students with the design, analyze and application of electronic devices.							
INSTRUCTIONAL OBJECTIVES.		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Familiarize with the electronic devices and its applications.	a						
2.	Understand the concepts of frequency response of amplifiers and different types of feedback	a	c	e				
3.	Gain knowledge about the design and analysis of multi-vibrators, oscillators and wave shaping circuits	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I : SEMICONDUCTOR DEVICES AND ITS APPLICATIONS	**8**			
1.	Construction and Characteristics of DIAC, TRIAC, GTO, HEMT	2	C	1	1,7
2.	LED, LCD characteristics, Tunnel diode, Schottky diode.	2	C	1	3,4
3.	MOS as a charge transferring device-CCD,BBD	1	C	1	2
4.	Analysis and Performance of L, C, LC,CLC filters ,series and shunt regulators	2	C	1	3
5.	Switched mode power supply	1	C	1	3
	UNIT II : SMALL SIGNAL ANALYSIS	**10**			
6.	Operating point of a BJT - Biasing circuits for BJT- Bias stability- Thermal runaway - Use of a heat sink	2	C	2	3
7.	JFET – Biasing a JFET and MOSFET	2	C	2	3
8.	CE,CB,CC amplifier, Hybrid model- Evaluation of H- parameters - Cascade – Darlington connection	2	C	2	3
9.	Small signal equivalent circuits-Miller's theorem- boot-strapping	2	C	2	4
10.	Small signal model – CS and CD amplifiers-problems	2	C	2	3
	UNIT III : LARGE SIGNAL AMPLIFIERS	**9**			
11.	Classification of large signal amplifiers, Distortion in amplifiers	1	C	2	6
12.	Frequency response of different coupling schemes	2	C	2	3,7
13.	Determining efficiency of Class A amplifiers, Class B amplifier, push-pull amplifier	2	C	2	3
14.	Class C-Single , Double-stagger tuned amplifiers-neutralization methods, Class D amplifier – Class S amplifier -	2	C	2	3
15.	MOSFET power amplifier -Differential amplifiers: DC and AC analysis-CMRR.	2	C	2	3,5
	UNIT IV : FEED BACK AMPLIFIERS AND OSCILLATORS	**10**			
16.	Feedback amplifiers – Barkhausen criterion-Stability –Distortion	2	C	2	2,7
17.	Current - Voltage, series / shunt feedback amplifiers	3	C	2	3,7,8
18.	Design and analysis of RC phase-shift oscillator.	1	C,D	3	3,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
19.	Design and analysis - Wien-bridge oscillator, Hartely oscillator.	2	C,D	3	3,4
20.	Design and analysis of Colpitt's oscillator and Crystal oscillators.	1	C	3	3
21.	Working - Franklin, Armstrong and Twin T oscillators.	1	C	3	3,4
	UNIT V – WAVE SHAPING CIRCUITS	**8**			
22.	RC wave shaping circuits - Clampers and Clippers	1	C	3	3
23.	RC, RL-Integrator and Differentiator circuits-Storage, Delay and Calculation of Transistor Switching Times	1	C	3	5
24.	Speed-up Capacitor -Voltage Multiplier	1	C	3	5
25.	Multivibrators – Astable, Monostable	2	C	3	3
26.	Bistable - Analysis of performance parameters of multivibrators	1	C	3	3
27.	Schmitt trigger -UJT relaxation oscillators-Blocking Oscillators	1	C	3	3
28.	Time base circuits – Voltage-Time base circuit, Current-Time base circuit	1	C	3	3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Jacob. Millman, Christos C.Halkias, "*Electronic Devices and Circuits*", Tata McGraw Hill Publishing Limited, New Delhi, 2010.
2.	Floyd, "*Electronic Devices*", Pearson Education Ltd", New Delhi, 2012
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	Sedha.R.S, "*A Text Book of Applied Electronics*", Sultan Chand Publishers, 2008..
4.	Theodre F.Bogart,Jeffrey S.Beasley , Guilermo Rico,"*Electronic Devices and Circuits*", Pearson education ltd, New Delhi,2013
5.	Malvino, "*Electronic Principles*", Tata McGraw Hill, 6th edition, 2006.
6.	Boylestad & Nashelsky, "*Electronic Devices and Circuit Theory*", Prentice Hall of India (P) Ltd., Eighth edition, 2003.
7.	Gupta.J.B, "*Electron Devices and Circuits*"- S.K.Kataria & Sons, 2012
8.	David A Bell, "*Electronic Devices and Circuits*", 5th edition, 2008, Oxford University Press India

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%**

15EE209L	Analog And Digital Circuits Laboratory	L	T	P	C
		0	0	3	2
Co-requisite:	15EE208,15EE206				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE ELECTRONICS				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To acquire a fair knowledge on the performance characteristics of various electron devices and digital logic circuits.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Design circuits using discrete components.	a	b	c				
2.	Analyze the performance characteristics of electronic devices and their applications.	a	b	c	e			
3.	Design and analyze the frequency response of amplifiers.	a	b	c	e			
4.	Design combinational logic circuits using digital IC's.	a	b	c	e			

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Characteristics of BJT and FET	6	I,D,O	1,2	1,2
2.	PSpice simulation of BJT and FET characteristics	6	I,D,O	1,2	1,2
3.	Halfwave Rectifier, Full Wave rectifier, Clipper and Clampers.	6	I,O	1	1,2
4.	Design of Wien-bridge Oscillator and RC phase shift oscillator.	6	I,D,O	1	1,2
5.	Frequency response of voltage series feedback amplifier	3	I,O	3	1,2
6.	Adder, Subtractor and Flipflops	3	I,O	4	1,2
7.	Design of MUX and DEMUX	3	I,D,O	4	1,2
8.	Design of Counters	6	I,D,O	4	1,2
9.	Design of Digital logic circuits using VHDL	6	I,D,O	4	1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Sedha.R.S, "*A Text Book of Applied Electronics*", Sultan Chand Publishers, 2008..

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%**

15EE210	Electrical Machines II	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE ELECTRICAL MACHINES				
Course designed by	Dept. of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting , 2016				

PURPOSE	To acquire knowledge about different types of AC machines							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Comprehend the construction, principle of operation, characteristics of three phase and single phase induction motor and their application.	a	e					
2.	Know the construction and performance of synchronous machines	a	e					
3.	Understand the construction and characteristics of special motors and their applications	a	h					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	References
	UNIT I: THREE PHASE INDUCTION MOTOR	**9**			
1	Construction details of three-phase induction motor, Rotating magnetic field, principle of operation	2	C	1	1,2
2	Slip, Effect of slip on rotor parameters	1	C	1	1,2
3	Torque equation, Torque-slip characteristics	1	C	1	1,2
4	Power Stages	2	C	1	1,2
5	Induction motor as generalized transformer-Equivalent circuit	2	C	1	1,2
6	No load and blocked rotor tests, Equivalent circuit	1	C	1	1,2
	UNIT II: STARTING, SPEED CONTROL AND PERFORMANCE CALCULATION FROM CIRCLE DIAGRAM	**9**			
7	Performance calculation from circle diagram	2	C,D	1	1,2
8	Need for starters–Starting methods of three-phase induction motor	1	C	1	1,2
9	Speed control of three-phase induction motor: Stator side, Rotor side	2	C	1	1,2
10	Slip power recovery schemes	1	C	1	1,2
11	Double cage rotor, Induction generator, Cogging, Crawling,	2	C	1	1,2
12	Electric Braking	1	C	1	1,2
	UNIT III: SINGLE-PHASE INDUCTION MOTOR AND SPECIAL MOTORS	**8**			
13	Single-phase induction motor: Construction detail, Double revolving field theory, Torque equation, Torque-speed characteristics	1	C	1	1,2
14	Equivalent circuit, No load and Blocked rotor tests, Performance analysis	2	C	1	1,2
15	Methods of Self-starting-shaded pole induction motor	1	C	1	1,2
16	Construction, Principle of operation and applications of Linear Induction motor, Universal motor, stepper motor	2	C	3	2,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	References
17	Construction, Principle of operation and applications of reluctance motor, repulsion motor, AC series Motor	2	C	3	2,3
	UNIT IV - SYNCHRONOUS GENERATORS	**10**			
18	Alternators: Construction features and types	1	C	2	1,2
19	EMF equation of alternators, armature reaction in alternators	1	C	2	1,2,6
20	Alternator on load, Synchronous reactance, Synchronous Impedance	1	C	2	1,2
21	Voltage regulation, Pre-determination of voltage regulation using EMF and MMF methods	2	C	2	1,2
22	Pre-determination of voltage regulation using ZPF and ASA methods	2	C	2	1,2
23	Synchronizing and parallel operation of alternators	1	C	2	1,2,5
24	Salient pole synchronous machine, two-reaction theory, slip test	2	C	2	1,2,5
	UNIT V- SYNCHRONOUS MOTOR	**9**			
25	Principle of operation, Methods of starting	1	C	2	1,2
26	Torque and power equations	1	C	2	1,2
27	Synchronous motor on load, Synchronous motor on constant excitation variable load.	1	C	2	1,2,4
28	Synchronous motor on constant load variable excitation, 'V' and inverted 'V' curves, Synchronous condenser	1	C	2	1,2,3
29	Hunting and its suppression	1	C	2	1,2,4
30	Behavior of synchronous machine on short circuit, capability curves	2	C	2	1,2
31	Brushless DC motor, PMSM	2	C	3	1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Nagarath.I.J. and Kothari.D.P., "*Electric Machines*", T.M.H. Publishing CoLtd., New Delhi, 4th edition 2010.
2	Gupta., "*Theory and Performance of Electrical Machines",*. Kataria andSons, 14th edition 2009.
3	MulukutlaS.Sarma and MukeshK.Pathak, "*Electric Machines*", Cengage Learning.,New Delhi, 2012
REFERENCE BOOKS / OTHER READING MATERIAL	
4	Fitzgerald Kingsley and Umans, "*Electric Machinery*" McGraw HillBooks co., New Delhi, 7th Edition, 2013.
5	R.K.Srivastava, "*Electric Machines*", Cengage Learning.,New Delhi,2nd edition, 2013
6	Bhag S.Guru and Huseyin R.Hiziroglu "*Electric Machinery and Transformers*" Oxford University Press,3rd edition, 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%**

15EE210L	Electrical Machines Laboratory- II	L	T	P	C
		0	0	3	2
Co-requisite:	15EE210				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	ELECTRICAL MACHINES			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32 nd Academic Council Meeting, 2016				

PURPOSE	To acquire fair knowledge on the working of different types of AC machines							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Understand the characteristics and performance of induction and synchronous machines.	a	b	e				
2.	Gain knowledge about speed control techniques on induction motor.	a	b	e				

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Load test on induction motor	6	I,O	1	1
2.	No load and blocked rotor test on 3-phase induction motor: To draw circle diagram and equivalent circuit	6	I,O	1	1
3.	Speed control of three-phase induction motor	6	I,O	1	1
4.	Voltage regulation of alternators by EMF,MMF and ZPF methods	9	I,O	2	1
5.	Synchronization and parallel operation of alternators	3	I,O	2	1
6.	Determination of 'V' and inverted 'V' curves	3	I,O	2	1
7.	Determination of X_d and X_q and regulation of salient pole alternator	3	I,O	1	1
8.	Determination of positive, Negative and Zero sequence reactance of synchronous machines	3	I,O	1	1
9.	Power angle characteristic of synchronous machine	3	I,O	1	1
10.	No load and blocked rotor test on 1-phase induction motor: To draw equivalent circuit	3	I,O	1	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Nagarath.I.J. and Kothari.D.P., "*Electric Machines*", T.M.H. Publishing CoLtd., New Delhi, 4thedition 2010.
3.	Gupta., "*Theory and Performance of Electrical Machines",*. Kataria andSons, 14th edition 2009.

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%**

15EE211	Control Systems	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	CIRCUITS AND SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To provide students an introduction to the basic principles and tools for the design and analysis of feedback control systems.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	understand the basic components of control systems	a						
2.	gain knowledge in time and frequency domain tools for the design and analysis of feedback control systems	a	c	e	h	k		
3.	design compensators using time and frequency responses	a	c	e	h	k		
4.	understand the concepts of state variable analysis	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I : INTRODUCTION TO CONTROL SYSTEMS	**10**			
1.	Introduction to Control Systems	1	C	1	1
2.	Modeling and mathematical description of dynamic systems in the time and frequency domain	3	C	1	1,2
3.	System classification: Continuous-time systems, convolution and impulse response, step response. Transfer function analysis, poles, zeros	1	C	1	1,2
4.	Basic Characteristics of feedback control systems: stability, reference tracking, disturbance rejection, sensitivity and robustness	1	C	1	1,2
5.	Closed-loop systems. Block diagram algebra. Signal flow graphs	2	C	1	1,2
6.	Control hardware and their models: Servo motors, tachogenerators, gear train	1	C	1	2,4,5
7.	Case Study- DC motor Modeling using time and frequency domain.	1	C	1	1,2,3
	UNIT II : TRANSIENT, STEADY STATE AND STABILITY ANALYSIS	**9**			
8.	Time response of first and second order system	1	C	1,2,3	1,2
9.	Performance specifications in the time domain, Steady state error and generalized error constants	1	C	1,2,3	1,2
10.	Basic modes of feedback control: Proportional, Integral, Derivative	1	C	1,2,3	1,2
11.	Tuning (Ziegler-Nichols tuning-Step Response and Frequency response method) and design of PID controllers	2	C,D	1,2,3	1,4
12.	Stability, BIBO stability, Routh-Hurwitz stability criterion and Root Locus	3	C	1,2,3	1,2
13.	Case study- Speed Control of DC Motor using PID -Simulation	1	C,D,I	1,2,3	1,2,3
	UNIT III : FREQUENCY RESPONSE ANALYSIS	**9**			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
14.	Frequency response of dynamic systems, graphical representation of gain and phase data	1	C	1,2,3	1,2
15.	Constant M-circles, constant N-circles, Nichols Chart	1	C	1,2,3	1
16.	Nyquist plot (Polar Plot), Use of Nyquist stability criterion for stability analysis	2	C	1,2,3	1,2,4,5
17.	Bode diagrams, Gain margin and phase margin	2	C	1,2,3	1,2,4,5
18.	Performance specifications in frequency domain, Case study- Motor Control	3	C,D	1,2,3	1,2,3
	UNIT IV : COMPENSATOR DESIGN USING TIME AND FREQUENCY RESPONSES	**9**			
19.	Feedback compensation -Lead, Lag compensation	1	C	1,2,3	1,2
20.	Control system design using Root locus	3	C,D	1,2,3	1,2
21.	Control system design using Bode Plot	3	C,D	1,2,3	1,2
22.	Case Study- Motor Control –Stability Analysis	2	C,D,I	1,2,3	1,2,3
	UNIT V : STATE SPACE ANALYSIS	**8**			
23.	Introduction to multiple input multiple output systems, State variables, State equation	1	C	4	1,4
24.	State transition matrix	3	C	4	1,4
25.	Controllability, Observability	2	C	4	1,4
26.	State space feedback, Design of control systems in State space	1	C	4	1,4
27.	Pole placement technique. Case Study – Electric machines Control	2	C,D,I	4	1,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Nise, N.S, "*Control System Engineering"*, Wiley, 6th Edition, 2010.
2.	Golnaraghi, F and Kuo, B.C, "*Automatic control systems*" Prentice Hall, 9th Edition, 2008.
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	Dorf, R.C and Bishop, R.H, "*Modern Control systems*", Addison-Wesley, 12th Edition, 2011.
4.	Ogata, K, "*Modern control engineering*", Prentice Hall, 5th Edition, 2010.
5.	Nagrath I.J and Gopal M, "*Control Systems Engineering*", New Age Publishers, 5th Edition, 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%**

15EE212L	Measurements And Control Systems Laboratory	L	T	P	C
		0	0	2	1
Co-requisite:	15EE211, 15EE207				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	ELECTRICAL MACHINES			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting ,2016				

PURPOSE	To develop skills in designing and conducting experiments related to applications of measuring instruments, transducers and control systems							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Learn the measurement of non-electrical variables and electrical quantities using LABVIEW	a	b	h				
2.	Gain knowledge about the working of various Transducers	a	b	h				
3.	Simulate various controllers and stability analysis using software package.	a	b	h				

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Measurement of R, L and C using bridge circuit in Labview	3	I,O	1-3	1-3
2.	Measurement of power and energy using ARDUINO interfaced with Labview	3	I,O	1	1
3.	Power factor measurement using Labview	3	I,O	1	2,1
4.	Measurement of water level using capacitive Transducer	3	I,O	2	1
5.	Measurement of strain using strain Gauge	3	I,O	3	1
6.	Measurement of liquid flow rate -Water flow gauge using ARDUINO	3	I,O	3	1
7.	Output characteristics of LVDT and Measuring displacement using LVDT	2	I,O	3	1
8.	Speed control of DC motor using LABVIEW	2	I,O	1	1
9.	Stability analysis of a second order system using MATLAB software-Calculation of Phase margin and gain margin using MATLAB	2	I,O	2	3
10.	Digital simulation of the P,PI,PD,PID controllers using MATLAB software	2	I,O	2	3
11.	Obtaining transfer function and state model using MATLAB software	2	I,O	2	3
12.	Lead ,lag compensator using MATLAB software	2	I,O	2	3
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Jerome J "Virtual Instrumentation Using Labview" PHI publication, paperback 2010.
3.	P. Gruggett," LABVIEW Technical Resource Lynda" LTR Publishers, Dallas, TX.

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%**

15EE213	Generation, Transmission And Distribution	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE POWER SYSTEMS				
Course designed by	Department of electrical and electronics Engineering				
Approval	32nd Academic Council Meeting 2016				

PURPOSE	To acquire knowledge in the economics associated with power generation and enrich with the fair knowledge in the recent trends in power Transmission and Distribution Systems

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Learn the economics connected with power generation	a						
2.	Analyze the performance of transmission lines.	a	e					
3.	Understand the types and constructional features of cables and insulation.	a						
4.	Know about the transmission and distribution Substation schemes	a	e	h				
5.	Familiarize with IE rules for transmission and distribution systems	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: GENERATION AND ITS ECONOMICS	**9**			
1.	Load curve and load duration curve – Load, demand and diversity factors – Plant capacity and plant use factors	1	C	1	1,3
2.	choice of type of generation – choice of size and number of unit – cost of energy generated – Tariffs	1	C	1	1,3
3.	Conventional source of electrical energy-basic layout of thermal power generation, hydro electric power generation and nuclear power plant.	2	C	1	1,3
4.	Energy, power, efficiency calculations of conventional power plant	1	C	1	1,3
5.	Basic layout of sustainable energy resources (PV, wind, biomass, OTEC)	2	C	1	1,3
6.	Different operating voltages of generation, transmission and distribution – advantage of higher operating voltage for AC transmission-Indian energy scenario.	1	C	1	1,3
7.	An introduction to EHV AC transmission, HVDC transmission, IE Rules for insulators, cables, OHT and substation.	1	C	2,5	1,3
	UNIT II TRANSMISSION LINE PARAMETERS	**9**			
8.	Transmission Line Parameters, types of conductors (single and double circuits - solid, stranded and bundled conductors)	2	C	2,5	2,3,5,6
9.	Impact of transmission line parameters by introducing RES to utility-Resistance and Inductance calculation for conductor in transmission line	2	C,D	2	2,3,5,6
10.	Inductance calculation for symmetrical and unsymmetrical conductors - qualitative analysis	2	C,D	2	2,3,5,6
11.	Capacitance calculation for symmetrical and unsymmetrical conductors-qualitative analysis	2	C,D	2	2,3,5,6
12.	skin and proximity effects - interference with neighbouring communication circuits-Corona discharge characteristics	1	C	2	2,3,5,6
	UNIT III PERFORMANCE OF TRANSMISSION LINES	**9**			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
13.	Performance of short, medium and long transmission line	2	C,D	2	2,3,5,6
14.	Ferranti effect - surge impedance, attenuation constant and phase constant - voltage regulation and transmission efficiency	2	C,D	2	2,3,5,6
15.	Performance of Transmission Lines and Voltage Regulation quantitative analysis	2	C,D	2	2,3,5,6
16.	real and reactive power flow in lines – power circle diagrams	2	C,D	2	2,3,5,6
17.	shunt and series compensation- surge-impedance loading, loadability limits based on thermal loading	1	C	2	2,3,5,6
	UNIT IV INSULATORS,CABLES AND SAG CALCULATION	**9**			
18.	Classification of insulators for transmission and distribution purpose – voltage distribution in insulator string and grading	2	C	3	1,2,3,4
19.	improvement of string efficiency	2	C	3	1,2,3,4
20.	Underground cables - constructional features of LT and HT cables	1	C	3	1,2,3,4
19.	Insulation, resistance, capacitance, dielectric stress and grading – tan δ and power loss - thermal characteristics.	2	C	3	1,2,3,4
20.	Stress and Sag calculations – effect of wind and ice	2	C,D	3	1,2,3,4
	UNIT V SUBSTATION, GROUNDING SYSTEM AND DISTRIBUTION SYSTEM	**9**			
21.	Classification, major components of substations- Bus-bar arrangements	1	C	4	2,3,4
22.	Substation bus schemes- (single bus, double bus with double breaker, double bus with single breaker, main and transfer bus)	2	C	4	2,3,4
23.	Double bus-bar with bypass isolators	1	C	4	2,3,4
24.	Importance of earthing in a substation - Qualitative treatment to neutral grounding and earthing practices in substations	1	C	4	2,3,4,8
25.	Feeders, distributors and service mains. DC distributor – quantitative analysis of radial distribution	2	C	4	2,3,4,8
26.	Ring main distribution- AC distribution – single phase and three phase 4-wire distribution.	2	C	4	2,3,4,8
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Rai G.D., "*Non conventional energy resources"*, Khanna publishers, 2014.
2.	Wadwa. C.L., "*Electric Power Systems*, Wiley Eastern Ltd", New Dellhi 2001.
3.	Metha.V.K, and Rohit Metha,"*Principles of Power System*", S.Chand, 2005.
REFERENCE BOOKS/OTHER READING MATERIAL	
4.	Luces M. Fualkenberry, Walter Coffer, "*Electrical Power Distribution and Transmission*", Pearson Education,1996.
5.	Despande.M.V, "*Electrical Power Systems Design"* , Tata McGraw Hill PublishingCompany, New Delhi, 2005.
6.	William.D.Stevenson. Jr., "*Elements of Power System Analysis*", McGraw Hill, NewDelhi, 2014
7.	Nagarath.I.J. & Kothari.D.P., "*Modern Power System Analysis",* Tata McGraw Hill Publishing Company, New Delhi ,2014.
8.	Central Electricity Authority (CEA), "*Guidelines for Transmission System Planning",* New Delhi

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%**

15EE301J	Power Electronics	L	T	P	C
		3	0	2	4
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	-				
Course Category	P PROFESSIONAL CORE ELECTRONICS				
Course designed by	Department of Electrical & Electronics engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To learn the characteristics and applications of power electronic devices and circuits.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Learn the characteristics of different types of power electronic devices	a						
2.	Understand and analyze the operation of controlled rectifiers, choppers, inverters	a	e	h				
3.	Understand the operation of AC to AC converters and applications of power electronic circuits	a		h	j			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: POWER ELECTRONIC DEVICES	**9**			
1.	Introduction to power semiconductor devices	2	C	1	1,3
2.	Construction - Principle of operation - Dynamic characteristics of Power diodes, SCR, Power MOSFET, IGBT	4	C	1	1,3
3.	Protection circuits: Snubber, over voltage and over current, Crowbar	2	C	1	1,3
4.	Power loss calculation (Switching, conduction and leakage losses)	1	C	1	3,6
	UNIT II: AC TO DC CONVERTERS	**9**			
5.	Single-phase and three-phase controlled rectifiers (half and full converters) with R, RL and RLE load	2	C	2	1,2
6.	Estimation of average and RMS load voltages, RMS load current and input power factor	2	C	2	1,3
7.	Effect of source inductance	1	C	2	1,3
8.	Single-phase and three-phase dual converters	2	C	2	1,3
9.	Generation of control signals for single-phase AC to DC converters – Cosine wave crossing control, ramp comparator approach	2	C	2	3,4
	UNIT III: DC TO DC CONVERTERS	**9**			
10.	Principle of step up and step down operation – single quadrant DC chopper with RLE load –Time ratio control	2	C	2	1,2
11.	Forced commutated chopper:Voltage commutated choppers	2	C	2	1,4
12.	Forced commutated chopper:Current and load commutated choppers	2	C	2	1,4
13.	Sepic, Cuk converter - Buck-Boost converter	3	C	2	1,6
	UNIT IV: DC TO AC CONVERTERS	**9**			
14.	Single-phase voltage source inverter	2	C	2	1,3
15.	Three-phase voltage source inverter (120° and 180°)	3	C	2	1,3
16.	Single phase diode clamped multilevel inverter	1	C	2	1,7
17.	PWM techniques: multiple PWM, SPWM, modified SPWM - Harmonic reduction	3	C,D	2	1,5
	UNIT V: AC TO AC CONVERTERS AND POWER ELECTRONIC APPLICATIONS	**9**			
18.	AC Voltage regulator	1	C	3	1,4
19.	Cycloconverter: Step up and step down	1	C	3	1,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
20.	Cycloconverter: Three-phase to single-phase and three-phase to three- phase	2	C	3	3,4
21.	Introduction to matrix converter	2	C	3	1,7
22.	UPS - SMPS – HVDC systems – Tap changing of transformers	3	C	3	1,3
	Total contact hours	**45**			

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Single-phase Semi and Full converter	3	I,O	2	1-3
2.	Cuk converter	3	I,O	2	1,6
3.	Sepic converter	3	I,O	2	1,6
4.	3-phase PWM inverter using IGBT	3	I,O	2	1,3
5.	Series inverter and Parallel Inverter	3	I,O	2	1,3
6.	Single-phase Cycloconverter	3	I,O	3	1,3
7.	Single-phase AC voltage controller using Triac	3	I,O	3	1,3
8.	Fly back converter(SMPS)	3	I,O	3	1,3
9.	FPGA based single-phase diode clamped multi-level inverter	3	D,I,O	2	1,7
10.	Simulation of Boost converter using MATLAB	3	D,I	2	1,3
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Rashid, M.H., "*Power Electronics - Circuits Devices and Applications*", Prentice Hall of India,2014, 4th edition.
2.	Sen.P C, "*Power Electronics*", Tata Mc Graw Hill Education, 2012, 39th reprint .
3.	Bhimbra .P. S. ''*Power Electronics*", Khanna publishers, 2012, Fifth edition.
REFERENCE BOOKS/OTHER READING MATERIAL	
4.	Singh. M.D and Kanchandani-"*Power Electronics*"-Tata McGraw-Hill & Hill Publication Company Ltd, 2015, 23rd reprint.
5.	Joseph Vithayathil, "*Power Electronics Principle and applications*", Mc Graw Hill Education, edition 2010.
6.	Ned Mohan,T.M Undeland and W.P Robbin, "*Power Electronics: converters, Application and design*", John Wiley and sons, 3rd edition, 2006.
7.	Andrzej M. Trzynadlowski "*Introduction to modern power electronics*", John Wiley and sons, 3rd edition, 2015.
8.	V R Moorthi, "*Power Electronics: Devices, Circuits and Industrial Applications*", Oxford University Press India, 2005.

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%**

15EE302	Power System Protection	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE POWER SYSTEMS				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting , 2016				

PURPOSE	To gain the knowledge on the basic concepts of protection schemes of power system equipment, Switch gear and get familiarized with the modern trends in protection.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Realize the basic protective schemes applied in power system protection.	a						
2.	Emphasize the significance and application of protection for electrical equipment	a	e					
3.	Educate the new developments in power system protection	a	h					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO PROTECTIVE SCHEMES	**9**			
1.	Realise the basic protective schemes applied in power system protection.	1	C	1	1,2,3
2.	Evolution of protective relays - Zones of protection - Primary and Back -up Protection	1	C	1	1,2,3
3.	Essential qualities of Protection - Classification of Protective schemes	1	C	1	1,2,3
4.	Concept of reset, pick up, inverse time and definite time characteristics, over current, over voltage, directional, relay	2	C	1	1,2,3
5.	Differential relay	1	C	1	1,2,3
6.	Distance relays on R-X diagram	1	C	1	1,2,3
7.	Static Relays: Introduction, advantages and limitations of static relays, static over current, directional relays.	1	C	1	1,2,3
8.	Negative sequence relays	1	C	1	1,2,3
	UNIT II : PROTECTION OF EQUIPMENT	**9**			
9.	Types and detection of faults and their effects	1	C	2	1,2,3
10.	Alternator protection schemes (stator, rotor, reverse power protection etc.)internal faults protection), generator-transformer unit protection scheme	2	C	2	1,2,3
11.	Transformer protection (External and internal faults protection), Buccholz relay, generator-transformer unit protection schemes	2	C	2	1,2,3
12.	Bus bar protection	1	C	2	1,2,3
13.	Transmission line protection (current/time grading, distance)	1	C	2	1,2,3
14.	Pilot relaying schemes.	1	C	2	1,2,3
15.	Power line carrier protection	1	C	2	1,2,3
	UNIT III : SWITCHGEAR	**9**			
16.	Theory of current interruption- energy balance and recovery rate theory, arc quenching, recovery and restriking voltagesTypes of circuit breakers. bulk oil CB	1	C	2	1,3
17.	Types of circuit breakers. bulk oil CB	1	C	2	1,3
18.	Minimum oil CB	1	C	2	1,3
19.	Air break and air blast CBs	1	C	2	1,3
20.	Sulphur hexafluoride (SF6) and vacuum circuit breakers	2	C	2	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
21.	Rating selection and testing of circuit breakers	1	C	2	1,3
22.	Operating mechanisms - LT switchgear, Gas insulated switchgear	1	C	2	1,3
23.	HRC fuses, types, construction and applications.	1	C	2	1,3
	UNIT IV : SURGE PROTECTION AND INSULATION CO-ORDINATION	**9**			
24.	Introduction-Power frequency, switching and lightning overvoltages	1	C	2	1,3,4
25.	Klydonograph and magnetic link	1	C	2	1,4
26.	Protection of transmission lines against direct line strokes	1	C	2	1,4
27.	Protection of stations and sub-stations from direct strokes	2	C	2	1,4
28.	Protection against travelling waves	1	C	2	1,4
29.	Peterson coil, Insulation co-ordination, Basic impulse insulation level	3	C	2	1,4
	UNIT V : MODERN TRENDS IN POWER SYSTEM PROTECTION	**9**			
30.	Numerical Protection-Data acquisition systems (DAS), Numerical over current protection	2	C	3	1,2,3,5
31.	Numerical differential protection,	1	C	3	1,2,3,5
32.	Numerical distance protection	1	C	3	1,3,5
33.	Fibre optic based relaying, microwave relaying	2	C	3	1
34.	FPGA based relays, adaptive protection, Wide area protection	1	C	3	1,6
35.	Applications of AI techniques to power system protection, protection substation Automation	2	C,I	3	1,3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Badriram & Vishwakarma, "*Power System Protection''*, Tata McGraw-Hill Education,10th reprint, 2015.
2.	Paithankar Y. G., S. R. Bhide., "*Fundamentals of power system protection*''PHI Learning Pvt. Ltd., 10th reprint,2010.
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	Ravindra Nath.B, and Chandar.M ''*Power systems protection and switchgear''*, New age international (P) Ltd.3rd reprint, 2014.
4.	Rao Sunil.S, "*Switchgear and protection''* Khanna Publishers,2nd Edition,2011.
5.	T.S.M Rao, "*Digital/Numerical Relays''*, Tata McGraw-Hill Education, 2005.
6.	Bhavesh Bhalja, R P Maheswari, Nilesh G Chothani, "*Protection and Switchgear*" Oxford University press, first edition, 5th reprint 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%**

15EE303	Discrete Transforms And Signal Processing	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE	INTELLIGENT SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting , 2016				

PURPOSE	To acquire indepth knowledge in analyzing discrete time signals and systems in the time and frequency domain and also in designing filters.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Classify signals and systems and their mathematical representation.	a	c					
2.	Learn discrete Fourier transform and its properties.	a	c	e				
3.	Design IIR filters using analog to digital transformation.	a	c	e	h			
4.	Design FIR filters using windows technique.	a	c	e	h			
5.	Understand digital signal processors and their programming.	a	j					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: Discrete Time Signals and Systems	**9**			
1.	Need and benefits of Digital Signal Processing – Signal Classification and basic operations on them – Properties of DT system	3	C	1	1,2
2.	Linear, Time Invariance, Causal, Stable, Passive and Lossless – LTI system	2	C	1	1,2
3.	Convolution Sum- Interconnection Schemes-I/O relationship determination of impulse response and step response	2	C	1	1,2
4.	Antialiasing and Anti Imaging Filtering-Typical DSP system: ADC/DAC – sampling, quantization and encoding	2	C	1	1,2
	UNIT II: Discrete Transforms	**9**			
5.	Discrete Fourier Transform (DFT): Properties	3	C,I	2	1,2
6.	DIT FFT and DIF FFT algorithms	2	C,I	2	1,2
7.	Linear filtering via circular convolution-inverse FFT	2	C,I	2	1,2
8.	Wavelet Transform: Multi Resolution Analysis	2	C,I	2	1,2,8
	UNIT III: Infinite Impulse Response Digital Filters	**9**			
9.	Review of design of Analogue Butterworth and Chebyshev Filters, Frequency transformation in analogue domain	4	C,D	3	1,2,4
10.	Design of IIR digital filters using impulse invariance technique	1	C,D,I	3	1,2,4
11.	Design of digital filters using bilinear transform	1	C,D,I	3	1,2,3
12.	Pre warping – Frequency transformation in digital domain	1	C,D	3	1,2,3
13.	Realization using direct, cascade and parallel forms.	2	C,I	3	1,2
	UNIT IV: Finite Impulse Response Digital Filters	**9**			
14.	Symmetric and Anti symmetric FIR filters, Linear phase FIR filters design using Frequency Sampling technique	3	C	4	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
15.	Window design using Hamming, Hanning and Blackmann	3	D,I	4	1,2,
16.	Realization of FIR filters: Transversal, Linear phase and Polyphase realization structures.	3	D,I	4	1,2,7
	UNIT V: General Purpose Signal Processors	**9**			
17.	Computer Architectures for Signal Processing – Van Neumann and Harvard architectures pipelining	3	C	5	1,4,6
18.	Hardware multiplier-accumulator-special instructions-replication on-chip memory	3	C	5	1,4,6
19.	SIMD, VLIW and super scalar processing – selecting digital signal processors.	3	C	5	1,4,6
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	John. G. Proakis , Dimitris .G. Manolakis, "*Digital Signal Processing: Principles, Algorithms & Applications*", Prentice Hall of India, New Delhi, 2014
2.	Oppenheim, A.V.and Schaffer, R.W., "*Discrete Time Signal Processing*", Prentice Hall of India, New Delhi,2007
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	Emmanuel C. Ifeachor, Barrie W.Jervis, "*Digital Signal Processing , A Practical approach*", Pearson Education India Series, New Delhi, 2004
4.	Sanjit K.Mitra, "*Digital Signal Processing, A Computer based Approach*", Tata McGrawHill Publishing Company Limited, New Delhi, 2010
5.	Lonnie C.Ludeman, "*Fundamental of Digital Signal Processing*", John Wiley & Sons, New Jersey, 2003.
6.	Venkataramani.B.,Bhaskar.M. " *Digital Signal Processors, Architecture, Programming and Application*", Tata McGrawHill, New Delhi,2003
7.	Johny R. Jhonson, "*Introduction to Digital Signal Processing*" PHI, 2006
8.	Robert X. Gao and Ruqiang Yan, *Wavelets: Theory and Applications for Manufacturing*, Springer, 2010.
9.	"ARM education weblink" {https://www.arm.com/resources/education/education-kits}

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%**

15EE304	Power System Analysis	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE	POWER SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32 nd Academic Council Meeting, 2016				

PURPOSE	To gain comprehensive knowledge on power system analysis problems.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Develop mathematical model of a given power system.	a	e					
2.	Perform power flow analysis using numerical techniques.	a	e					
3.	Analyze the behavior of the power system under faulted condition.	a	e					
4.	Study the stability status of power system under transient condition.	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: POWER SYSTEM OVERVIEW	**7**			
1.	Power scenario in India, Power system components	1	C	1	1
2.	Representation, Single line diagram, per unit quantities, p.u impedance diagram	2	C	1	1
3.	Network graph, Bus incidence matrix, Primitive parameters	1	C	1	1
4.	Bus admittance matrix from primitive parameters	1	C	1	1
5.	Representation of off nominal transformer, Formation of bus admittance matrix of large power network	2	C	1	1
	UNIT II: POWER FLOW ANALYSIS	**10**			
6.	Bus classification, Formulation of Power Flow problems	1	C	2	1,4
7.	Power flow solution using Gauss Seidel method	2	C	2	1,4
8.	Handling of Voltage controlled buses	1	C	2	1,4
9.	Power Flow Solution by Newton Raphson method	4	C	2	1,4
10.	Fast Decoupled Power Flow Solution	2	C	2	1,4
	UNIT III: SYMMETRICAL FAULT ANALYSIS	**8**			
11.	Symmetrical short circuit on Synchronous Machine	1	C	3	2
12.	Bus Impedance matrix building algorithm (without mutual coupling),	2	C	3	2
13.	Symmetrical fault analysis through bus impedance matrix	3	C	3	2
14.	Fault level, Current limiting reactors	2	C	3	2
	UNIT IV: UNSYMMETRICAL FAULT ANALYSIS	**10**			
15.	Symmetrical components	1	C	3	2
16.	Sequence impedances, Sequence networks	1	C	3	2
17.	Analysis of unsymmetrical fault at generator terminals	3	C	3	2
18.	Bus impedance matrices of zero sequence, positive sequence and negative sequence	2	C	3	2
19.	analyzing unsymmetrical fault occurring at any point in a power system.	3	C	3	2
	UNIT V: POWER SYSTEM STABILITY	**10**			
20.	Introduction to stability studies	1	C	4	1,3,5
21.	Swing equation	1	C	4	1,3,5
22.	Swing curve, Power-Angle equation	1	C	4	1,3,5
23.	Equal area criterion	2	C	4	1,3,5
24.	Critical clearing angle and time	1	C	4	1,3,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
25.	Further applications of the equal-area criterion	2	C	4	1,3,5
26.	Classical step-by-step solution of the swing curve	2	C	4	1,3,5
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	John.J.Grainger, William D. Stevenson, Jr ,*"Power System Analysis",* Mc Graw Hill Education (India) Private Limited, New Delhi, 2015.
2.	William D. Stevenson, Jr. ,*"Elements of Power System Analysis",* McGraw-Hill Hill Education (India) Private Limited, New Delhi, 2014.
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	Nagarath I.J. and Kothari D.P. ,*"Modern Power System Analysis"*, Fourth Edition, Mc Graw Hill Education (India) Private Limited, New Delhi, 2015.
4.	Hadi Sadat, *"Power System Analysis",* Tata Mc Graw Hill Publishing company, New Delhi, 2002.
5.	Pai M.A. and Dheeman Chatterjee *"Computer Techniques in Power System Analysis",* Mc Graw Hill Education (India) Private Limited, New Delhi, 2016.

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%**

15EE305J	Microcontrollers	L	T	P	C
		3	0	2	4
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE	INTELLIGENT SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting ,2016				

PURPOSE	To acquire knowledge on Microcontrollers, Processors and interfacing devices.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Gain knowledge in INTEL 8085 architecture, interrupt and programming structures.	a						
2.	Design ARM processor based systems along with I/O interfacing.	a	c					
3.	Understand the impact of 8051 and PIC microcontrollers in Engineering applications.	a	c	e	k			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: PROCESSOR BASED SYSTEM	**9**			
1.	Evolution of Microprocessors, Microcontrollers and Computers, Microprocessor based system design – need and steps-Advantages and limitations.	2	C	1	1, 2
2.	Intel 8085, Pentium Architecture Bus system – Decoders – Tri state logic.	2	C	1	1, 2
3.	Memory devices: classifications, Mapping and its interfacing- Data Transfer.	3	C,D	1	1, 2
4.	Concepts, Methods – Parallel I/O interfacing – Serial I/O interfacing concepts –DMA method of transfer.	2	C	1	1, 2
	UNIT II: INTERFACING DEVICES	**9**			
5.	8255 programmable peripheral interface - 8257/8237 programmable DMA controller, 8279 keyboard/display interfacing – 8253/8254 programmable Timer.	4	C	1	1, 2
6.	Need of Interrupts – 8259 programmable interrupt controller.	5	C	1	1, 2
	UNIT III: HIGH PERFORMANCE RISC ARCHITECTURE-ARM PROCESSORS	**9**			
7.	The ARM (nuvoTon –NU-LB-NUC140) architecture - ARM organization and implementation – ARM instruction set.	3	C,I	2	1, 2
8.	Basic ARM ALP (32-bit addition, subtraction, multiplication, binary sorting),ARM memory interface – AMBA bus architecture.	2	C	2	1, 2,
9.	Hardware system prototyping tools - the ARMulator.	4	C,D	2	1, 2
	UNIT IV: INTEL 8051 MICROCONTROLLERS	**9**			
10.	Role of microcontrollers – 8 bit microcontrollers.	3	C	3	1, 2,
11.	Architecture of Intel 8031/8051/8751 –hardware description memory organization.	3	C	3	1, 2,
12.	Addressing modes – overview of instruction set – simple programs.	3	D,I	3	1, 2
	UNIT V: PIC MICROCONTROLLERS and APPLICATIONS	**9**			
13.	Introduction - PIC microcontroller- Architecture-memory organization – I/O ports – Reset circuits – Instruction set.	3	C	3	1, 2
14.	Compare/capture/PWM- Application and introduction to MPLAB.	2	C	3	1, 2
15.	Stepper motor control – Speed control of DC motor – Waveform Generator – Frequency counter - Real time clock– Generation of Gating Signals for Converters and Inverters.	4	C, D	3	1, 2
	Total contact hours	**45**			

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
PART-A: GENERAL PURPOSE PROGRAMMING EXERCISES (Minimum Five experiments to be conducted)					
1.	Introduction of Microprocessor and Microcontroller Kit.	3	I	1-3	1-3
2	Addition, Subtraction, Multiplication and Division.	3	C	1,2	1
3.	Finding the maximum value in an array.	3	D	1,2	2
4.	Sorting of data.	3	I	1-3	1-3
5.	Finding number of positive / negative elements in a block of data.	3	C	1-3	1
6.	BCD-to-Hex conversion and Hex-to-BCD conversion.	3	D	1-3	2
7.	Binary-to-ASCII and ASCII-to-Binary conversion.	3	I	1-3	1-3
8.	Square Root of a given data.	3	C	1-3	1
9.	LCM and GCD	3	D	1-3	2
PART-B: INTERFACING WITH APPLICATION BOARDS ({8051, ARM}) (Minimum Five experiments to be conducted)					
10.	8255 PPI.	3	C	1-3	1-3
11.	Transfer data serially between two kits (Study of 8253/8251).	3	D	1-3	1
12.	8279 Keyboard & display using 8051 controller.	3	I	1-3	2
13.	Seven segment display	3	C	1-3	1-3
14.	LCD Display using 8051	3	I	1-3	1-3
15.	Traffic light.	3	C	1-3	1
16.	8259 programmable interrupt controller.	3	D	1-3	2
17.	8257/8237 DMA controller.	3	I	1-3	1-3
18.	8 bit ADC and 8 bit DAC.	3	C	1-3	1
19.	Stepper motor control using 8051 controller.	3	D	1-3	2
20.	DC motor speed measurement and control module.	3	I	1-3	1-3
21.	Real Time Clock	3	C	1-3	1-4
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Gaonkar.R.S, "*Microprocessor Architecture, Programming and Applications*", Wiley Eastern Limited, New Delhi, 5th Edition, 1997.
2.	Kenneth Ayala, "*Intel 8051 – Microcontrollers*", Prentice hall, Second Edition, 2005.
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	Mazidi and Mazidi, "*8051 Microcontrollers*", Pearson Education India, 2006.
4.	Peatman, "*Microcomputer Hardware*", McGraw Hill Book Company.,1995.
5.	Douglas V. Hall, "*Microprocessor and Interfacing*", Tata McGraw Hill, 2006.
6.	John Peatman, "*Design with PIC Microcontrollers*", Pearson Education Asia, 2001.
7.	Steve Furber, "*ARM System-on-chip architecture*", Pearson Education, India, 2000.
8.	Andrew N Sloss, Symes.D, Wright.C, "*ARM system developers guide*", Morgan Kauffman/Elsevier, 2007.
9.	Steve Furber, "*ARM Systems-on-Chip architecture*" Addison Wesley, Reprint, 2012.
10.	Michael J. Pont, "*Embedded C*", Addison Wesley, 2002.
11.	David Seal, "*ARM Architecture Reference Manual*", Pearson Education, 2007.
12.	Satish Shah," *8051 Microcontrollers- Mcs 51 family and its variants*" Oxford University press,1st edition, 2010.
13.	"ARM education weblink" {https://www.arm.com/resources/education/education-kits}

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%**

15EE306M	Multi Disciplinary Design	L	T	P	C
		2	2	0	3
Co-requisite:					
Prerequisite:					
Data Book / Codes/Standards					
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 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, coneptualise 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, student will be able								
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	l	
2.	To rationalize a system architecture or product design problem by selecting appropriate design variables, parameters and constraints	a	c	e	f	i	l	
3.	To design for value and quantitatively assess the expected lifecycle cost of a new system or product	a	c	e	f	i	l	
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	l	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1	Introduction: Facilitating Multidisciplinary Projects		C,D,I,O	1,2,3,4	
2	Identifying and formulating a problem				
3	System Modelling				
4	Thinking perspectives: Decomposition–Composition Thinking Hierarchical Thinking, Organizational Thinking, Life-Cycle Thinking, Safety Thinking, Risk Thinking, Socio-politico-cultural thinking, Environment thinking				
5	Decomposing a system– Identifying the major sub-systems				
6	Mathematical Modeling and Governing equations for each sub systems				
7	Objectives, Constraints and Design Variables				
8	Conceptual Design				
9	Collaborative Design – Disciplinary teams satisfy the local constraints while trying to match the global constraints set by the project coordinator.				
10	Tools for modeling, designing, analysis, data interpretation, decision making etc				
11	Design Analysis, evaluation and selection				
12	Costing and Financial model				
13	Documentation, reviewing and presentation				
	Total contact hours	**60**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	**Systems Design and Engineering: Facilitating Multidisciplinary Development Projects** G. Maarten Bonnema, Karel T. Veenvliet, Jan F. Broenink December 15, 2015, CRC Press ISBN 9781498751261
2.	**Exploring Digital Design-Multi-Disciplinary Design Practices,** Ina Wagner , Tone Bratteteig , Dagny Stuedahl, Springer-Verlag London, 2010, ISSN:1431-1496 ***Additional references can be included by the respective departments based on the domain and / or theme.***

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.

15EE375L	Minor Project I	L	T	P	C
		0	0	3	2
Co-requisite:					
Prerequisite:					
Data Book / Codes/Standards					
Course Category	P PROFESSIONAL				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To obtain an 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, student will be able								
1.	To conceptualise a novel idea / technique into a product	c						
2.	To think in terms of multi-disciplinary environment		d					
3.	To understand the management techniques of implementing a project				k			
4.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.			g				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	An 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.		C,D,I	1,2,3,4	
	Total contact hours				

Course nature		**Project – 100% internal continuous assessment**	
Assessment Method (Weightage 100%)			
In-semester	**Assessment tool**	Refer the table	**Total**
	Weightage	Refer the table below	**100%**
End semester examination Weightage :			**0%**

Assessment components

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**

15EE376L	Minor Project II	L	T	P	C
		0	0	3	2
Co-requisite:					
Prerequisite:					
Data Book / Codes/Standards					
Course Category	P PROFESSIONAL				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To obtain an 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, student will be able								
5.	To conceptualise a novel idea / technique into a product	c						
6.	To think in terms of multi-disciplinary environment		d					
7.	To understand the management techniques of implementing a project				k			
8.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.			g				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
2.	An 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.		C,D,I	1,2,3,4	
	Total contact hours				

Course nature		**Project – 100% internal continuous assessment**	
Assessment Method (Weightage 100%)			
In-semester	**Assessment tool**	Refer the table	**Total**
	Weightage	Refer the table below	**100%**
End semester examination Weightage :			**0%**

Assessment components

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**

Assessment component	Expected outcome	Evaluators	Criteria or basis	Marks
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**

15EE380L	Seminar I	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To enhance the disseminating skills of the student about the current and contemporary research work that are being carried out across the world.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To understand the research methodology adopted by various researchers	h	i	j				
2.	To mathematically model a problem, critically analyse it and adopt strategies to solve	b	c	e				
3.	To understand and present a well documented research	e	g					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Guidelines for conducting 15xx390L Seminar for B.Tech 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.		C,D	1,2,3,4	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	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. This course is 100% internal continuous assessment.				
	Total contact hours				

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

Department of EEE

EVALUATION OF SEMINAR PRESENTATIONS

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

15EE381L	Seminar II	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To enhance the disseminating skills of the student about the current and contemporary research work that are being carried out across the world.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
4.	To understand the research methodology adopted by various researchers	h	i	j				
5.	To mathematically model a problem, critically analyse it and adopt strategies to solve	b	c	e				
6.	To understand and present a well documented research	e	g					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Guidelines for conducting 15xx390L Seminar for B.Tech 11. 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. 12. 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. 13. The course faculty, after discussion with the student will approve TWO research papers that is appropriate for presentation. 14. The student must collect additional relevant reference materials to supplement and compliment the two research papers and start preparing the presentation. 15. Each student must present a 15-minute presentation on each of the approved research paper to the panel of evaluators. 16. 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. 17. All other students registered for the course will form the audience. 18. The audience as well as the evaluators will probe the student with appropriate questions and solicit response from the presenter. 19. The presentation will be evaluated against 7 to 8 assessment criteria by 4 to 5 evaluators.		C,D	1,2,3,4	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	20. The score obtained through the presentations of TWO research papers will be converted to appropriate percentage of marks. This course is 100% internal continuous assessment.				
	Total contact hours				

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

Department of EEE
EVALUATION OF SEMINAR PRESENTATIONS

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

15EE385L	Massive Open Online Courses (MOOCs) I			L	T	P	C
				0	0	3	2
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL					
Course designed by	Department of Electrical and Electronics Engineering						
Approval	32nd Academic Council Meeting, 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, student will be able								
1.	To apply the concepts, theories, laws, technologies learnt herein to provide engineering solutions.	f	h	i	j			

Course nature		**Online - 100% internal continuous assessment.**				
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,

15EE390L	Industrial Training I	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd, Academic Council Meeting, 2016				

10. the attendance will be considered as ZERO.

PURPOSE	To provide short-term work experience in an Industry/ Company/ Organisation

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
4.	To get an inside view of an industry and organization/company				j			
5.	To gain valuable skills and knowledge				j			
6.	To make professional connections and enhance networking	f	g					
7.	To get experience in a field to allow the student to make a career transition			i				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	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.		D, I,O	1,2,3,4	
	Total contact hours				

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%**

15EE386L	Massive Open Online Courses (MOOCs) II			L	T	P	C
				0	0	3	2
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL					
Course designed by	Department of Electrical and Electronics Engineering						
Approval	32nd Academic Council Meeting, 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, student will be able								
2.	To apply the concepts, theories, laws, technologies learnt herein to provide engineering solutions.	f	h	i	j			

Course nature		**Online - 100% internal continuous assessment.**				
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:

11. Students can register for courses offered by approved global MOOCs platforms like edX, Coursera or Universities with which SRM partners specifically for MOOCs.
12. 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.
13. 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.
14. 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.
15. The maximum credit limits for course registration at SRM will include the MOOCs course registered.
16. 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.
17. The student must take the final test as a Proctored / Supervised test in the university campus.
18. 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.
19. 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,

15EE390L	Industrial Training I	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd, Academic Council Meeting, 2016				

20. the attendance will be considered as ZERO.

PURPOSE	To provide short-term work experience in an Industry/ Company/ Organisation

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
8.	To get an inside view of an industry and organization/company				j			
9.	To gain valuable skills and knowledge				j			
10.	To make professional connections and enhance networking	f	g					
11.	To get experience in a field to allow the student to make a career transition			i				

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	12. It is mandatory for every student to undergo this course. 13. Every student is expected to spend a minimum of 15-days in an Industry/ Company/ Organization, during the summer vacation. 14. The type of industry must be NOT below the Medium Scale category in his / her domain of the degree programme. 15. 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. 16. The committee will then assess the student based on the report submitted and the presentation made. 17. Marks will be awarded out of maximum 100. 18. Appropriate grades will be assigned as per the regulations. 19. Only if a student gets a minimum of pass grade, appropriate credit will be transferred towards the degree requirements, as per the regulations. 20. It is solely the responsibility of the individual student to fulfill the above conditions to earn the credits. 21. 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. 22. 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.		D, I,O	1,2,3,4	
	Total contact hours				

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%**

15EE490L/	Industry Module I /	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To impart an insight into the current industrial trends and practices							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To obtain an insight into the current industrial trends and practices			j				
2.	To obtain an insight into the technologies adopted by industries			j				
3.	To obtain an insight into the technical problems encountered by the industries and the scope for providing solutions.		h					
4.	To network with industry	g						

Description of Topic	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
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.		C,D,I,O	1,2,3,4	
Total contact hours	**30**			

Course nature		**100% internal continuous assessment.**					
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%**

15EE491L	Industry Module II	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To impart an insight into the current industrial trends and practices							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
5.	To obtain an insight into the current industrial trends and practices			j				
6.	To obtain an insight into the technologies adopted by industries			j				
7.	To obtain an insight into the technical problems encountered by the industries and the scope for providing solutions.		h					
8.	To network with industry	g						

Description of Topic	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
11. The department will identify and shortlist few emerging topics that are trending in industry. 12. The department will identify experts from industry who are willing to deliver modules on the shortlisted topics. 13. 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. 14. 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. 15. 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. 16. 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. 17. 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. 18. The maximum credit limits for course registration at SRM will include the Industry Module also. 19. All academic requirements of a professional course like minimum attendance, assessment methods, discipline etc will be applicable for this Industry Module. 20. The course will be conducted on week ends or beyond the college regular working hours.		C,D,I,O	1,2,3,4	
Total contact hours	**30**			

Course nature		**100% internal continuous assessment.**					
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%**

15EE401	Solid State Drives	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	15EE204, 15EE210, 15EE301J				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE ELECTRONICS				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To acquire a comprehensive knowledge on solid state drives, digital control and applications of electric drives.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Understand the steady state operation and transient dynamics of motor-load system	a		e				
2.	Learn the characteristics and control of solid state DC and AC drives	a		e				
3.	Learn digital control and applications of electric drives	a	c	e	h	j		

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: CLASSIFICATION OF ELECTRIC DRIVES	**9**			
1.	Electric Drives-Selection of motor power rating	2	C	1	1,2
2.	Thermal model of motor for heating and cooling	2	C	1	1,2
3.	Classes of duty cycle- Determination of motor rating	1	C	1	1,2
4.	Drive classifications – Closed loop control of electric drives	2	C	1	1
5.	Modes of operation - Speed control	2	C	1,2	1,2
	UNIT II: SOLID STATE CONTROL OF DC DRIVES	**9**			
6.	DC Motor Drives - DC motors and their performance, Braking, Transient analysis	2	C	2	1,2
7.	Separately excited motor with armature and field control	2	C	2	1,2,3
8.	Ward Leonard drives-Transformer and uncontrolled rectifier control	1	C	2	1
9.	Controlled rectifier fed DC drives	2	C	2	1,2,3
10.	Chopper controlled DC drives – Single, two and four quadrant operations.	2	C	2	1,2,3
	UNIT III: SOLID STATE CONTROL OF INDUCTION MOTOR DRIVE	**9**			
11.	Induction motor drives -Stator control , Stator voltage and frequency control	2	C	2	1,2,3
12.	AC chopper fed induction motor drives	1	C	2	1,3,4
13.	Voltage source inverter- current source inverter - Z – source inverter fed induction motor drive	2	C	2	1,3,4
14.	Cyclo-converter fed induction motor drives	1	C	2	1,3,4
15.	Rotor control	1	C	2	1,2
16.	Static rotor resistance control and slip power recovery schemes matrix from element stiffness	2	C	2	1,2,3
	UNIT IV: SOLID STATE CONTROL OF SYNCHRONOUS MOTOR DRIVE	**9**			
17.	Synchronous motor drives	2	C	2	1,2,3
18.	Speed control of three-phase synchronous motor drives	2	C	2	1,2,3
19.	Voltage source inverter and current source inverter fed synchronous motor drive	2	C	2	1,3,4
20.	Z - source inverter fed synchronous motor drive	1	C	2	4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
21.	Cyclo-converter fed synchronous motor drive	2	C	2	1,3
	UNIT V: DIGITAL CONTROL OF DRIVES AND ITS APPLICATIONS	**9**			
22.	Digital technique in speed control-Advantages and Limitations	1	C	3	3
23.	Microprocessor based control of drives	2	C	3	3
24.	Solar powered pump drives	2	C	3	1
25.	Selection of drives and control schemes for paper mills	2	C,D	3	3
26.	Selection of drives for lifts and cranes	2	C	3	3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
13.	G.K. Dubey, "*Fundamentals of Electrical Drives*", Narosa Publishing House Pvt. Ltd., 2nd Edition, 2010
14.	Pillai.S.K., "*A First Course on Electrical Drives*", New Age International (P) Ltd., 2nd Edition, 2015
REFERENCE BOOKS/OTHER READING MATERIAL	
15.	Vedam Subramanyam, "*Thyristor control of Electrical Drives*", Mc Graw Hill Education (India) Pvt. Ltd., 3rd Edition, 2015
16.	Bimal K.Bose "*Modern Power Electronics and AC Drives*", Prentice Hall of India, 2nd Edition, 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%**

15EE401L	Electric Drives Laboratory			L	T	P	C
				0	0	3	2
Co-requisite:	15EE401						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	PROFESSIONAL CORE	ELECTRONICS				
Course designed by	Department of Electrical and Electronics Engineering						
Approval	32nd Academic Council Meeting, 2016						

PURPOSE	To acquire training and skills on the hardware programming and control of power electronics circuit based motor control							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	To learn about control of power electronic converters and motors	a	b	e				
2.	To acquire skills in FPGA and DSP processors	a	b	e	h	k		

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	FPGA based DC Motor control using DC Chopper	6	D,I,O	1,2	1,2
2.	Braking of DC Motor using FPGA based DC Chopper	6	D,I,O	1,2	1,2
3.	DSP based servo motor position control system	3	D,I,O	1,2	1,2
4.	FPGA based PWM control of three-phase voltage source inverter fed induction motor drive	6	D,I,O	1,2	1,3
5.	Open loop and closed loop v/f control of 3-phase induction motor	3	D,I,O	1,2	1,3
6.	AC voltage controller based speed reversal of three-phase induction motor drive	3	D,I,O	1,2	1,3
7.	Rotor resistance control of three-phase slip ring induction motor using Chopper	3	D,I,O	1,2	1,3
8.	DSP based PWM control of three- phase Z source inverter fed induction motor drive	6	D,I,O	1,2	1,3
	Total contact hours	**36**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Electric Drives-Laboratory Manual
2.	Dubey.G.K, "*Fundamentals of Electrical drives*", Narosa Publishing House Pvt. Ltd., Second Edition, 2010.
3.	Bose.B.K, "*Modern Power Electronics and AC drives*", McGraw Hill , Second Edition, 2010.

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%**

15EE402	Power System Operation and Control			L	T	P	C
				3	0	0	3
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	P	Professional Core	POWER SYSTEMS				
Course designed by	Department of Electrical and Electronics Engineering						
Approval	32nd Academic Council Meeting , 2016						

PURPOSE	To gain knowledge in the operation and control of power systems and to learn the modern computer control in power systems							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Learn the basics of power system control	a						
2.	Control the frequency and voltage of power system	a	e					
3.	Understand the economic operation of power system	a	e	h	j			
4.	Realize the modern computer control in power system	a	e	h	j			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: REAL POWER FREQUENCY CONTROL	**9**			
1.	Basic concepts of operation and control of power system, Plant and system level control	1	C	1	1,3,4
2.	Modeling of speed governing mechanisms	1	C	1	1,3,4
3.	Speed load characteristics - regulation of two alternators in parallel	1	C	1	1,3,4
4.	Control area concept - single area frequency control-modeling	1	C	1,2	1,3,4
5.	Steady state and dynamic response of single area system- state space model for single area	2	C	1,2	1,3,4
6.	Two area frequency control modeling-proportional plus integral controllers - block diagram representation	2	C	1,2	1,3,4
7.	Static and dynamic response of two area system- Economic dispatch added to LFC control.	1	C	1,2	1,3,4
	UNIT II: REACTIVE POWER CONTROL	**8**			
8.	Production and absorption of reactive power	1	C	2	1,2,3
9.	Types of Excitation systems (DC, AC, Static and brushless) – mathematical model of IEEE type I	2	C	2	1,2,3
10.	Methods of voltage control (shunt reactors, shunt capacitors, synchronous condensers, static var systems, tap changing transformers)	3	C	2	1,2,3
11.	Load compensation	2	C	2	1,2,3
	UNIT III: ECONOMIC OPERATION OF POWER SYSTEM	**10**			
12.	Optimal operation of Generators in Thermal Power Stations – heat rate Curve – Cost Curve	1	C	3	3,4,5
13.	Incremental fuel and Production costs, input-output characteristics, Optimum generation allocation with line losses neglected	2	C	3	3,4,5
14.	Optimum generation allocation including the effect of transmission line losses – Loss Coefficients, General transmission line loss formula	3	C	3	3,4,5
15.	Base point and participation factors	2	C	3	3,4,5
16.	Classical economic dispatch by gradient method	1	C	3	3,4,5
17.	Concept of Security constrained economic dispatch by linear programming	1	C	3	3,4,5
	UNIT IV: UNIT COMMITMENT AND OPTIMAL POWER FLOW	**9**			
18.	Statement of unit commitment- constraints	1	C	3	3,4
19.	Priority method (quantitative analysis)	2	C	3	3,4
20.	Dynamic programming (quantitative analysis)	2	C	3	3,4
21.	Lagrange relaxation method (qualitative analysis)	1	C	3	3,4
22.	OPF problem formulations	1	C	3	3,4
23.	Newton's method of OPF neglecting security constraints.	2	C	3	3,4
	UNIT V: COMPUTER CONTROL OF POWER SYSTEMS	**9**			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
24.	Concept of energy control centre- monitoring, data acquisition and control	2	C	4	3,6,7
25.	SCADA and EMS configurations	1	C	4	3,6,7
26.	PLC architecture and communication links	2	C	4	3,6,7
27.	Operating strategies, state transition diagram	1	C	4	3,6,7
28.	State estimation by weighted least square method	1	C	4	3,6,7
29.	Introduction to phasor measurement units	1	C	4	3,6,7
30.	Integration, control and operation of distributed generation	1	C	4	3,6,7
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl.No	**TEXT BOOKS**
1.	Olle.I.Elgerd, "*Electric Energy systems theory- An Introduction"*, Tata Mc Graw Hill publishing Ltd, New Delhi, 2008
2.	I.J.Nagrath and D.P.Kothari, "*Power system engineering'',* 2nd edition, Tata Mc Graw Hill publishing Ltd, 2008.
3.	John J.Grainger, William D. Stevenson, "*Power system analysis*'', McGraw Hill series, 1994
REFERENCE BOOKS	
4.	Prabha Kundur, "*Power system stability and control*", Tata Mc Graw Hill publishing Ltd, New Delhi, 5th reprint, 2008.
5.	Allen J.Wood and Bruce F. Woollenburg, "*Power generation, operation and control*", 2nd edition, John Wiley and sons, 1996
6.	M.E. El-Hawary, G.S. Christensen, "*Optimal Economic Operation of Electric Power Systems*", Academic Press (1979)
7.	E. Mariani, S.S. Murthy, "*Control of Modern Integrated Power Systems*", Springer, 1997

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%**

15EE403L	Power Systems Laboratory	L	T	P	C
		0	0	3	2
Co-requisite:	15EE402				
Prerequisite:	15EE304				
Data Book / Codes/Standards	Nil				
Course Category	P Professional core	POWER SYSTEMS			
Course designed by	Department of EEE				
Approval	32 Academic Council Meeting , 2016				

PURPOSE	To develop skills in simulation softwares and conducting experiments related to power system studies.

INSTRUCTIONAL OBJECTIVES		**STUDENT UTCOMES**						
At the end of the course, student will be able to								
1.	Acquire skills of using computer packages for power system studies.	a	b	e	h	k		
2.	Acquire knowledge in conducting experiments related to power system studies	a	b	e	h	k		

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
	SIMULATION STUDIES	**18**			
1.	Power flow solution-Gauss seidal, Newton Raphson and FDLF	3	C-D	1	1,3
2.	Zbus building algorithm	3	C-D	1	1,3
3.	Contingency analysis	3	C-D	1	1,3
4.	MVAR Compensation studies on normal and heavily loaded power systems	3	C-D	1	1,3
5.	Steady state and dynamic response of LFC in single area system	3	C-D	1	1,2
6.	Transient stability analysis of DFIG based wind system	3	C-D	1	1,3
	HARDWARE	**27**			
7.	Perform series and shunt compensation and determine A, B,C,D constants of transmission line	3	C-D-I-O	2	1,3
8.	Characteristics of under-voltage and over-voltage relays	3	C-D-I-O	2	1
9.	SCADA- data acquisition and data logging	3	C-D-I-O	2	1
10.	Energy metering	3	C-D-I-O	2	1
11.	Location of fault in a cable	3	C-D-I-O	2	1
12.	Emulation of wind turbine characteristics	3	C-D-I-O	2	1
13.	Performance analysis of PV module	3	C-D-I-O	2	1
14.	Determination of power factor and total harmonic distortion associated with power electronics interface	3	C-D-I-O	2	1
15.	Performance and testing of transformer protection system	3	C-D-I-O	2	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Olle.I.Elgerd, "*Electric Energy systems theory- An Introduction"*, Tata Mc Graw Hill publishing Ltd, New Delhi, 2008
3.	D.P.Kothari, I.J.Nagrath, "*Modern Power System analysis*", 4th Edition, Mc Graw Hill, 2011

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%**

15EE496L	Major Project	L	T	P	C
		0	0	24	12
Co-requisite:					
Prerequisite:					
Data Book / Codes/Standards					
Course Category	P	PROFESSIONAL CORE			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	The Major Project experience is the culminating academic endeavor of students who earn a degree in their Undergraduate Programs. The project provides students 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 student'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 students' ability to think critically and creatively, to solve practical problems, to make reasoned and ethical decisions, and to communicate effectively.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able								
1.	To provide students with the opportunity to apply the knowledge and skills acquired in their courses to a specific problem or issue.	a	c		e	f		i
2.	To allow students to extend their academic experience into areas of personal interest, working with new ideas, issues, organizations, and individuals.	a	c		e	f		i
3.	To encourage students 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	h	i
4.	To provide students with the opportunity to refine research skills and demonstrate their proficiency in written and/or oral communication skills.	a	c		e	f	g	i
5.	To take on the challenges of teamwork, prepare a presentation in a professional manner, and document all aspects of design work.			d			g	

Session	**Description of Topic**	**Contact hours**	**C-D-I-O**	**IOs**	**Reference**
	1. The Major project is a major component of our engineering curriculum: it is the culmination of the program of study enabling the students 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 students. 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.		C,D,I,O	1,2,3,4,5	

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	9. A group project may be interdisciplinary, with students 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 students to exercise analytical, evaluation and design skills at the appropriate level.				
	Total contact hours				

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%**

15EE251E	Sustainable Energy	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	E PROFESSIONAL ELECTIVE	POWER SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting , 2016				

PURPOSE	To understand the different types of non-conventional energy resources like solar, wind, biomass, ocean, tidal and wave sources and their conversion techniques

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, the student will be able to								
1.	Understand the concept of various non-conventional energy resources	a						
2.	Acquire in-depth knowledge on the conversion of non-conventional energy resources into Electrical power	a						
3.	Become intellectual in new developments of renewable energy studies	a	e					
4.	Attain knowledge in green energy technologies	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: SOLAR ENERGY	**09**			
1.	Various solar energy systems and their applications	1	C	1	1
2.	Solar spectra-latitude and longitude, Declination angle, solar window, cosine law, seasonal variations, daily variation, hour angle	2	C	1,2	2
3.	Calculation of angle of incidence	1	C	3	2
4.	Principle of photovoltaic conversion of solarenergy - Types of solar cells and fabrication	2	C	4	3
5.	Photovoltaic - battery charger, domestic lighting, street lighting, water pumping etc	2	C	4	3
6.	Solar Photovoltaic power plant – Net metering concept	1	C	3	2
	UNIT II: WIND ENERGY	**09**			
7.	Nature of the wind – wind power– factors influencing wind	2	C	1	1
8.	Wind data and energy estimation - wind speed monitoring - wind resource assessment - Betz limit - site selection	2	C	2	1
9.	Types of wind turbines – Various control-Tip Speed Ratio – Solidity	2	C	3	3
10.	Torque on wind-wind thrust calculations	2	C	2	3
11.	Repowering concept	1	C	1	2
	UNIT III: BIO-ENERGY	**09**			
12.	Energy from Biomass - Biomass as Renewable Energy Source - Types of Biomass Fuels - Solid, Liquid and Gas	2	C	1	1
13.	Biomass Conversion Techniques- Wet Process, Dry Process-Photosynthesis - Biogas Generation	2	C	1,2	1
14.	Factors affecting Bio-digestion –Different digesters – Digesters sizing - Advantages and Disadvantages	2	C	1,2	2
15.	Digesters power generated and problems	1	C	2	3
16.	Energy Forming –Pyrolysis	2	C	1,3	1
	UNIT IV: ENERGY FROM OCEANS	**09**			
17.	Ocean Thermal Energy Conversion (OTEC): Principle- Lambert Law of absorption - Open and closed OTEC Cycles -.Major problems and operational experience	2	C	1	1,4
18.	Tidal energy: Tide – Spring tide, Neap tide – Tidal range – Tidal Power – Types of Tidal power plant	2	C	1,4	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
19.	Single and dual basin schemes - Requirements in tidal power plant	2	C	2	2
20.	Wave Energy – Wave Characteristics	1	C	1,3	1
21.	Different wave energy convertors -Saltor Duck , Oscillating water column and dolphin types	2	C	2	1,4
	UNIT V: GEOTHERMAL ENERGY	**09**			
22.	Geothermal Energy – Classification	2	C	1	1
23.	Fundamentals of geophysics	1	C	1	1
24.	Dry rock and hot aquifers energy analysis	3	C	1,2	3
25.	Estimation of thermal power , Extraction techniques	3	C	3	3
	Total hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Rai , G.D.,"*Non Conventional sources of Energy*", Khanna Publishers ,5th Edition 2016.
2.	Khan. B.H, "*Non-Conventional Energy Resources*", The McGraw Hills, 2nd Edition, 2016.
REFERENCE BOOKS / OTHER READING MATERIAL	
3.	Rao. S. & Pamlekar Dr.B.B. "*Energy Technology* ", Khanna Publishers, 3rd Edition 2016
4.	John W Twidell and Tony D Weir, "*Renewable Energy Resources*", Taylor and Francis, 2nd Edition 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%**

15EE252E	Electrical Power Utilization and Illumination			L	T	P	C
				3	0	0	3
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes/Standards	NIL						
Course Category	E	PROFESSIONAL ELECTIVE	CIRCUITS AND SYSTEMS				
Course designed by	Department of Electrical and Electronics Engineering						
Approval	32nd, Academic Council Meeting, 2016						

PURPOSE	To gain the knowledge about power utilization by heating, welding, traction, refrigeration and air conditioning and illumination systems							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Select the heating and welding requirements and the lighting system	a	e					
2.	Familiarize the industrial drives and traction system	a	e					
3.	Bring solutions for the problems in refrigeration and air conditioning systems	a	e	h				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I ELECTRIC HEATING AND WELDING	**9**			
1.	Principle of heating – modes of heat transfer	1	C	1	1,2
2.	Types of heating – Resistance heating	1	C	1	1,2
3.	Arc heating – Induction heating	1	C	1	1,2
4.	Eddy current heating – dielectric heating	1	C	1	1,2
5.	Advantages – Applications – related simple problems	1	C	1	1,2
6.	Principles of welding – types of welding	1	C	1	1,2
7.	Welding electrodes – Resistance welding	1	C	1	1,2
8.	Arc welding – ultrasonic welding – testing of welding	1	C	1	1,2
9.	Power supply – comparison of types – problems	1	C	1	1,2
	UNIT II: ILLUMINATION	**9**			
10.	Laws of illumination – lighting calculation	2	C	1	1,2
11.	Sources of light - photometers	1	C	1	1,2
12.	Illumination systems – lighting schemes	1	C	1	1,2
13.	Lighting systems – indoor / outdoor lighting	1	C	1	1,2
14.	Electrical lamps – discharge / arc lamps	1	C	1	1,2
15.	Sodium Vapour – High Pressure Mercury Vapour lamps	1	C	1	1,2
16.	Neon lamps – Fluorescent tubes	1	C	1	1,2
17.	Design of lighting - illumination calculation	1	C,D	1	2
	UNIT III: INDUSTRIAL UTILISATION	**9**			
18.	Selection of motors – types of drives	1	C	2	1,2
19.	Nature of load – characteristics	1	C	2	1,2
20.	Speed control – enclosures	1	C	2	1,2
21.	Transmission of drives	1	C	2	1,2
22.	Size and Rating	1	C	2	1,2
23.	Temperature – time curves	1	C	2	1,2
24.	Insulation materials	1	C	2	1,2
25.	Energy conservation in electrical drives - Types of services, problems	2	C	2	1,2
	UNIT IV: TRACTION AND BRAKING	**9**			
26.	Systems of electric traction – comparison of supply systems – requirement	1	C	2	1,2
27.	Speed – time curves – mechanics of train movement	1	C	2	1,2
28.	Power energy output – factors affecting energy consumption	1	C	2	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
29.	Related simple problems	1	C	2	1,2
30.	Types of braking – regenerative braking	1	C	2	1,2
31.	Mechanical braking – auxiliary equipment	1	C	2	1,2
32.	Over-head equipment – current collectors	1	C	2	1,2
33.	Sag and tension of trolley wires	1	C	2	1,2
34.	Feeding and distribution systems - Energy saving	1	C	2	1,2
	UNIT V: REFRIGERATION AND AIR-CONDITIONING SYSTEMS	**9**			
35.	Elements of refrigeration system - rating	1	C	3	2
36.	Vapour compression system	1	C	3	2
37.	Domestic refrigerator – water cooler	1	C	3	2
38.	Electrical circuits of refrigerator and controls	1	C	3	2
39.	Concept of Psychometrics	1	C	3	2
40.	Human comfort	1	C	3	2
41.	Air conditioning system	1	C	3	2
42.	Classification of air conditioning systems	1	C	3	2
43.	Applications of air conditioning systems	1	C	3	2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	S.L.Uppal, " *Electric power* ", Khanna publication, 1997
2.	R.K.Rajput, " *Utilisation of electrical power*", First edition, Lakshmi publications, 2006
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	Soni, Gupta, Bhatnagar, " *A course in electric power*" , Dhanpatrai and sons, 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%**

15EE253E	Advanced Topics in Electrical Insulation	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE POWER SYSTEMS				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting 2016				

PURPOSE	To acquire fair knowledge on the characteristics of insulation materials and to familiarize the testing and measurement of insulation for various equipment							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Select the appropriate insulation material and to understand about failures	a						
2.	Familiarize about dielectrics and vacuum insulation	a						
3.	Acquire knowledge on advanced measuring and testing techniques	a	h	k				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT-I INSULATION MATERIALS AND FAILURES	**9**			
1.	Electrical discharge – partial break down	1	C	1	1
2.	Classification of electric fields	1	C	1	1
3.	Types of Dielectrics	1	C	1	1
4.	Electric strength of dielectrics	1	C	1	1
5.	Organic and inorganic insulation materials	1	C	1	1
6.	Insulation materials properties – application	1	C	1	1
7.	Causes of insulation degradation	1	C	1	2
8.	Failure modes	1	C	1	2
9.	Recent insulation testing and diagnostic techniques	1	C	1	2
	UNIT II: DIELECTRICS	**9**			
10.	Sources of dielectrics – characteristics	2	C	2	1,2
11.	Behavior of dielectrics in electric fields	2	C	2	1,2
12.	Machine insulation system	1	C	2	1,2
13.	Insulation defects – insulation stress	1	C	2	1,2
14.	Composite insulation system	1	C	2	1,2
15.	Nano dielectrics	1	C	2	1,2
16.	Properties and handling of Sulphur hexafluoride – application	1	C	2	1,2
	UNIT III: VACUUM INSULATION	**9**			
17.	Breakdown electron emission	1	C	2	1,2
18.	Pre-breakdown conduction	1	C	2	1,2
19.	Effective condition of electrodes	1	C	2	1
20.	Breakdown mechanism in vacuum	2	C	2	1
21.	Factors affecting breakdown voltage	1	C	2	1
22.	Vacuum circuit breaker	1	C	2	1
23.	Space application	1	C	2	1
24.	Tutorial	1	C	2	1
	UNIT IV: INSULATION TESTING	**9**			
25.	Classification of testing – Procedures and standards	2	C	3	2
26.	Testing automation	1	C	3	2
27.	Partial discharge test	1	C	3	2
28.	Dielectric loss test	1	C	3	2
29.	Insulation Testing of equipments	1	C,I	3	2
30.	Testing of Transformer and cable accessories	1	C,I	3	2
31.	Testing of Electrical switchgear and circuit breakers	1	C,I	3	2
32.	Testing of Motor and Generators	1	C,I	3	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT V: ADVANCED MEASUREMENT AND DIAGNOSTIC TECHNOLOGIES	**9**			
33.	Digital impulse recorders – digital techniques in testing	2	C	3	3
34.	Testing automation	1	C	3	3
35.	Electric field measurements	1	C	3	3
36.	Electro optic sensors – Magneto Optic Sensors	2	C	3	3
37.	Space charge measurement techniques	1	C	3	3
38.	Electro – optical imaging techniques	1	C	3	3
39.	Insulation resistance measuring instruments	1	C	3	3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Ravindra Arora, Wolfgang Mosch, "*High voltage and electrical insulation engineering*", IEEE press series on power engineering, 2011
2.	Paul Gill, "*Electrical power equipment maintenance and testing*", Second edition, CRC Press, Taylor & Francis group, 2009
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	N.H.Malik, A.A.Al-Arainy, M.I.Qureshi, " *Electrical insulation in power systems*", CRC Press, Taylor & Francis group, 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%**

15EE254E	Instrumentation Systems			L	T	P	C
				3	0	0	3
Co-requisite:	NIL						
Prerequisite:	NIL						
Course Category	P	PROFESSIONAL ELECTIVE	CIRCUITS AND SYSTEMS				
Course designed by	Department of Electrical and Electronics Engineering						
Approval	32nd Academic Council Meeting , 2016						

PURPOSE	To acquire knowledge on working of sensors, transducers and signal conditioning circuits							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the methods of representation, operations and performance of the system	a						
2.	Familiarize the knowledge in various types of transducers working	a	e					
3.	Provide adequate knowledge in interfacing devices	a						
4.	Understand the concept of interfacing various input output devices	a	k					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: BASICS OF INSTRUMENTATION SYSTEM	**9**			
1.	Basic concept of measurement	1	C	1,2	1,2
2.	Characteristics of instrumentation devices	2	C	1	1
3.	Types of Errors	2	C	1	1
4.	Calibration of instruments	1	C	1,2	1,2
5.	Statistical methods	2	C	1	1
6.	Types of instrumentation systems-zero order, first order and second order systems	1	C	1,2	1,2
	UNIT II: DISPLACEMENT AND SPEED SENSORS	**9**			
7.	Introduction to displacement sensor	1	C	2	2
8.	Optical encoder	1	C	2	2
9.	Moiré fringes	1	C	2	2
10.	Optical proximity sensor	1	C	2	2
11.	Mechanical switches	1	C	2	2
12.	Capacitive proximity sensor	1	C	2	2
13.	Inductive proximity sensor	1	C	2	2
14.	Incremental encoder	1	C	2	2
15.	Tachogenarator	1	C	2	2
	UNIT III: PRESSURE AND FLOW SENSOR	**9**			
16.	Diaphragm and piezoelectric sensor	1	C	2	2
17.	Differential pressure methods	1	C	2	2
18.	Turbine meter	2	C	2	2
19.	Ultrasonic time of Flight flow meter	2	C	2	2
20.	Vortex flow rate method	2	C	2	2
21.	Simple problems	1	C	2	2
	UNIT IV: SIGNAL CONDITIONING	**9**			
22.	Instrumentation amplifier	2	C,D	3	1,2
23.	Modulators and demodulators	1	C	3	1,2
24.	Sample and Hold circuits	1	C	3	1,2
25.	Various types of ADC	2	C,D	3	1,2
26.	Types of DAC	1	C	3	1,2
27.	Active and passive filters	1	C	3	1,2
28.	Design of signal conditioning system,simple problems	1	C	3	2
	UNIT V: APPLICATIONS OF INSTRUMENTATION SYSTEM	**9**			
29.	Temperature measurement case study	2	C,D	4	1,2
30.	Encoder and Speed measurement	2	C,D	4	1,2
31.	Position measurement	2	C,D	4	1,2
32.	IR sensor and Obstacle detection	1	C,D	4	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
33.	Humidity measurement	2	C,D	4	1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	*Sawhney A.K.,"A course in Electrical& Electronic Measurement and Instrumentation", Dhanpat Rai and Co(P)Ltd.,reprint 2013*
2	William Bolton, "*Instrumentation and control systems*", Newnes, 2nd Edition, 2015
REFERENCE BOOKS/OTHER READING MATERIAL	
3	Neubert H K P, "*Instrument Transducers - An introduction to their performance and design*" Clare don press, Oxford (1975).
4	Patranabis D., "*Sensors and Transducers*",PHI,2003.
5	Slater Michael, "*Microprocessor Based Design*", Prentice Hall of India Pvt Ltd. New Delhi (1999)

Course nature				**Theory**			
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%**

15EE351E	Power Quality	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	EE301J				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE POWER SYSTEMS				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To study the various issues affecting Power Quality, their production, monitoring and mitigation methods.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Perceive the power quality major events like voltage sag, interruptions and harmonics.	a	e	h				
2.	Study the various methods of power quality mitigation and monitoring	a		h	j			
3.	Understand the power quality issues due to distributed generation	a		h	j			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	References
	UNIT I: INTRODUCTION TO POWER QUALITY EVENTS	**9**			
1.	Introduction to power distribution system-deregulated environment- Power quality: concepts and definition.	1	C	1	1,2,4
2.	Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation.	3	C	1	1,2,4
3.	Causes and effects of power quality problems-CBEMA, ITIC curves.	3	C	1	1,2
4.	Domestic Appliances and industrial- linear and nonlinear loads.	1	C	1	1,2
5.	Computer simulation of Power Quality events	1	I	1	2,4
	UNIT II: VOLTAGE SAG, SHORT AND LONG DURATION VARIATIONS	**9**			
6.	Sources and characteristics (magnitude, duration) of Voltage sag, short and long duration power quality events.	2	C	1	1,2
7.	Voltage sag influence on computer and consumer equipment-Voltage sag and interruption indices-Basic Reliability evaluation techniques-interruption criterion- general component model	3	C	1	1,2
8.	Voltage regulation using Dynamic Voltage Restorer (DVR).	2	C	1	1,2
9.	Distribution static synchronous compensator (DSTATCOM) and unified power quality conditioner (UPQC)	2	C	1	1,2
	UNIT III: HARMONICS	**9**			
10.	Definitions- Average –RMS value- True power factor –phase sequence - Fourier series – Numerical example for harmonic analysis	2	C	1	1,3,5
11.	Voltage and current distortions. Harmonics indices-(THD and TDD). Harmonics standards (IEEE, IEC)	1	C	1	1,3,5
12.	Harmonics sources from commercial and industrial loads. Effect of harmonics on various equipment.	2	C	1	1,3,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	References
13.	Devices for controlling Harmonics- Inline choke - Zig Zag transformer, Harmonic filters: Passive, Active and Hybrid filters.	2	C	1	1,3,5
14.	Computer aided simulation of Harmonics filters, Harmonic analysis of Industry-case study	2	I	1	2,6
	UNIT IV: POWER QUALITY MONITORING	**9**			
15.	Power Quality Monitoring –Industry requirements – standards	3	C	2	1,2,6
16.	Power Quality Measurement Equipment: Power line disturbance analyser, Harmonic analyser-Spectrum analyser,	3	C	2	1,2
17.	Flicker meters and Disturbance analyser-Assessment of Power Quality Measurement Data.	2	C	2	1,2
18.	Application of Intelligent Systems to power quality monitoring.	1	C	2	6
	UNIT V: POWER QUALITY IN DISTRIBUTED GENERATION	**9**			
19.	Introduction to DG Technologies-Interface to the Utility System-Power Quality issues.	3	C	3	1,2
20.	Operating conflicts-DG on Distribution Networks.	2	C	3	1,2
21.	Site study for Distributed Generation-Interconnection standards.	3	C	3	1,2
22.	Issue on Power Quality in Smart Grids and Micro Grids	1	C	3	6
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Roger C. Dugan, Mark Mc Granaghan, Surya Santoso, H.Wayne, H. Wayne Beaty," Electrical Power Systems Quality " Tata McGraw Hill, Third edition.2012
2.	Dash.S.S, Rayaguru.N.K, " Power Quality Management", 2nd Edition, Vijay Nicole Publishers, 2016
3.	Jos Arrillaga, Neville R. Watson, "Power System Harmonics", 2nd Edition, Wiley Publishers, 2015
REFERENCE BOOKS/OTHER READING MATERIAL	
4.	Arindam Ghosh ,"Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, 2002
5.	G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, 1994(2nd edition)
6.	www.ieeexplorer.com, www.sciencedirect.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%**

15EE352E	Advanced Control Theory	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	15EE211				
Data Book / Codes / Standards	Nil				
Course Category	E Professional Elective	CIRCUITS AND SYSTEMS			
Course designed by	Dept of Electrical and Electronics Engineering				
Approval	32 nd Academic Council Meeting , 2016				

PURPOSE	To study and analyze various advanced control strategies with the applications of mathematical problems							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Apply various stability concepts to non-linear systems	a		e	j			
2.	Gain knowledge on the basics of optimal and adaptive control	a	c	e	j			
3.	Familiarize with the practical utility of controllability, observability and state observer concepts	a	c	e	j			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	References
	UNIT I: NON-LINEAR SYSTEMS	**09**			
1.	Introduction- Types of non-linear phenomena- singular point	2	C	1	3
2.	Phase plane method-Construction of phase trajectories using delta method	2	C	1	3
3.	Construction of phase trajectories using isoclines method	2	C	1	3
4.	Derivation of describing functions – Relay, Hysteresis, Dead-zone, Saturation and Jump resonance	3	C	1	3
	UNIT II: STABILITY CONCEPTS	**09**			
5.	Stability concepts – stability in the sense of Lyapunov, BIBO stability	1	C	1	1,2,8
6.	Stability of non- linear systems by describing function method	2	C	1	3
7.	Lyapunov Theory - Generation of Lyapunov functions - Variable gradient method, Krasooviski's method	2	C	1	2,3,8
8.	Stability analysis of linear continuous time invariant systems using Lyapunov criterion	3	C	1	1,2,8
9.	Stability analysis – Popov and Circle criterion	1	C	1	1
	UNIT III: OPTIMAL CONTROL	**10**			
10.	Performance Indices - Linear Optimal Control with quadratic performance index - Solution of Riccati equation	2	C	2	3,4,7
11.	Method of calculus of variations - minimum principle	2	C	2	1,4,7,
12.	Formulation of the optimal control problem- State regulator problem for continuous time systems	2	C, D	2	1,4,7
13.	Output regulator problem for continuous time systems	2	C, D	2	3,4,7
14.	Optimal control problem using Hamiltonian – Jacobi method	2	C, D	2	1,4,7
	UNIT IV: ADAPTIVE CONTROL	**09**			
15.	Need for adaptive control systems - Mathematical models used in adaptive control - MIT rule	1	C	2	3,6
16.	Methods of adaptation- Gain scheduling - Classifications of Model Reference Adaptive Control (MRAC)	2	C	2	3,6
17.	Direct and indirect MRAC	2	C	2	3,6
18.	Design of MRAC using Lyapunov theory	1	C, D	2	3,6
19.	Different approaches to self-tuning - Recursive parameter estimation , Implicit and explicit STR	2	C	2	3,6
20.	Pole assignment approaches to multivariable self-tuning regulators	1	C, D	2	3,6

	UNIT V: MODAL CONTROL	**08**			
21.	Controllable and Observable companion forms	3	C	3	1, 5
22.	State feedback - Effect on Controllability and Observability, Pole placement technique	2	C	3	1, 5
23.	Observer - Full order, Reduced order	3	C, D	3	1, 5
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	M.Gopal, "*Modern Control System Theory*", New Age International (P) Limited, Publishers, Third edition, 2015
2	Ogata.K, "*Modern Control Engineering*", Prentice Hall of India, Fifth edition, 2010
3	Nagrath.I.J, and Gopal.M, "*Control Systems Engineering*", New Age International (P) Limited, Publishers, Fifth edition, 2014
	REFERENCE BOOKS / OTHER READING MATERIAL
4	Donald E.Kirk, " *Optimal Control Theory an Introduction*", Dover Publications, 2004
5	Graham.C, Goodwill, Graebe.S, and Salgado.M, "*Control System Design*" Prentice Hall India, New Delhi, 2000
6	Astrom.K.J, and Wittenmark.B, "*Adaptive control*", Pearson Education India, Fifth impression, 2009
7	Brian D. O. Anderson, John Barratt Moore, "*Optimal Control: Linear Quadratic Methods*", Dover Publications, 2007
8	R.T.Stefani, B. Shahian, C.J.Savant and G.H Hostetter, "*Design of feedback control systems,*" Oxford University Press, 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%**

15EE353E	Modern Optimization Techniques	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE INTELLIGENT SYSTEMS				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting,2016				

PURPOSE	To learn the concepts and techniques of evolutionary and optimization techniques in power system applications.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Obtain knowledge on optimization techniques applied to power system problems.	a	e					
2.	Understand the different evolutionary computation techniques and multi objective optimization and their applications in power system problems.	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I : FUNDAMENTALS OF OPTIMIZATION	9			
1.	Definition-Classification of optimization problems-Unconstrained and Constrained optimization-Optimality conditions-	2	C	1	1,2
2.	Classical Optimization techniques (Linear and non-linear programming, Quadratic programming, Mixed integer programming)	2	C	1	1,2
3.	Intelligent Search methods – Genetic Algorithm, Ant Colony Optimization	2	C	1	1,2
4.	Tabu search, Particle swarm optimization	3	C	1	1,2
	UNIT II : GENETIC ALGORITHM	9			
5.	Evolution in nature-Fundamentals of Evolutionary and Genetic algorithms	2	C	1	3,4
6.	Working Principles of Genetic Algorithm	2	C	1	3,4
7.	Genetic Operators-Selection, Crossover and Mutation	2	D	1	3,4
8.	Issues in GA implementation	1	D	1	3,4
9.	Applications of GA in Engineering optimization problems.	2	D	1	3,4
	UNIT III : PARTICLE SWARM OPTIMIZATION	**9**			
10.	Fundamental principle-Velocity Updating	2	D	2	5,6
11.	Advanced operators-Parameter selection	2	D	2	5,6
12.	Hybrid approaches (Hybrid of GA and PSO)	2	D	2	5,6
13.	Implementation issues-Convergence issues	2	I	2	5,6
14.	Applications of PSO in Engineering optimization problems.	1	I	2	5,6
	UNIT IV : NATURE INSPIRED METHODS	**9**			
15.	Simulated annealing algorithm	2	I	2	3,6
16.	Differential Evolution	3	I	2	3,6
17.	Ant colony optimization	2	I	2	3,6
18.	Bacteria Foraging optimization –Firefly algorithm	2	I	2	3,6
	UNIT V : MULTI OBJECTIVE OPTIMIZATION	**9**			
19.	Concept of pareto optimality-Conventional approaches for MOOP	2	O	2	1,7
20.	Multi objective GA-Fitness assignment	2	O	2	1,7
21.	Sharing function- MOGA	2	O	2	1,7

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
22.	Multiobjective PSO (dynamic neighbourhood PSO, Vector evaluated PSO)	2	O	2	1,7
23.	Multi objective OPF problem.	1	O	2	1,7
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	S.P.Kothari and J.S.Dhillon,"*Power System Optimization*", 2nd Edition, PHI Learning Private Limited, 2010.
2.	Kalyanmoy Deb,"*Multi objective optimization using Evolutionary Algorithms*", John Wiley and Sons, 2008.
3.	Kalyanmoy Deb,"*Optimization for Engineering Design*", Prentice Hall of India First Edition,1988.
Sl. No.	**REFERENCE BOOKS**
4.	Carlos A.Coello Coello, Gary B.Lamont, David A.Van Veldhuizen,"*Evolutionary Algorithms for solving Multi Objective Problems*", 2nd Edition, Springer, 2007.
5.	Soliman Abdel Hady, Abdel Aal Hassan Mantawy, "*Modern optimization techniques with applications in Electric Power Systems*", Springer, 2012.
6.	Jizhong Zhu, "*Optimization of Power System Operation*", John Wiley and sons Inc publication, 2009.
7.	Kwang Y.Lee,Mohammed A.El Sharkawi, "*Modern heuristic optimization techniques*", John Wiley and Sons,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%**

15EE354E	Special Electrical Machines	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	ELECTRICAL MACHINES			
Course designed by	Dept of Electrical and Electronics Engineering				
Approval	32 nd Academic Council Meeting , 2016				

PURPOSE	To acquire a fair knowledge in the construction, operating principle and performance of special electrical machines							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Understand the working principle, construction and applications of stepper motors and reluctance motors	a	h	j				
2.	Gain knowledge in principle of operation, characteristics and control of permanent magnet brushless dc motors and synchronous motors	a	h	j				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: STEPPER MOTOR	**09**			
1.	Constructional features-Principle of operation-Modes of excitations-Theory of torque predictions	2	C	1	1
2.	Types of stepper motor- Variable reluctance motor , Single and multi stack configurations	2	C	1	1
3.	Hybrid motor, Disc Magnet motor, Claw tooth motor	1	C	1	1
4.	Linear and non-linear analysis-Static and Dynamic Characteristics, Drive Circuits	2	C	1	1
5.	Microprocessor based control of stepper motors, Closed loop control	1	C,D	1	1
6.	Applications of stepper motors in robotics, CNC, computer peripherals, 3D printers	1	C	1	1
	UNIT II: SWITCHED RELUCTANCE MOTOR	**09**			
7.	Constructional features, Principle of operation, Types of SRM, Torque production, design of stator and rotor pole arc	2	C	1	2,3
8.	Steady state performance, Non-linear analysis	2	C	1	2,3
9.	Power converter circuits- Control of SRM	2	C	1	2,3
10.	Rotor position sensors-Hall effect sensing scheme, Optical position sensing scheme	1	C	1	2,3
11.	Current Regulators-Voltage PWM type, Hysteresis type	1	C	1	7
12.	Sensor-less operation-Closed loop control of SRM-Characteristics	1	C	1	2,3
	UNIT III: SYNCHRONOUS RELUCTANCE MOTORS	**09**			
13.	Constructional features-Types-Axial and Radial flux motors - Operating principles	2	C	1	2
14.	Variable Reluctance and Hybrid Motors	2	C	1	2
15.	SYNREL Motors- Voltage and Torque Equations	1	C	1	2
16.	Control of SRM	1	C	1	2
17.	Phasor diagram- Characteristics-Vernier motor	1	C	1	2
18.	Steady state and Dynamic analysis of Synchronous reluctance motors controlled by voltage -fed converters	2	C	1	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT IV: PERMANENT MAGNET BRUSHLESS D.C.MOTORS	**09**			
19.	Permanent Magnet materials-Magnetic Characteristics – Permeance coefficient-Magnetic circuit analysis	2	C	2	1,5,6
20.	Electronic commutation- Principle of operation –Types of motors	2	C	2	1,5,6
21.	Theory of brushless DC Motor as variable speed synchronous motor, EMF and torque equations, Commutation	2	C	2	1,5,6
22.	Power controllers, Motor characteristics and control	2	C	2	1,5,6
23.	Closed loop control of BLDC motor-using DSP, Microprocessor	1	C,D	2	7
	UNIT V: PERMANENT MAGNET SYNCHRONOUS MOTORS	**09**			
24.	Principle of operation, Ideal PMSM	1	C	2	4,5
25.	EMF and Torque equations, Armature reaction MMF, Synchronous Reactance	2	C	2	4,5
26.	Sine wave motor with practical windings , Phasor diagram	1	C	2	4,5
27.	Circle diagram-Control of PMSM	2	C	2	7
28.	Power Converter-Volt-ampere requirements-Torque speed characteristics	2	C	2	4,5
29.	Linear Synchronous Motors, Microprocessor based control of synchronous motors	1	C, D	2	4,5
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Kenjo T., "*Stepping Motors and Their Microprocessor Controls*", Clarendon Press, Oxford, 1984
2	Miller T.J.E., "*Brushless Permanent Magnet and Reluctance Motor Drives*", Oxford University Press,1989
REFERENCE BOOKS / OTHER READING MATERIAL	
3	Krishnan R., "*Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application*", CRC Press, New York, 2009.
4	Krishnan R., "*Permanent Magnet Synchronous and Brushless DC Motor Drives*", CRC Press, New York, 2010.
5	Jacek F. Gieras, Jacek F. Gieras, Mitchell Wing, "*Permanent Magnet Motor Technology: Design and Applications*", CRC Press , Second Edition, 2002.
6	Hendershot J. R. and Miller T. J. E., "*Design of Brushless Permanent Magnet Machines*", Motor Design Books LLC, 2nd Edition, 2010.
7	Janardanan E.G., "*Special Electrical Machines*", PHI Learning Private Limited, 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%**

15EE355E	HVDC and EHVAC Systems	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15EE213				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	POWER SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting , 2016				

PURPOSE	To acquire knowledge in basic principles, economic aspects and calculations involved in EHVAC and HVDC System.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1.	Understand the basic concepts of Extra High Voltage Transmission.	a						
2.	Learn the general background and operational concepts in EHVAC Transmission Systems	a	e					
3.	Realize the significance of HVDC Transmission and its modern trends and applications.	a	h					
4.	Gain idea in the general principle of HVDC control and harmonic elimination in HVDC Systems	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I – EHV TRANSMISSION	**08**			
1.	Brief Description of Energy Sources and their Development	1	C	1	1
2.	Introduction to and the necessity for EHV Transmission.	1	C	1	3
3.	Challenges involved in EHV Transmission.	1	C	1	1,3
4.	Operational Aspects of EHV AC and HVDC power transmission.	3	C	1	3
5.	Gas insulated EHV transmission lines.	1	C	1	1
6.	Environmental issues of EHV transmission lines.	1	C	1	1
	UNIT II – GENERAL BACKGROUND OF EHVAC TRANSMISSION SYSTEMS	**10**			
7.	Standard Voltage levels and Hierarchical levels for Transmission systems	1	C	2	1
8.	Determination of line parameters- resistance, inductance and capacitance of EHV lines	4	C	2	1
9.	Power handling capacity and line losses	2	D	2	1
10.	Mechanical considerations in transmission line performance	2	C	2	1
11.	Comparison of Overhead and Underground lines - Examples of Giant power pools in the world.	1	C	2	1
	UNIT III – ASPECTS OF EHVAC SYSTEM	**09**			
12.	Bundled conductors	1	C	2	1
13.	Corona Effects – Power loss and audible noise	2	C	2	1
14.	Telephone Interference.	1	C	2	1
15.	Design of filter.	1	D	2	1
16.	General principles of the lighting protection problem.	2	C	2	1
17.	Insulation Coordination based on lightning.	1	C	2	1
18.	Arresters used for EHV systems.	1	C	2	1
	UNIT IV – HVDC TRANSMISSION SYSTEMS	**09**			
19.	Choice of HVDC Transmission	1	C	3	2,4
20.	Comparison – Economics, Technical Performance and Reliability of DC power Transmission	2	C	3	2,4
21.	Description of HVDC Converter station	2	C	3	2,3,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
22.	Types of HVDC Links, Merits and limitations of HVDC System	1	C	3	2,3,4
23.	Applications -Modern Trends in HVDC transmission	2	C	3	2
24.	Case Studies of HVDC links in the world.	1	C	3	2
	UNIT V – CONVERTERS AND HVDC SYSTEM CONTROL	**9**			
25.	Pulse number – Choice of Converter Configuration	1	C	4	2
26.	Simplified analysis of Graetz circuit	2	C,D	4	2
27.	Principles of HVDC link Control	2	C	4	2,3,4
28.	DC Breaker	1	C	4	2,4
29.	Harmonic Elimination – AC and DC Filter design	1	I	4	2,3,4
30.	Protection Systems in HVDC Substation	1	C	4	2,4
31.	HVDC Simulator	1	C	4	2,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Rakosh Das Begamudre, "*Extra High Voltage AC Transimission Engineering*", Third Edition , New Age International(P) Limited,Publishers.,2009
2.	Padiyar K.R., "*HVDC Power Transmission Systems*", New Age International (P) Limited,Publishers.,2015.
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	Chakrabarti A., M.L.Soni,P.V.Gupta,U.S.Bhatnagar , "*Power System Engineering*", Dhanpat Rai & Co., 2010.
4.	Sunil S.Rao, "*Switchgear Protection and Power Systems*",Khanna Publishers.,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%**

15EE356E	Photonics	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	E PROFESSIONAL ELECTIVE	ELECTRONICS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting , 2016				

PURPOSE	To acquire knowledge on the physical principles and engineering applications of optical electronics and LASER.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the concept of Photonics	a						
2.	Familiarize with the terms associated with Opto Electronic devices	a						
3.	Enrich knowledge in Fiber Optic Photonics and its applications	a	h					
4.	Understand the concepts of LASER and Microwave Photonics.	a						
5.	Familiarize to the industrial need of Photonics.	a	h					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO PHOTONICS MATERIALS	**9**			
1.	Organic materials for photonics, evaluation of second order and third order optical.	2	C	1	1,2
2.	Organic materials for second and third order nonlinear optics, photo refractive polymers, polymers for light emitting sources	2	C	1	1,2
3.	Optical limiting, polymers for optical fiber- Sol-Gel materials for Photonics applications	2	C	1	1,2
4.	Method of preparations, electro optic-magneto, optic and acousto optic materials	3	C	1	1,2
	UNIT II: OPTO ELECTRONICS	**9**			
5.	Basics of all solid state lamps-LED materials and device configuration, efficiency	2	C	2	1,4
6.	High brightness LEDs, Light extraction from LEDs	1	C	2	1,4
7.	LED structures-SH, DH, SQW, MQW, Device performance characteristics.	2	C	2	1,4
8.	Manufacturing processing and applications- White solid state lamps, Photo detectors - Thermal detectors, photoconductors	2	C	2	1,4
9.	Junction photodiodes, APD, Optical Heterodyning and electro-optic measurements, fiber coupling, phototransistor.	2	C	2	1,4
	UNIT III: FIBRE OPTICS PHOTONICS	**9**			
10.	Fiber optic sensors - Intensity modulation and interference type sensors, intrinsic and extrinsic fiber.	2	C	3	1,2
11.	Polarization modulation type sensors.	1	C	3	1,2
12.	Sagniac and fiber gyro, temperature, pressure, force and chemical sensors	2	C	3	1,2
13.	Fiber components - couplers, connectors, Packaging	1	C	3	1,2
14.	Fiber Optic communication- basic principle, WDM, telemetric applications	2	C	3	1,2
15.	Industrial, medical and technological applications of optical fiber.	1	C	3	1,2
	UNIT IV: LASER AND MICROWAVE PHOTONICS	**9**			
16.	Necessary and sufficient conditions for laser action (population invasion and saturation intensity)	2	C	4	3
17.	threshold requirements for laser with and without cavity	1	C	4	3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
18.	LASER amplifiers, rate equations for three and four level systems, pumping mechanisms.	3	C	4	3,6
19.	Steering techniques for optical fibers.	1	C	4	3,6
20.	Optical beam steering of antennas using lasers	2	C	4	3
	UNIT V: INDUSTRIAL PHOTONICS	**9**			
21.	Photonics Technology; Components -couplers, isolators, circulators.	2	C	5	5
22.	Multiplexers, and fillers -Fiber gratings, interferometers	2	C	5	5
23.	FO amplifiers, transmitters and deletions, switches, wavelength converters	2	C	5	5
24.	Nonlinear effects in signal transmission	1	C	5	5
25.	Self-phase and cross phase modulation, soliton pulse propagation.	2	C	5	5
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	S C Gupta ,"*Optoelectronic devices and systems*",Prentice Hall India ,2008
2.	J Hecht ,"*Understanding Fiber optics*", Pearson Education, 2006
Sl. No.	**REFERENCE BOOKS**
3.	Ghatak and Thyagarajan , "*Lasers-Theory and Applications*", McMillan ,2010
4.	E Fred Scheubert , "*Light Emitting Diodes*" ,Cambridge University Press,2003
5.	H T Mouftah, J M H Elmirghani , "*Photonic switching technology*", IEE Press 1999
6.	Amnon Yariv and Pochi Yeh ,"Photonics – Optical Electronics in Modern Communications", Oxford University Press, 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%**

15EE357E	Power System Harmonics	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	E PROFESSIONAL ELECTIVE	POWER SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To acquire knowledge on the sources causing harmonics and its detailed analysis for elimination.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Familiarize with the terms and standards associated with harmonics	a						
2.	Understand the causes for harmonic producing loads	a						
3.	Outline the various effects of harmonics	a	e					
4.	Understand the concepts of harmonic instrumentation with computer simulation	a	k					
5.	Design filters for harmonic elimination	a	c	e				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: DEFINITIONS AND STANDARDS	**9**			
1.	Definition – RMS value, average power, True power factor	2	C	1	1, 2
2.	Definition – K factor, Phase shift, Phase sequence	2	C	1	1, 2
3.	Standards – factors influencing the development of standards, existing harmonic standards (IEC, IEEE)	3	C	1	1, 2
4.	General harmonic indices	2	C	1	1, 2
	UNIT II: SOURCES AND GENERATION OF HARMONICS	**9**			
5.	Transformer magnetization, machines, fluorescent lamps with magnetic ballasts	2	C	2	1, 2
6.	Power electronics loads such as line-commutated converters – typical current waveforms and THD	2	C	2	1, 2
7.	Switched mode power supplies – typical current waveforms and THD	2	C	2	1, 2
8.	Uncharacteristic and inter-harmonics	3	C	2	1, 2
	UNIT III: EFFECTS OF HARMONICS	**9**			
9.	Resonance, nuisance tripping, blown capacitor fuses and capacitor cells	4	C	3	1, 2
10.	Degradation of internal capacitance, digital clocks, motor overheating	3	C,D	3	1, 2
11.	Overloading neutrals, telephone interference.	2	C,D	3	1, 2
	UNIT IV: INVESTIGATION OF HARMONICS	**9**			
12.	Field measurements, requirements, harmonic phase angle displacement	2	C, D	4	1, 2
13.	Harmonic symmetrical components, transducers, Harmonic instrumentation	4	C, D	4	1, 2
14.	Computer simulation with an example	3	D, I	4	1, 2
	UNIT V: HARMONICS ELIMINATION	**9**			
15.	Passive filter definitions, Conventional design criteria	1	C, D	5	1, 2
16.	Tuned filters (basics only singly-tuned), automatically tuned filters with an example	4	C, D	5	1, 2
17.	Damped filters – design, conventional six-pulse design with an example	4	C, D	5	1, 2
	Total contact hours	45			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Arrillaga J. and Watson N. R., "*Power system harmonics*", Wiley, Second Edition, U. S. A
2.	Prof. Mack Grady, "*Understanding Power System Harmonics*", Dept. of Electrical & Computer Engineering University of Texas at Austin, U.S. A, grady@mail.utexas.edu, www.ece.utexas.edu/~grady

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%**

15EE358E	Advanced CMOS Devices and Technology			L	T	P	C
				3	0	0	3
Co-requisite:	Nil						
Prerequisite:	Nil						
Data Book / Codes/Standards	Nil						
Course Category	E	PROFESSIONAL ELECTIVE	ELECTRONICS				
Course designed by	Department of Electrical and Electronics Engineering						
Approval	32nd Academic Council Meeting, 2016						

PURPOSE	To gain a fair knowledge on characteristics and protection of advanced CMOS devices and Technology							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Learn the basic concepts of CMOS technology.	a						
2.	Study the effect of stress and strain on CMOS Devices.	a						
3.	Understand the concepts of dielectric technology and scaling	a						
4.	Familiarize with metallization and isolation technology	a	c					
5.	Know the technology progression	a	h					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: CMOS TECHNOLOGY	**8**			
1.	Evolution of Silicon technology	1	C	1	1-3
2.	Metal gates integration options	2	C	1	1,3
3.	Problems in Scaling of Gate Oxide -MOSFET Scaling Limit	2	C	1	1,2
4.	Scaling trends for gate dielectrics	1	C	1	1
5.	Basic quantum mechanics	2	C	1	1,3,4
	UNIT II: EFFECT OF STRESS AND STRAIN ON CMOS DEVICES	**9**			
6.	Effect of stress and strain on the band structure of silicon	1	C	2	1,3,6
7.	Effect of gate length on stress effect	1	C	2	1,3
8.	Mobility Enhancements in Strained Silicon MOSFETs	2	C	2	1,3
9.	Types and realization of stress elements- Strained Isolation Oxide	2	C	2	1
10.	Fermi level pinning	2	C	2	3
11.	Effect of strain to improve the CMOS performance	1	C	2	3,4
	UNIT III: DIELECTRIC TECHNOLOGY AND SCALING	**10**			
12.	High-k dielectric Technology- High-k material selection	2	C	3	2,5,7
13.	Process integration of high-k gate dielectrics and metal gates	2	C	4	2,5, 1
14.	Ways of realization- single metal dual cap CMOS	2	C	3	2,5,7
15.	Fabrication issues and integration challenges	2	C	3	1,2
16.	Key scaling challenge- Scaling pathways	2	C	3	1,2
	UNIT IV: METALLIZATION AND ISOLATION TECHNIQUES	**9**			
17.	Ultra shallow junctions - Solutions to Shallow Junction Resistance Problem	1	C	4	7
18.	Dopant activation methods -Device Isolation pitch	2	C	4	2
19.	Interconnects - Limits on Interconnects	1	C	4	1
20.	Current Interconnect Technologies - Optical Interconnects	2	C	4	1,2
21.	Scaling of Device Isolation	1	C	4	1,2
22.	Layout dependent effects- Test structures used for characterization	2	C	4	4,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT V: TECHNOLOGY PROGRESSION	**9**			
23.	Sub-wavelength lithography - Advanced Lithography	1	C	5	3,4
24.	Nano scaled CMOS technology	2	C	5	2
25.	Design for manufacturability	2	C,D	4	4
26.	High voltage devices in advanced CMOS technologies	2	C	5	2,5,6
27.	Case Study on Emerging Technology	2	C,D	5	2,3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	HeiWong , "Nano-CMOS Gate Dielectric Engineering," CRC, 2011
2.	S. Deleonibus, "Electronic Device Architectures for the Nano-CMOS Era," Pan Stanford 2009
REFERENCE BOOKS/OTHER READING MATERIAL	
3.	J.-P. Colinge, "FinFETs and Other Multi-Gate Transistors," Springer, 2010
4.	B. Wong, A. Mittal, Y. Cao, G. Starr, "Nano-CMOS Circuit and Physical Design", Wiley Inter-science, 2004
5.	Yongke Sun, Scott E. Thompson, Toshikazu Nishida, "Strain Effect in Semiconductors: Theory and Device Applications", Springer 2010
6.	B. Wong, F. Zach, V. Moroz, A. Mittal, G. Starr, A. Kahng, "Nano-CMOS Design for Manufacturability", Wiley 2009
7.	Chris Mack, "Fundamental Principles of Optical Lithography: The Science of Microfabrication", Wiley Interscience, 2008
8.	http://web.stanford.edu/class/ee410/AdvCMOS.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%**

15EE359E	Industrial Power Systems	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE	POWER SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32 nd Academic Council Meeting, 2016				

PURPOSE	To gain knowledge on various aspects of power system in industries.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Acquire knowledge on Induction Motor Starting Studies.	a	e					
2.	Understand about Power Factor Correction in Induction Motor	a						
3.	Analyze Harmonic, Flicker, Ground Grid problem in power system	a	e	h				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INDUCTION MOTOR STARTING STUDIES	**09**			
1.	Introduction, Evaluation Criteria and Starting Methods	2	C	1	1,2
2.	System Data, Voltage Drop Calculations and Calculation of Acceleration time	3	C	1	1,2
3.	Motor Starting with Limited Capacity Generators	1	C	1	1,2
4.	Computer-Aided Analysis: For multiple generators with feedback network Connections	3	C,I	1	1,3
	UNIT II: POWER FACTOR CORRECTION STUDIES	**09**			
5.	Introduction, System Description, Modeling & Acceptance Criteria	3	C,D	2	1,2
6.	Frequency Scan Analysis and Voltage Magnification Analysis	2	C	2	1,2
7.	Sustained Overvoltage, Switching Surge Analysis	3	C	2	1,2
8.	Back-to-Back Switching	1	C	2	1,2
	UNIT III: HARMONIC ANALYSIS	**09**			
9.	Harmonic Sources	2	C	3	1,3
10.	System Response to Harmonics	2	C	3	1,3
11.	System Model for Computer Aided Analysis	1	C,D	3	1,3
12.	Acceptance Criteria	1	C	3	1,3
13.	Harmonic Filters and Harmonic Evaluation	2	C	3	1,3
14.	Case Study: Chemical plant	1	C	3	1,3
	UNIT IV: FLICKER ANALYSIS	**09**			
15.	Sources of Flicker	1	C	3	1,2
16.	Flicker Analysis	1	C	3	1,2
17.	Flicker Criteria	1	C	3	1,2
18.	Data for Flicker analysis	2	C	3	1,2
19.	Case Study: Arc Furnace Load	2	C	3	1,2
20.	Minimizing the Flicker Effects	2	C	3	1,2
	UNIT V: GROUND GRID ANALYSIS	**09**			
21.	Introduction	1	C	3	1,3
22.	Acceptance Criteria	2	C	3	1,2
23.	Ground Grid Calculations	2	C	3	1,2
24.	Computer-Aided Analysis for ground grids	2	C	3	1,3
25.	Improving the Performance of the Grounding Grids	2	C	3	1,3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Ramasamy Natarajan, "*Computer-Aided Power System Analysis*", Marcel Dekker Inc., 2002.
2.	J. Duncan Glover, Mulukutla S.Sarma, Thomas Overbye, "*Power System Analysis and Design*", 2011
3.	Turan Gonen" *Electrical Power Transmission System Engineering: Analysis and Design*",Mcgraw Hill publishers,1986.

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%**

15EE361E	Flexible AC Transmission Systems	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15EE304				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	POWER SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd , Academic Council Meeting , 2016				

PURPOSE	Students gain a fair knowledge about flexible AC transmission systems to enhance overall power system performance.

INSTRUCTIONAL OBJECTIVES		STUDENT OUTCOMES						
At the end of the course, student will be able to								
1.	Understand the concept of FACTS controllers	a	e					
2.	Know the concept of shunt and series compensation techniques and its objectives	a	e	h				
3.	Learn basic idea of voltage and phase angle regulator in power system	a	e					
4.	Familiarize the concept of versatile FACTS controllers	a	e	h	j			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO FACTS	**9**			
1.	Electrical Transmission Network – HVDC Vs HVAC -Analysis of uncompensated Transmission system- Necessity of FACTS controller.	3	C	1	1,2
2.	Load Compensation-System compensation- Real and reactive power flows in AC system	2	C	1	1,2
3.	Modelling of long transmission line-Symmetrical lossless line-Midpoint compensation -Surge Impedance Loading	2	C	1	1,2
4.	Classification of FACTS controllers -controllable parameters – Applications of FACTS. Overview of Installed FACTS projects.	2	C	1	1,2
	UNIT II: STATIC VAR COMPENSATOR (SVC)	**9**			
5.	Introduction to passive compensation – Objectives of shunt and series compensation.	1	C	2	1,2
6.	Single-phase and three phase-Thyristor controlled Reactor (TCR) - Analysis of single phase TCR- SVC configurations. Fixed-Capacitor–Thyristor-Controlled Reactor (FC–TCR) and its operating characteristics.	2	C	2	1,2
7.	SVC voltage control operation- Q-V characteristics. Thyristor-Switched Capacitor (TSC)-operation-practical switching strategy-V-I characteristics. (TSC-TCR)-operation -VI characteristics	3	C	2	1,2
8.	Advantages of slope in SVC dynamic characteristics –SVC Applications: Enhancement of steady state and transient stability.	3	C	2	1,2
	UNIT III: THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC)	**9**			
9.	Need for variable series compensation, TCSC: Basic and practical module	1	C	2	1,2
10.	Net reactance offered by TCSC	1	C	2	1,2
11.	Operation of TCSC: Basic principle and different modes of operation –Analysis of TCSC- The TSSC	1	C	2	1,2
12.	Capability Characteristics (single and multi module TCSC)-TCSC losses. TCSC applications- power flow enhancement –variable reactance model for transient stability study	2	C	2	1,2
13.	TCSC: Open loop and closed loop current control	2	C	2	1,2
14.	Computer simulation of SVC and TCSC with SMIB system	2	I	2	3,4,6
	UNIT IV: STATIC PHASE SHIFTING TRANSFORMER	**9**			
15.	Basic principle of Phase shifting transformer- Configurations of SPST.	1	C	3	4,5
16.	Objectives of voltage and phase angle regulators. Real and reactive power of voltage and phase angle regulators	2	C	3	2,4,5
17.	Applications of Phase Angle Regulator: Improvement of Transient Stability and Power Oscillation Damping	2	C	3	2,4,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
18.	Approaches to Thyristor controlled voltage and phase angle regulators.	2	C	3	2,4,5
19.	Continuously Controllable Thyristor Tap changers and Thyristor Tap Changer with Discrete Level Control	2	C	3	2,4
	UNIT V: EMERGING FACTS CONTROLLERS	**9**			
20.	Basic concepts of voltage source converters and current source converter.	1	C	4	1,2
21.	Static synchronous series compensator (SSSC): principle of operation – VI characteristics – Applications	2	C	4	1,2
22.	Static synchronous compensator (STATCOM): principle of operation – VI characteristics – Applications.	2	C	4	1,2
23.	UPFC: basic module -capabilities -Modes of operation – Applications	2	C	4	1,2
24.	Inter line power flow controller (IPFC). Configuration of IPFC-Application	1	C	4	1,2
25.	Introduction to Generalized unified power flow controller (GUPFC)	1	C	4	6
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Mohan Mathur, R. & Rajiv K. Varma, "*Thyristor Based FACTS Controller for Electrical Transmission Systems*", Wiley Interscience Publications, 2002.
2.	Narain G. Hingorani& Laszlo Gyugyi, "*Understanding FACTS – Concepts & Technology of Flexible AC Transmission Systems"*, Standard Publishers, New Delhi, 2001.
3.	Enrique Acha, Claudio R. Fuerte-Esquivel, Hugo Ambriz-Pe´rez and Ce´sar Angeles-Camacho, "*FACTS - Modelling and Simulation in Power Networks*" John Wiley and sons Ltd., 2004
4.	Dash.S.S , "*Flexible AC Transmission Systems for Power system*", Vijay Nicole publication, Second edition, 2015
REFERENCE BOOKS/OTHER READING MATERIAL	
5.	K.A. Padiyar, "*FACTS Controllers in Power Transmission and Distribution"*, New Age International Publishers., India, 2007.
6.	www.ieeexplore.com, www.sciencedirect.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%**

15EE362E	High Voltage Engineering	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	POWER SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd,Academic Council Meeting ,2016				

PURPOSE	To get a fair knowledge on the generation, measurements, testing of high voltages and currents.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the students will be able to								
1.	Understand the causes of over voltages and their effects on power system	a						
2.	Familiarize the concept of solid, liquid and gaseous dielectrics	a	e					
3.	Gain knowledge on the generation and measurement of high voltages and currents as well as the testing of high voltage equipment.	a	e	h				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS	**9**			
1.	Causes of over voltages and their effects on power system	1	C	1	1,2
2.	Lightning, switching and temporary over voltages	3	C	1	1,2
3.	Protection against over voltages – insulation Coordination-estimation and control of electric stress	3	C	1	1,2,3
4.	Coordination between insulation and protection level	2	C	1	1,2,3
	UNIT II: ELECTRICAL BREAKDOWN IN GASES, SOLIDS AND LIQUIDS	**9**			
5.	Gaseous breakdown in uniform and non-uniform fields	3	C	2	1,2
6.	Corona discharges – vacuum breakdown	1	C	2	`1,2
7.	Conduction and breakdown in pure and commercial liquids	2	C	2	1,2
8.	Breakdown mechanisms in solid and composite dielectrics	3	C	2	`1,2
	UNIT III: GENERATION OF HIGH VOLTAGE AND CURRENTS	**9**			
9.	Generation of high dc voltages - multiplier circuits –Van de graff generator	3	C	3	1,2
10.	High alternating voltage generation using cascade transformers - production of high frequency AC high voltages.	2	C	3	`1,2
11.	Standard impulse wave shapes-Marx circuit generation of switching surges	2	C	3	1,2
12.	Impulse current generation	1	C	3	`1,2
13.	Control of impulse generators	1	C	3	1,2
	UNIT IV: MEASUREMENT OF HIGH VOLTAGES AND CURRENTS	**9**			
14.	HVDC measurement techniques – measurement of power frequency A.C voltages - sphere gap measurement technique	3	C	3	1,2
15.	Potential divider for impulse voltage measurements- measurement of high DC, AC and impulse measurements	3	C	3	1,2
16.	Measurement of dielectric constant and loss factor	1	C	3	`1,2
17.	Fast digital transient recorders for impulse measurement	2	C	3	1,2
	UNIT V: HIGH VOLTAGE TESTING	**9**			
18.	Tests on insulators and testing of bushings	2	C,I	3	1,2
19.	Testing of isolators, circuit breakers and cable testing	2	C,I	3	`1,2
20.	Testing of transformers and surge diverter testing -radio interference Measurement	2	C,I	3	1,2
21.	Application of high voltage engineering in food processing and Bio Medical industry- safety and electrostatic hazards	3	I	3	1,4,5

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
7.	Naidu.M.S, and Kamaraju, "*High Voltage Engineering*", Tata McGraw Hill,2014.
8.	Wadhwa.C.L, "*High Voltage Engineering*" New age international publishers Ltd.-New Delhi 2010.
	REFERENCE BOOKS/OTHER READING MATERIAL
9.	Ravindra Arora, Wolfgang Mosh, "*High Voltage and Electrical Insulation Engineering*", Wiley-IEEE Press 2011.
10.	G.V. Barbosa –Canovas , "*Pulsed electric fields in food processing: Fundamental Aspects and applications*" CRC Publisher Edition March 1 2001.
11.	H L M Lelieveld and Notermans.S,et.al., "*Food preservation by pulsed electric Fields: From research to application*", Woodhead Publishing Ltd. October 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%**

15EE363E	Power Converter Analysis and Design	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15EE301J				
Course Category	E PROFESSIONAL ELECTIVE ELECTRONICS				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting , 2016				

PURPOSE	To acquire knowledge on configurations, analysis, design and control of power converters.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Know the basics of snubber and drive circuits design	a	e					
2.	Develop the knowledge on analysis and design of power converters	a	e					
3.	Design various types of controller	a	e	h	j	k		
4.	Understand the operation and design of resonant converter	a	e	h	j	k		

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: SNUBBER AND DRIVE CIRCUITS	**9**			
1.	Design considerations: Snubber circuit for power switching devices	1	C	1	1,3
2.	Thermal design: temperature control, Heat sink	2	C	1	1,3
3.	Gate Trigger Circuits for Thyristors	2	C	1	1.3
4.	Base drive circuits for BJT and Gate drive circuit for MOSFET	2	C	1	1,6
5.	Practical converter design considerations	2	D	1	1,2,6
	UNIT II: ANALYSIS AND DESIGN OF DC-DC CONVERTERS	**9**			
6.	Classification of DC-DC converters. Analysis of buck, boost in continuous and discontinuous operations	2	C	2	1,4,5
7.	Analysis of buck- boost, Cuk and Sepic converters in continuous and discontinuous operations	2	C	2	1,4
8.	Analysis of Forward, Fly back ,half bridge and full bridge isolated converters	2	C	2	1,4
9.	Design of isolated and non-isolated DC-DC converters	2	C,D	2	1,4,5
10.	Estimating the Output Voltage Ripple in Converters Containing Two-Pole Low-Pass Filters, Input and output filter design	1	C,D	2	1,4
	UNIT III- ANALYSIS AND DESIGN OF MULTILEVEL INVERTERS	**9**			
11.	Multilevel concept, Classification of multilevel inverters	1	C	2	1,2
12.	Diode clamped, improved diode Clamped, Flying capacitors multilevel inverter analysis.	2	C	2	2
13.	Design of multilevel inverters	2	C,D	2	1,2
14.	PWM for multilevel inverters	2	C	2	1
15.	Influence of PWM techniques on switching loss, design of PWM for low inverter loss	2	C	2	1
	UNIT IV-DESIGN OF CONVERTER CONTROL	**9**			
16.	Control and analysis of voltage mode and current modes.	2	C	3	2
17.	Review of different controllers used in power electronic converters	3	C	3	2
18.	Introduction to controller design	1	C	3	1,2,6
19.	Sliding Mode Control of Power Converters , Fuzzy Logic Control of Power Converters	3	C,D	3	6,2
	UNIT V-RESONANT CONVERTERS	**9**			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
20.	Principles of resonant converters, Classical series resonant and parallel resonant converters	2	C	4	2,4,6
21.	Quasi-Resonant Converters	1	C	4	2,4
22.	Multi resonant Converters, Zero-Voltage-Transition (ZVT) Converters	2	C	4	2,4,6
23.	Zero-voltage and Zero-current switching	2	C	4	2,4
24.	Resonant converter design techniques based on frequency response.	2	C,D	4	2,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Ned Mohan, Tore M. Undeland, William P. Robbins, "*Power Electronics Converters, Applications, and Design*", Wiley India Pvt Ltd,Third Edition, 2011.
2.	Rashid M.H., "*Power Electronics Circuits, Devices and Applications*", Prentice Hall India, Third Edition, 2011.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Umanand.L ,"*Power Electronics Essentials and Applications*", John Wiley & Sons, First Edition 2009.
4.	Erickson R. W. and Maksimovic .D, "*Fundamentals of Power Electronics"*, Kluwer Academic Publishers, Second Edition, Reprint 2012.
5.	http://www.peg.ee.iisc.ernet.in/people/faculty/vram/smpc/smpcbook.pdf-Course Material on Switched Mode Power Conversion, V. Ramanarayanan 2008.
6.	M.H. Rashid "*Power Electronics Handbook*", ISBN 978-0-12-382036-5, Elsevier Third Edition, 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%**

15EE365E	Modeling And Analysis of Electrical Machines			L	T	P	C
				3	0	0	3
Co-requisite:	NIL						
Prerequisite:	15EE210						
Course Category	P	PROFESSIONAL ELECTIVE	ELECTRICAL MACHINES				
Course designed by	Department of Electrical and Electronics Engineering						
Approval	32nd Academic Council Meeting 2016						

PURPOSE	To acquire a comprehensive knowledge on mathematical modeling and analysis of electrical machines.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the various parameters of electrical machines in mathematical form.	a	c					
2.	Learn the different types of reference frame theories and transformation relationships.	a	c					
3.	Familiarize the modeling of electrical machines through equivalent circuit parameters.	a	c	e				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	References
	UNIT I: GENERALIZED MACHINE THEORY	**9**			
1.	Discrete and continuous description of distributed windings of electrical machines	1	C	3	1
2.	Air-gap magnetomotive force and rotating mmf in electrical machines	2	C,D	1	1
3.	Elements of generalized circuit theory used in electrical machines (resistance, inductance)	1	C,D	1,3	1,2,3,4
4.	Voltage and flux linkage equations for distributed winding induction machine	2	D	1,3	1,2,3,4
5.	Flux linkage equations for distributed winding synchronous machine	2	D	1,3	1
6.	Kron's primitive machine	1	D	1	2,4
	UNIT II: REFERENCE FRAME THEORY	**9**			
7.	Equations of transformation: change of variables from stationary circuit elements to the arbitrary reference	1	C,D	1,2	1,2
8.	Stationary circuit variables transformed to the arbitrary reference frame (resistive elements, inductive elements, capacitive elements)	3	C,D	1,2	1,2
9.	Commonly used reference frames (arbitrary reference frame, stationary reference frame, rotor reference frame, synchronously rotating reference frame) - Transformation of a balanced set (abc to dq)	1	C,D	1,2	1,2
10.	Balanced steady-state phasor relationships between abc and dq frames and its voltage equations	1	C,D	1,2	1,2
11.	Variables observed from several frames of reference (arbitrary reference frame, stationary reference frame, rotor reference frame, synchronously rotating reference frame)	1	C,D	1,2	1,2
12.	Transformation between reference frames	1	D	1,2	1
13.	Speciality transformations for unbalanced system	1	C,D	1,2	1
	UNIT III: INDUCTION MACHINES	**9**			
14.	Voltage equations of induction motor in machine variables form	2	C,D	1,2,3	1,2,3,4
15.	Torque equation of induction motor in machine variables	1	C,D	1,2,3	1,2,3,4

16.	Equations of transformation for rotor circuits in induction motor	1	C,D	1,2,3	1,2,3,4
17.	Voltage equations and torque equations of induction motor in arbitrary reference-frame variables	2	C,D	1,2,3	1,2,3,4
18.	Analysis of steady-state operation of induction motor	1	C,D	1,2,3	1
19.	Free acceleration characteristics of induction motor	1	C	1,3	1,3
20.	Dynamic performance of induction motor during sudden changes in load torque	1	C,D	1,2,3	1,3
	UNIT IV: SYNCHRONOUS MACHINES	**9**			
21.	Voltage equations of synchronous machine in machine variable forms	1	C,D	1,2,3	1,2,3,4
22.	Torque equation of synchronous machine in machine variables forms	1	C,D	1,2,3	1,2,3,4
23.	Stator voltage equations of synchronous machine in arbitrary reference-frame variables and rotor reference-frame variables	2	C,D	1,2,3	1,2,3,4
24.	Torque equations of synchronous motor in rotor reference frame	1	C,D	1,2,3	1
25.	Analysis of steady-state operation of synchronous machine	2	C,D	1,2,3	1
26.	Generator operation of synchronous motor (stator currents positive out of machine)	1	C,D	2,3	1
27.	Dynamic performance of synchronous motor during sudden changes in load torque	1	C,D	1,2,3	1
	UNIT V: PERMANENT MAGNET SYNCHRONOUS MACHINES	**9**			
28.	Voltage and torque equations of permanent magnet synchronous machine in machine variables	2	C,D	1,2,3	1,2,3,4
29.	Voltage and torque equations of permanent magnet synchronous machine in rotorreference-frame variables	2	C,D	1,2,3	1,2,3,4
30.	Analysis of steady-state operation of permanent magnet synchronous machine	2	C,D	1,2,3	1
31.	Phase shifting of applied voltages of a permanent-magnet ac motor	2	C,D	1,3	1
32.	Torque control using stator current method	1	C,D	1,3	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Paul C.Krause, Oleg Wasyzczuk, Scott S, Sudhoff, "*Analysis of Electric Machinery and Drive Systems"*, John Wiley, Third Edition, 2013.
	REFERENCE BOOKS/OTHER READING MATERIAL
2.	P S Bimbhra, "*Generalized Theory of Electrical Machines*", Khanna Publishers, 5th Edition, 2014.
3.	R. Krishnan, "*Electric Motor Drives - Modeling, Analysis & Control*", PHI Learning Private Ltd, 2009.
4.	A.E, Fitzgerald, Charles Kingsley, Jr, and Stephan D, Umanx, "*Electric Machinery*", Tata McGraw Hill, 5th Edition, 1992

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%**

15EE367E	Design Of Electrical Machines	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15EE204,15EE210				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE ELECTRICAL MACHINES				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To impart the knowledge on the concepts of design of different types of electrical machines							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be well versed with								
1.	MMF calculation and thermal rating of various types of electrical machines.	a	b	c	e			
2.	Design of DC machines.	a	b	c	e			
3.	Design of AC machines	a	b	c	e			
4.	Computer aided design of Rotating Electrical machines	a	b	c	e			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO DC MACHINES	**10**			
1.	Major considerations in Electrical Machine Design - Electrical Engineering Materials – Space factor – Choice of Specific Electrical and Magnetic loading	1	C	1	1,3
2.	Thermal considerations - Heat flow – Temperature rise - Rating of machines – Standard specifications	1	C	1	1,3
3.	DC machines - Output Equations – Design of main dimensions	2	C	2	1,3
4.	Magnetic circuit calculations – Carter's Coefficient - Net length of Iron –Real and Apparent flux densities.	2	C	2	1,3
5.	Selection of number of poles – Design of Armature	2	C	2	1,3
6.	Design of commutator and brushes	2	C	2	1,3
	UNIT II: TRANSFORMERS	**9**			
7.	Output Equations – Main Dimensions - kVA output for single and three-phase transformers	2	C	3	1,3
8.	Window space factor – Overall dimensions	2	C	3	1,3
9.	Operating characteristics – Regulation – No load current-Temperature rise in Transformers	2	C	3	1,3
10.	Design of Tank - Methods of cooling of Transformers	3	C	3	1,3
	UNIT III: INDUCTION MOTOR	**9**			
11.	Output equation of Induction motor – Design of main dimensions – Length of air gap	2	C	3	1,3
12.	Rules for selecting rotor slots of squirrel-cage machines	2	C	3	1,3
13.	Design of rotor bars and slots – Design of end rings	4	C	3	1,3
14.	Design of wound rotor	1	C	3	1,3
	UNIT IV: SYNCHRONOUS MACHINES	**9**			
15.	Pole construction – run away speed – output equation, choice of specific loading	2	C	3	1,3
16.	Short circuit ratio – shape of pole face – Armature design – Armature parameters	3	C	3	1,3
17.	Estimation of air gap length– Design of field system	3	C	3	1,3
18.	Design of turbo alternators	1	C	3	1,3
	UNIT V: COMPUTER AIDED DESIGN OF ROTATING ELECTRICAL MACHINES	**8**			
19.	Introduction-manual versus Computer aided design - Approach to Computer aided design – Design synthesis	3	C	4	2.3
20.	Special Requirements – Program for Different machines –Computer aided design in industry	3	C	4	2,3
21.	Illustrative design – limitations in Computer aided designs	2	C	4	2,3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Sawhney, A.K., "*A Course in Electrical Machine Design"*, Dhanpat Rai & Sons, New Delhi, 2013
2	Deshpande,M.V."*Design and Testing of Electrical Machines*", PHI learning Pvt Ltd',2015
	REFERENCE BOOKS/OTHER READING MATERIAL
3	A.Shanmugasundaram, G.Gangadharan, R.Palani "*Electrical Machine Design Data Book"*, New Age Intenational Pvt. Ltd., Reprint 2007
4	Rai.H.M, "*Electrical Machine Design*", Sathiya Prakashan Publications, Third edition, 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%**

15EE451E	Power System Dynamics	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	15EE304, 15EE402				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	POWER SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To become familiar with the modeling of components and system for carrying out transient stability analysis of large scale power systems.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Learn the modeling of synchronous machines.	a	e					
2.	Design the controller for excitation system and speed governing system.	a	c	e	h			
3.	Understand and analyze the small signal stability and transient stability of power systems	a	c	e	h			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION	**7**			
1.	Introduction - Stability of simple systems, power system stability Manifestation - causes nature and effects of disturbance.	1	C	3	1,3
2.	Classification of power system stability, characterization of rotor angle stability.	2	C	3	1,3
3.	Damping and synchronizing torques, power system dynamics, electromechanical and electromagnetic transients – nature of equations and solution methods.	2	C,D	3	1,3
4.	Short term and long term stability of generator and load driven stability.	2	C	3	2
	UNIT II: SYNCHRONOUS MACHINE MODELING	**10**			
5.	Three phase synchronous machine – basic equations, schematic of seven winding model, flux linkage equations.	1	C,D	1	1
6.	Parks transformation matrix – flux linkage and voltage equations in park's coordinates expression for electrical torque.	2	C,D	1	1
7.	Equivalent circuit and phasor diagram, synchronous machine model for stability analysis, assumptions.	2	C,D	1	1
8.	Model described by constant and variable voltage behind transient reactance.	2	C,D	1	1
9.	Type 1A and 1B models and equation, modeling of mechanical part, acceleration and swing equation.	3	C,D	1	1
	UNIT III: MODELING OF EXCITATION AND TURBINE – GOVERNOR	**10**			
10.	Functional block diagram of an excitation system, classification of excitation systems	1	C,D	2	1.2,3
11.	DC excitation system and IEEE block diagram for type-1 excitation systems, separately excited exciter block equation	2	C,D	2	1,2,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
12.	Functional block diagram of steam turbine, equations of single reheat tandem – compounded steam turbine	3	C,D	2	1
13.	Speed governing systems, steady state speed regulation characteristics, secondary control characteristics of speed governing ems	3	C,D	2	1
14.	Classification of hydraulic turbines and simplified model of hydraulic turbine	1	C,D	2	1
	UNIT IV: SMALL SIGNAL STABILITY ANALYSIS	**9**			
15.	Introduction – the SMIB system– generator represented by classical model, expression for air gap power and torque, state equations and block diagram.	2	C,D	3	1
16.	Numerical example: SMIB system-type 1B synchronous machine , network equations ,block diagram analysis, torque phasor diagram	2	C,D	1,3	1
17.	Simplified block diagram of excitation system – K constants effect on synchronizing and damping torque, torque phasor diagram at the rotor oscillation frequency.	3	C,D	2.3	1,2,3
18.	Power system stabilizer-principle, block diagram, application of excitation system with PSS and including delta P – omega stabilizer	2	C	3	1
	UNIT V: TRANSIENT STABILITY	**9**			
19.	Types of algorithm for transient stability analysis using trapezoidal rule of integration	2	C,D	3	1
20.	Simplified analysis with ITAM – assumptions, algorithm to advance simulation by one time step, initialization of state, algebraic and memory variables	4	C,D	3	1
21.	Selected methods of enhancing transient stability – fast valving, controlled system of operation and single -pole switching	3	C,D	3	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Kundur.p, "*Power System Stability and Control*", McGraw Hill Inc.,USA, 1994
2.	R.Ramunujam, "*Power system dynamics –analysis and simulation*"PHI Learning,New Delhi,November2013
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Pai.M.A and Sauer.W,"*Power System Dynamics and Stability*",Pearson Education Asia,India,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%**

15EE452E	Modern Power System Analysis	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	15EE304				
Data Book / Codes/Standards	Nil				
Course Category	E PROFESSIONAL ELECTIVE POWER SYSTEMS				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32 nd Academic Council Meeting, 2016				

PURPOSE	To acquire ability to analysis power system problems and state estimation with various numerical tools.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
4.	Learn the algorithms for computing network matrices	a	e					
5.	Understand the use of numerical methods for power flow analysis and optimal power flow analysis	a	e	h	j			
6.	Analyze the contingency, Stability and state estimation problems in Power systems.	a	e	h	j			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: PRELIMINARIES FOR POWER SYSTEM PROBLEMS	**7**			
1.	Modeling of generators, transformers	1	C	1	2
2.	Off nominal tap setting and phase shifting transformers, transmission lines and load, Per unit quantities	1	C	1	2
3.	Primitive parameters - Bus admittance matrix	1	C	1	2
4.	Bus impedance matrix	1	C	1	2
5.	Solution through factored matrices	1	C	1	2
6.	Solution of non-linear algebraic equation and non-linear differential equations	2	C	1	2
	UNIT II: POWER FLOW ANALYSIS	**9**			
7.	Formulation of power flow problem	1	C	2	1,5,6
8.	Solution through Newton Raphson method	3	C	2	1,5,6
9.	Decoupled and fast decoupled power flow solutions ,DC power flow solution	2	C	2	1,5,6
10.	Power flow solution using FACTS devices	1	C	2	1,5,6
11.	Optimal power flow solution	2	C	2	1,5,6
	UNIT III: CONTINGENCIES ANALYSIS	**9**			
12.	Importance of contingency analysis	1	C	3	1
13.	Addition/removal of one line	2	C	3	1
14.	Construction of a column of bus impedance matrix from the bus admittance matrix	2	C	3	1
15.	Calculation of new bus voltages due to addition/removal of one line	2	C	3	1
16.	Calculation of new bus voltages due to addition/removal of two lines.	2	C	3	1
	UNIT IV: TRANSIENT STABILITY ANALYSIS	**10**			
17.	Swing equation - equal area criterion	1	C	3	1,4,6
18.	Critical clearing angle - critical clearing time	1	C	3	1,4,6
19.	Multi-machine transient stability studies by classical representation	3	C	3	1,4,6
20.	Solution of swing curve and algorithms for multi-machine transient stability studies using Modified Euler's method	3	C	3	1,4,6
21.	Algorithm for multi-machine transient stability studies using Fourth order Runge Kutta method	2	C	3	1,4,6

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT V: POWER SYSTEM STATE ESTIMATION	**10**			
22.	Introduction to Power system state Estimation	2	C	3	1,3
23.	Method of weighted least square for DC circuits	2	C	3	1,3
24.	Maximum Likelihood Estimation-Measurement Model	2	C	3	1,3
25.	Measurement Jacobian matrix-Gain matrix	2	C	3	1,3
26.	Development of WLS algorithm-solution procedure	2	C	3	1,3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
4.	John.J.Grainger, William D. Stevenson, Jr ,*"Power System Analysis",* Mc Graw Hill Education (India) Private Limited, New Delhi, 2015.
5.	William D. Stevenson, Jr. ,*"Elements of Power System Analysis",* McGraw-Hill Hill Education (India) Private Limited, New Delhi, 2014.
6.	Ali Abur and A.G.Exposito,*"Power System State Estimation-Theory and Implementation"*, Maecel Dekker,Inc.,2004
	REFERENCE BOOKS/OTHER READING MATERIAL
7.	Kothari D.P. and Nagarath I.J.,*"Power System Engineering"*, Second Edition, Mc Graw Hill Education (India) Private Limited, New Delhi, 2015.
8.	Hadi Sadat, *"Power System Analysis",* Tata Mc Graw Hill Publishing company, New Delhi, 2002.
9.	Pai M.A. and Dheeman Chatterjee *"Computer Techniques in Power System Analysis",* Mc Graw Hill Education (India) Private Limited, New Delhi, 2016.

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%**

15EE453E	Power System Deregulation	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE POWER SYSTEMS				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32 nd Academic Council Meeting, 2016				

PURPOSE	To study the various role of entities in restructured and deregulated power system							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the basics of deregulation, power systemeconomic operation and its benefits	a	c	e				
2.	Learn the role of independent systemoperator	a	c	e	h	j		
3.	Understand the transmission services	a	c	e	h	j		
4.	Acquire knowledge on security and congestion management	a	c	e	h	j		

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: INTRODUCTION TO DEREGULATION	**9**			
1.	Introduction- Deregulation- Different entities in deregulated electricity markets	2	C	1	1,2
2.	Background from competitive electricity markets- After effects of deregulation	2	C	1	1,2
3.	Review of Economic Load Dispatch problem (ELD)	3	C	1	1,2
4.	Recent developments in ELD	2	C	1	1,2
	UNIT II: POWER SYSTEM ECONOMIC OPERATION	**9**			
5.	Optimal power flow (OPF) as a basic tool- OPF model- Examples	3	C	1	1,2
6.	Characteristic features of OPF	1	C	1	1,2
7.	Unit commitment- basic model, additional issues	2	C	1	1,2
8.	Formation of power pools- Energy Brokerage system.	3	C	1	1,2
	UNIT III: ROLE OF INDEPENDENT SYSTEM OPERATOR	**9**			
9.	Role of Independent systemoperator (ISO) - structure of UK and Nordic Electricity deregulated market	1	C	2	1,2,3
10.	Operational planning activities of ISO- ISO pool and bilateral markets	3	C	2	1,2,3
11.	Operational planning activities of GENCO - GENCO in pool and bilateral markets- Market participation issues	3	C	2	1,2,3
12.	UC in deregulated environment- Competitive bidding.	2	C	2	1,2,3
	UNIT IV: TRANSMISSION PRICING	**9**			
13.	Power wheeling- Transmission open access	2	C	3	1,2,4
14.	Cost components in transmission pricing of power transactions and embedded cost based transmission pricing	3	C	3	1,2,4
15.	Incremental cost based transmission pricing	3	C	3	1,2,4
16.	Transmission open access and pricing mechanisms in various countries	1	C	3	1,2,4
	UNIT V: SECURITY AND CONGESTION MANAGEMENT	**9**			

17.	Developments in international transmission pricing- Security management in deregulated environment- scheduling of spinning reserves	3	C	4	1,2,5
18.	Interruptible load options for security management	3	C	4	1,2,5
19.	Congestion management in deregulation	2	C	4	1,2,5
20.	Economic instruments for handling congestion.	1	C	4	1,2,5
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Kankar Bhattacharya,"*Operation of Restructured Power Systems*", Kluwer academic publishers, 2001.
2	Mohammad Shahidehpoura and Muwaffaq A lomoush "*Restructured Electric Power System operation trading and volatility*", Macsel Dekker Inc,2001
3	Zaccour.G. "*Deregulation of Electric Utilities*", Kluwer academic publishers, 1998
	REFERENCE BOOKS/OTHER READING MATERIAL
4	Sally Hunt, *"Making competition work in electricity"*, John Willey and Sons Inc. 2002.
5	Steven Stoft, *"Power system economics: designing markets for electricity"*, John Wiley & Sons, 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%**

15EE454E	Distributed Energy Resources	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE POWER SYSTEMS				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting , 2016				

PURPOSE	To understand the different types of non-conventional energy resources like solar, wind, biomass, ocean, tidal and wave sources and the conversion techniques.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course the student will be able to								
1.	Understand the concept of various Non-conventional energy resources	a						
2.	Acquire in depth knowledge of the conversion of non-conventional energy resources into Electrical power.	a	c					
3.	Learn the latest developments of renewable Energy studies.	a	e	h				
4.	Attain knowledge in Green Energy Technologies	a	e	h	j			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: Non conventional energy resources	**09**			
1.	Definition, Concepts of Non Conventional Energy Sources, Limitations of Non Conventional Energy Sources	2	C	1	1
2.	Energy needs of India, and energy consumption patterns. Worldwide Potentials of these sources. Energy efficiency and energy security	2	C	1,2	2
3.	Energy and its environmental impacts	2	C	3	2
4.	Technical and Economical impact of Distributed generation.	2	C	4	3
5.	Classification of NCES, Solar, Wind, Geothermal, Biomass, Ocean energy sources, Comparison of these energy sources	1	C	4	3
	UNIT II: Solar Energy	**09**			
6.	Definition, Energy available from Sun, Solar radiation data, solar energy conversion in to heat	2	C	1	1
7.	Flat plate and Concentrating collectors, Principle of natural and forced convection	2	C	2	1
8.	Energy Storage systems. Case studies of Solar thermal systems for residential water heating, industrial heating and power generation	2	C	3	3
9.	Maximum Power Point Tracking, Battery Characteristics	1	C	2	3
10.	DC Power Conditioning Converters, AC Power Conditioning –Inverters, Testing of PV systems	2	C	1	2
	UNIT III: Wind Energy	**09**			
11.	Energy available from wind, General formula, Lift and drag. Basis of Wind energy conversion, Effect of density, Frequency variances, Angle of attack, Wind speed,	1	C	1	1,2
12.	Windmill rotors, Horizontal axis and Vertical axis rotors	2	C	1,2	1,3
13.	Choice of generators, turbine rating, electrical load matching	2	C	1,2	2
14.	Variable speed operation, maximum power operation, control systems, system design features, stand alone and grid connected operations	2	C	2	3
15.	Determination of torque coefficient, Induction type generators, Working principle of wind power plant	2	C	1,3	1

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT IV: Biomass, Wave, Tidal Energy Systems	**09**			
16.	Biomass Conversion Routes- Combustion, Gasification, Anaerobic Digestion, Pyrolysis, Cogeneration	2	C	1	1
17.	Performance analysis and testing, Case studies of Biomass systems for thermal applications and Power generation	3	C	1,4	2
18.	Difference between tidal and wave power generations. Principles of tidal and wave power generations	2	C	2	2
19.	OTEC power plants	2	C	1,3	1
	UNIT V: Energy storage and hybrid system configurations	**09**			
20.	Energy storage, Battery – types, equivalent circuit, performance characteristics	1	C	1	1
21.	Battery design, charging and charge regulators	2	C,D	1	1
22.	Battery management	2	C	1,2	3
23.	Flywheel-energy relations, components, benefits over battery	2	C	3	3
24.	Fuel Cell energy storage systems. Ultra Capacitors	2	C	3	3,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
10.	Rai ,G.D.,"*Non Conventional sources of Energy*", Khanna Publishers ,5th Edition, 2016.
11.	Rao. S. & Pamlekar Dr.B.B. "*Energy Technology"* , Khanna Publishers, 3rd Edition, 2016
	REFERENCE BOOKS
12.	Khan. B.H, "*Non-Conventional Energy Resources*", The McGraw Hills,Second edition, 2016.
13.	D.P.Kothari, "*Renewable Energy Sources and Emerging Technologies*", PHI Learning Private Limited, 4th Edition 2011.
14.	Bansal NK, Kleeman and Meliss M "*Renewable energy sources and conversion Techniques"*, Tata Mc Graw Hill, 1990 .

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%**

15EE455E	Smart Grid	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	E PROFESSIONAL ELECTIVE POWER SYSTEMS				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32 nd Academic Council Meeting, 2016				

PURPOSE	To equip the students with the fundamental knowledge on the smart grid.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Understand the challenging issues and architecture of smart grid	a	h	j				
2.	Understand the communication and wide area monitoring in smart grid	a	h					
3.	Rudimentary energy management issues in smart grid	a	h	j	k			
4.	Acquire the knowledge in computational intelligence and security issues in smart grid	a	h	j	k			
5.	Know the role of Power electronics and energy storage in smart grid	a	h	j				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I:SMART GRID ARCHITECTURE	**8**			
1.	Challenges in power grid	1	C	1	1,2,5
2.	Advantages of building integrated and distributed power systems - concept of smart grid	1	C	1	1,2,5
3.	Need for smart grid	1	C	1	1,2,5
4.	Smart grid components and their limitations	1	C	1	1,2,5
5.	Grid vision based on intelligent architecture	1	C	1	1,2,5
6.	Whole sale energy market in smart grid	1	C	1	1,2,5
7.	Stack holders roles and function	1	C	1	1,2,5
8.	Approach to smart grid interoperability standards.	1	C	1	1,2,5
	UNIT II: COMMUNICATIONS AND MEASUREMENTS	**10**			
9.	Latest wired and wireless technologies	1	C	2	1,2,5
10.	Characteristics of smart grid communications technology and communication techniques	1	C	2	1,2,5
11.	Switching techniques and communication channels	2	C,D	2	1,2,5
12.	Wide area monitoring systems	1	C	2	1,2,5
13.	Phasor measurement units	1	C	2	1,2,5
14.	Key components of smart metering	1	C	2	1,2,5
15.	Communication infrastructure and protocols for smart metering	1	C	2	1,2,5
16.	Advanced metering infrastructure	1	C	2	1,2,5
17.	Multi agent systems for smart grid implementation	1	C	2	1,2,5
	UNIT III: PERFORMANCE ANALYSIS TOOLS	**9**			
18.	Load flow studies for smart grid	1	C	3	1,2
19.	Extended formulations and algorithms	2	C,D	3	1,2
20.	Security assessment in smart grid	2	C	3	1,2
21.	Contingency studies for smart grid	1	C	3	1,2
22.	Voltage stability in smart grid	2	C	3	1,2
23.	Energy management in smart grid.	2	C	3	1,2
	UNIT IV: COMPUTATIONAL TOOLS AND SECURITY	**9**			
24.	Introduction to computational tools	1	C	4	1,2,3
25.	Optimization techniques and applications to smart grid	2	C,D	4	1,2,3
26.	Evolutionary computation techniques and computational challenges	2	C,D	4	1,2,3
27.	Network security: Encryption and decryption	2	C	4	1,2,3
28.	Network and system attacks	1	C	4	1,2,3
29.	Authentication and cyber security standards	1	C	4	1,2,3
	UNIT V: RENEWABLE ENERGY AND STORAGE	**9**			
30.	Benefits of renewable generation	1	C	5	3,4
31.	Importance of micro grid	1	C	5	3,4

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
32.	Demand response issues	2	C	5	3,4
33.	PHEV technology	1	C	5	3,4
34.	Energy storage technologies	2	C	5	3,4
35.	Grid integration issues of renewable energy sources	2	C	5	3,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**REFERENCE BOOKS**
1.	James Momoh, "*Smart Grid – fundamentals of design and analysis"*, John Wiley and Sons, 2012
2.	Janaka Ekanayake, "*Smart Grid-Technology and Applications"*, John Wiley and Sons, 2012
3.	Clark W. Gellings, "*The Smart Grid- Enabling energy efficiency and demand response*", CRC press, 2009
4.	Fereidoon P.Sioshansi, "*Smart grid- integrating renewable, distributed and efficient energy*", Elsevier, 2012
5.	Stuart Borlase,"*Smart Grids, Infratructure, technology and solutions"*, CRC press, 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%**

15EE456E	Energy Management System and SCADA	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE Power Systems				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting , 2016				

PURPOSE	To gain knowledge in energy management system and SCADA							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Understand the fundamentals of energy management functions	a	h					
2.	Understand the economic analysis and system energy management for electrical system and equipment.	a	c	h				
3.	Enhance the knowledge in lighting and cogeneration.	a	h					
4.	Expose to the concept of supervisory control and data acquisition.	a	h					
5.	Familiarize the application of SCADA in power systems	a	h					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: ENERGY MANAGEMENT FUNCTIONS	**9**			
1.	Need for energy management – energy management program	2	C	1-4	1,2
2.	Energy accounting – Energy monitoring	1	C	1	1,2
3.	Targeting and Reporting	1	C	1	1,2
4.	Energy audit process	1	C	1	1,2
5.	Energy Management Centers and their Functions	1	C	1	1,2
6.	Architectures of Centers and their Functions	1	C	1	1,2
7.	Energy performance assessment of HVAC system	2	C,D,I	1	1,2
	UNIT II: ECONOMIC ANALYSIS AND SYSTEM ENERGY MANAGEMENT	**9**			
8.	Important concepts in an economic analysis, Electricity tariff	2	C	2	1,2
9.	Electrical Load Management and Maximum Demand Control	2	C	2	1,2
10.	Systems and equipment, Electric motors, Transformers	2	C	2	1,2
11.	Capacitors -power factor and effect of harmonics on power quality	1	C	2	1,2
12.	Energy efficiency analysis on electrical power system, motor and transformer	2	C,D,I	2	1,2
	UNIT III: LIGHTING AND COGENERATION	**9**			
13.	Concept of lighting systems – the task and the working space	1	C	3	1,2
14.	Light sources – ballasts –luminaries	1	C	3	1,2
15.	Lighting controls	2	C	3	1,2
16.	Optimizing lighting energy, lighting and energy standards	1	C	3	1,2
17.	Forms of cogeneration – Feasibility of cogeneration	2	C	3	1,2
18.	Energy performance analysis of lighting and cogeneration	2	C,D,I	3	1,2
	UNIT IV: SUPERVISORY CONTROL AND DATA ACQUISITION	**9**			
19.	SCADA - Functional requirements and Components	2	C	4	3,4
20.	General features, Functions and Applications, Benefits	2	C	4	3,4
21.	Various SCADA architectures	2	C	4	3,4
22.	SCADA Communication: various industrial communication technologies	3	C	4	3,4
	UNIT V: SCADA APPLICATIONS	**9**			
23.	SCADA Applications: Utility Applications	2	C	5	3,4
24.	Transmission and distribution sector-Operations, Monitoring, Analysis and improvement	2	C	5	3,4
25.	Substation automation structure	1	C	5	3,4
26.	Substation automation architecture	2	C	5	3,4
27.	Introduction to wide area protection	2	C	5	3,4
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES AND LEARNING MATERIALS**
1.	Wayne C. Turner, Steve Doty "*Energy Management Hand book*", The Fairmont Press, 6th Edition, 2007
2.	Amit K. Tyagi, "*Handbook on Energy Audits and Management*", Tata Energy Research Institute, 2nd reprint, 2003
3.	Stuart A. Boyer: "*SCADA- Supervisory Control and Data Acquisition*", Instrument Society of America Publications, USA, The Instrumentation systemand Automation Society, 4th Edition, 2010
4.	Gordon Clarke, Deon Reynders" *Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems"*, Newnes An imprint of Elsevier Publications, 1st Edition, 2004
5.	www.energymanagertraining.com www.bee-india.nic.in

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%**

15EE457E	Hybrid Electric Vehicles	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE ELECTRICAL MACHINES				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting 2016				

PURPOSE	To acquire knowledge on the fundamental concepts, principles, and analysis of hybrid electric vehicles.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Realize the importance of electric transportation systems.	a						
2.	Understand the basics of electric vehicle components and configuration.	a	d					
3.	Understand the various charging types, comfort and safety methods.	a						
4.	Understand the application of electric vehicle in Smart grid.	a	d	j				

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: ELECTRIC VEHICLES	**7**			
1.	History of Modern Transportation.	1	C	1	1,3
2.	Importance of Different Transportation Development Strategies to Future Oil Supply.	1	C	1	1,3
3.	Introduction to Electric Vehicles, History of hybrid and electric vehicles.	1	C	1	1,3
4.	Social, environmental importance and key challenges of hybrid and electric vehicles.	2	C	1	1,3
5.	Specifications of PHEVs, BEVs, EVs, Plug-in Hybrid Vehicle characteristics.	1	C	1,2	1,2
6.	The future of electric vehicles.	1	C	1,2	1,2
	UNIT II: ENERGY STORAGE AND BATTERY TECHNOLOGY	**9**			
7.	Introduction to Energy Storage system, Battery Requirements for HEVs, PHEVs, and EVs.	1	C	2	1-4
8.	Types of batteries, Properties of batteries.	1	C	2	4
9.	Working principle and construction of lead-acid, nickel cadmium, nickel metal hydride, lithium ion batteries.	2	C	2	4
10.	Maintenance and charging of batteries.	1	C	2	4
11.	Diagnosing lead-acid battery faults.	1	C	2	4
12.	Advanced battery technology.	1	C	2	4
13.	Developments in electrical storage.	1	C	2	4
14.	Case studies.	1	C	2	4
	UNIT III: CHARGING AND STARTING SYSTEMS	**9**			
15.	Requirements of the charging system, Charging system principles.	1	C	2,3	1,2
16.	Alternators and charging circuits, Diagnosing charging system faults.	1	C	3	2
17.	Advanced charging system technology, New developments in charging systems.	1	C	3	2
18.	Requirements of the starting system, Starter motors and circuits	1	C	3	2
19.	Types of starter motor, Diagnosing starting system faults	2	C	3	2
20.	Advanced starting system technology, New developments in starting systems.	2	C	3	2
21.	Case studies	1	C	3	2
	UNIT IV: HYBRID ELECTRIC VEHICLE DRIVE TRAIN AND SAFETY	**9**			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
22.	Requirement of drive train.	1	C	2	3,4
23.	Architecture of hybrid drive train.	1	C	2	3,4
24.	Sizing of components.	1	C	2	3,4
25.	Series configuration, Parallel configuration, parallel and series configuration.	2	C	2	3,4
26.	Security, Airbags and belt tensioners.	1	C	2	1,2
27.	Diagnosing comfort and safety system faults.	1	C	2	1,2
28.	Advanced comfort and safety systems technology	1	C	2	1,2
29.	New developments in comfort and safety systems	1	C	2	1,2
	UNIT V: EMERGING TECHNOLOGIES	**11**			
30.	Introduction	1	C	4	6
31.	Electric Vehicle Supply Equipments.	2	C	4	6
32.	Smart vehicles in smart grid.	1	C	4	6
33.	Vehicle-to-grid technologies: Unidirectional and Bidirectional.	2	C	4	6
34.	Need of Charging Station Selection (CSS) server	1	C	4	6
35.	Smart grid technologies: Applications / Benefits.	2	C	4	6
36.	Smart meter, Smart charger: Purpose and benefits.	2	C	4	6
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	M. Ehsani, Y. Gao, and A. Emadi, "*Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design"* Second Edition,CRC Press, ISBN: 978-1-4200-5398-2, Aug. 2009.
2.	Tom Denton," *Automobile Electrical and Electronic Systems"* Elsevier Butterworth-Heinemann, Third edition, 2004.
3.	A. Emadi ,"*Advanced Electric Drive Vehicles*, CRC Press, ISBN: 978-1-4665-9769-3, Oct. 2014.
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	Iqbal Hussain, *"Electric & Hybrid Vehicles – Design Fundamentals",* Second Edition, CRC Press, 2011.
5.	James Larminie, *"Electric Vehicle Technology Explained",* John Wiley & Sons, 2003.
6.	Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "*Smart Grid: Technology and Applications",* John Wiley & sons inc, 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%**

15EE458E	Finite Element Analysis for Electrical Machines	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	15EE205				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL ELECTIVE ELECTRICAL MACHINES				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd , Academic Council Meeting , 2016				

PURPOSE	To acquire the knowledge of design in electrical machines							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand basics of design considerations for electrical machines	a	c	e				
2.	Understand the field equations of electrical machines	a	e					
3.	Educate scientifically the new developments in software for designing the machines	a	k					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I - BASIC DESIGN CONSIDERATIONS	**8**			
1.	Introduction to CAD	1	C	1	1,2,3
2.	Conventional design procedures : output equations	1	C	1	1,2
3.	Specific loadings	1	C	1	1,2
4.	Variation of output and losses with dimensions - design criteria	2	C	1	1,2
5.	Limitations of conventional methods of design	1	C	1	1,2
6.	Engineering Optimization and Optimization Methodology	1	C	1	1,2
7.	Need for field analysis based design	1	C	1	1,2
	UNIT II: FINITE ELEMENT METHOD	**10**			
8.	Introduction to finite element method and its Assumptions	1	C	1-2	1,4
9.	Maxwell equations, - Finite difference method	2	D	2	1,4
10.	Finite Element method	1	D	2	1,4
11.	Variation method	1	D	2	1,4
12.	2D field problems - Discretisation - shape functions	2	D	2	1,4
13.	Stiffness matrix - Solution techniques	2	C	2	1,4
14.	Computers in Finite Element Analysis - applications of FEA.	1	C	2	1,4
	UNIT III: CAD PACKAGE	**9**			
15.	Elements of a CAD system - Preprocessing - Modeling - Meshing	1	D	1	2,3,5
16.	Material properties - Boundary conditions	1	D	1	2,3,5
17.	Solver – Post processing	1	D	1	2,3,5
18.	Considerations in problem modeling : stator and rotor model, model replication	2	D	1	2,3,5
19.	Air gap discretisation and simulation of rotation	1	D	1	2,3,5
20.	Calculations : Flux plots	1	C	1	2,3,5
21.	Calculations : Flux linkages – Inductance and Co-energy	2	C	1	2,3,5
	UNIT IV: INTRODUCTION TO MODEL BUILDING	**11**			
22.	Introduction to MagNet – model building	1	C	3	6
23.	Modeling flowchart – geometric modeling	2	D	3	6
24.	Drawing edges – creating surface	2	D	3	6
25.	Creating components	1	C	3	6
26.	Selecting edges surfaces and components	2	D	3	6
27.	Positioning the construction slice	1	D	3	6

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
28.	Material, boundary condition and finite element mesh	1	D	3	6
29.	Solving the model	1	D	3	6
	UNIT V: DESIGN APPLICATIONS	**7**			
30.	Introduction to software packages of Finite Element analysis such as MagNet, Motorsolve and its comparison	3	D	3	6
31.	Design of C-core using software	1	D	3	6
32.	Design of Inductance using software	1	D	3	6
33.	Design of SRM motor with 6:4 slots using software	1	D	3	6
34.	Design of 3-phase 6-pole BLDC Motor with 9-slots using software	1	D	3	6
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Silvester and Ferrari, "*Finite Elements for Electrical Engineers*" Cambridge University press, 1983.
2.	S.R.H. Hoole, "*Computer - Aided, Analysis and Design of Electromagnetic Devices*", Elsevier, New York, Amsterdam, London, 1989
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	D.A.Lowther and P.P.Silvester, "*Computer Aided design in Magnetics*", Springer Verlag, New York, 1956.
4.	S.J.Salon, "*Finite Element Analysis of Electrical Machines*", Kluwer Academic Publishers, London, 1995.
5.	C.W.Trowbridge, "*An Introduction to Computer Aided Electromagnetic Analysis*", Vector field ltd.,
6.	Infolytica corporation, " *MAGNET version 6.11.1 Getting Started guide*"

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%**

15EE459E	Solar Photovoltaic Systems	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL ELECTIVE	CIRCUITS AND SYSTEMS			
Course designed by	Department of Electrical And Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To acquire knowledge on Photovoltaic and its applications.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Understand the principle of direct solar energy conversion to power using PV technology.	a						
2.	Comprehend the performance and operating characteristics of PV systemand its components	a	c	e	h	j		
3.	Understanding the design of photovoltaic systems for variety of applications.	a	c	e	h	j		

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: PHOTOVOLTAIC (PV) CELL	**10**			
1.	Historical development of PV –PV in world – Indian energy scenario Photovoltaic effect - Principle of direct solar energy conversion into electricity in a solar cell system.	3	C	1	1,2,3
2.	Solar cell - p-n Junction-Semiconductor properties-energy levels, basic equations and equivalent circuit.	2	C	1	1
3.	Solar cell- basic structure -crystalline, multi-crystalline, thin film silicon solar cells.	3	C	1	1,2,3
4.	Emerging new technologies and Characteristics-Single, Solar Cell Parameters.	2	C	2	1
	UNIT II: PV MODULE PERFORMANCE ANALYSIS	**8**			
5.	Solar PV Module, Specifications of Solar PV Module, PV Module Parameters, Parallel and series connections.	2	C	2	1,2
6.	I-V characteristics of a PV module, maximum power point-MPPT basic Algorithms.	3	C,D	2	1
7.	Cell efficiency, fill factor, effect of irradiation and temperature	3	C	2	1
	UNIT III: DESIGN OF PV SYSTEM	**9**			
8.	Classification -Central Power Station System, Distributed PV System-Stand alone PV System-Grid Interactive PV System	2	C	2	1
9.	Charge controllers -Batteries -Inverters	2	C,D	2	1
10.	Design of a standalone PV system-water pumping system	5	C,D	2	1
	UNIT IV: GRID TIED PHOTOVOLTAIC SYSTEMS	**9**			
11.	Principle components in Grid –PV system, Cost and Investment	2	C	2	1
12.	Classification of Grid Tie Inverters and Working Central inverter, String Inverter, Micro Inverter	3	C	2	2
13.	Sizing the inverter and efficiency, Metering Concepts in Grid Tie systems, Introduction to hybrid PV system.	4	C,D	2	1
	UNIT V: PV APPLICATIONS	**9**			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
14.	Building-integrated photovoltaic units, grid-interacting central power stations, stand-alone devices for distributed power supply in remote and rural areas.	3	C	3	5
15.	PV applications in aircraft, power satellites. Home lighting - solar water pumping systems	4	C	3	1
16.	Socio-economic and environmental merits of photovoltaic systems.	2	C	3	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Chetan Singh Solanki., "*Solar Photovoltaic: Fundamentals, Technologies and Application*", PHI Learning Pvt., Ltd., 2nd edition 2011
2.	R. Messenger, J. Ventre, "*Photovoltaic Systems Engineering*", CRC Press 3rd edition.,2010.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Jha A.R., "*Solar Cell Technology and Applications*", CRC Press, 2010.
4.	S.P. Sukhatme, J.K.Nayak., "*Solar Energy*", Tata McGraw Hill Education Private Limited, New Delhi, 2010.
5.	Antonio Luque , Steven Hegedus ,"*Handbook of Photovoltaic Science and Engineering*", Wiley 2nd Edition 2010.
6.	John R. Balfour, Michael L. Shaw, Sharlave Jarosek., "*Introduction to Photovoltaics*", Jones & Bartlett Publishers, Burlington, 2011.
7.	Michael Boxwell,"*Solar Electricity Handbook : A simple, practical guide to solar energy - designing and installing solar PV systems*" 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%**

15EE460E	Vehicular Power Systems	L	T	P	C
		3	0	0	3
Co-requisite:	Nil				
Prerequisite:	Nil				
Data Book / Codes/Standards	Nil				
Course Category	E PROFESSIONAL ELECTIVE POWER SYSTEMS				
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	To acquire knowledge in power sources for various vehicles.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Understand the development of electric power systems for various types of vehicles.	a						
2.	Familiarize with the modeling and analysis of recent power electronics system.	a	c	e	h	j		
3.	Equip themselves with advanced power electronic converters and electric motor drives for vehicular applications.	a	c	e	h	j		
4.	Design DC and AC distribution architectures	a	c	e	h	j		

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: AIRCRAFT POWER SYSTEMS	**9**			
1.	Introduction –conventional electrical systems, power generation systems - overview of vehicular power systems	3	C	1	1
2.	Introduction – aircraft electrical distribution systems	3	C	1,3, 4	1
3.	Stability analysis	3	C,D	1, 2, 3	1
	UNIT II: SPACE POWER SYSTEMS	**9**			
4.	Introduction – international space station, primary power system, secondary power system	2	C	1	1
5.	Support systems, space craft power systems, alternate power sources	2	C,D	1, 3, 4	1
6.	Earth observing system, electrical power systems for space based radar satellites	2	C,D	1, 3, 4	1
7.	Modeling, analysis and simulation considerations – typical DC/DC converter in a multi-converter dc power electronic system with the zero-order approximations of its inputs and outputs	3	C	1, 2, 3	1
	UNIT III: POWER SYSTEMS FOR SEA AND UNDERSEA VEHICLES	**9**			
8.	Introduction – power system configurations, power electronics building blocks – pebb applications in the system	1	C	1	1
9.	Controller architecture for power electronic – centralized digital controller	2	C,D	1, 3, 4	1
10.	Direct stiffness method - portal frames – single bay single storey – with and without sway	2	C,D	2, 3	1
11.	Tutorials on digital controller design and direct stiffness method	2	C, D	1, 2,3, 4	1
12.	Concepts -Element and Global stiffness matrices -Co-ordinate transformations - Rotation matrix – Derivation of global stiffness matrix from element stiffness	2	C,D	2, 4	1
	UNIT IV: AUTOMOTIVE POWER SYSTEMS	**9**			
13.	Introduction – conventional 14V electric system architecture	1	C	1	1

14.	Advanced electrical loads, increasing the system voltage to 42V	2	C,D	1, 2, 3	1
15.	Advanced distribution systems, starter, alternator and integrated starter/alternator (ISA)	3	C,D	1, 2, 3, 4	1
16.	Machine in brief: induction, permanent magnet and axial flow, ISA coupling configurations	3	C,D	1, 2	1
	UNIT V: FUEL CELL BASED VEHICLES	**9**			
17.	Introduction – important properties of fuel cells for vehicles, light-duty vehicles and heavy-duty vehicles	1	C	1	1
18.	Various alternate fuels cell vehicles, fuel cell transit bus technology current status and future technologies	4	C	1, 2, 3	1
19.	Aerospace applications, other applications of fuel cells	4	C	1, 2	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	A. Emadi, M. Ehsani and John M. Miller, "*Vehicular Power Systems*", Marcel Dekker, New York, 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%**

15EE461E	Robust Control Systems			L	T	P	C
				3	0	0	3
Co-requisite:	Nil						
Prerequisite:	15EE211						
Data Book / Codes/Standards	Nil						
Course Category	P	PROFESSIONAL ELECTIVE	CIRCUIT AND SYSTEMS				
Course designed by	Department of Electrical and Electronics Engineering						
Approval	32nd Academic Council Meeting , 2016						

PURPOSE	To acquire knowledge on fundamental concepts, principles, analysis and design of Robust control systems.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Introduce norms, random spaces and robustness measures	a	c	e				
2.	Synthesize H_2 optimal control and understand estimation techniques	a	c	e	h			
3.	Analyze H infinity optimal control techniques	a	c	e	h			
4.	Design H infinity control using LMI approach	a	c	e	h			
5.	Explore on synthesis techniques for robust controllers and illustrate through case studies	a	c	e	h			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: NORMS OF THE SYSTEM AND PERFORMANCES	**9**			
1.	Norms of vectors and Matrices - Norms of Systems	2	C	1	1,2
2.	Calculation of operator Norms, vector random spaces	2	C	1	1,2
3.	Specification for feedback systems , Co-prime factorization and Inner functions	3	C	1	1,2
4.	Structured and unstructured uncertainty, robustness	2	C	1	1,2
	UNIT II: H2 OPTIMAL CONTROL	**9**			
5.	Linear Quadratic Controllers- Controller Design by Minimization of a Cost Functional	2	C	2	1,2
6.	Characterization of H2 optimal controllers- Problem Formulation and Characterization Theorem -State Feedback	2	C	2	1,2
7.	H2 optimal estimation -KaIman Bucy Filter as Special H2 State Estimator	2	C	2	1,2
8.	LQG Controller	3	C,D	2	
	UNIT III: H-INFINITY OPTIMAL CONTROL-RICCATI APPROACH	**9**			
9.	Formulation – Characterization of H-infinity sub-optimal controllers by means of Riccati equations	3	C	3	1,2
10.	H-infinity control with full information using Mixed Hankel-Toeplitz Operators	3	C,D	3	1,2
11.	H infinity estimation	3	C,D	3	
	UNIT IV: H-INFINITY OPTIMAL CONTROL- LMI APPROACH	**9**			
12.	Formulation – Characterization of H-infinity sub-optimal controllers by means of LMI approach	3	C,D	4	1,2
13.	Properties of H-infinity sub-optimal controllers- Connection between Riccati- and LMI-approaches	3	C	4	1,2
14.	H-infinity synthesis with pole placement constraints - LMI Regions	3	C,D	4	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT V: SYNTHESIS OF ROBUST CONTROLLERS AND CASE STUDIES	**9**			
15.	Synthesis of Robust Controllers	3	C,D	5	1-2
16.	Small Gain Theorem, D-K –iteration.	1	D	5	1-2
17.	Control of Inverted Pendulum, Robust Control of Second-order Plant	3	C,D	5	1-5
18.	µ Optimal Controller.	2	C,D	5	1-5
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	U. Mackenroth "*Robust Control Systems: Theory and Case Studies*", Springer International Edition, 2010.
2.	J. B. Burl, " *Linear optimal control H2 and H-infinity methods*", Addison W Wesley,1998
3.	D. Xue, Y.Q. Chen, D. P. Atherton, "*Linear Feedback Control Analysis and Design with Matlab ,advances In Design and Control*", Society for Industrial and Applied Mathematics, 2007.
	REFERENCE BOOKS/OTHER READING MATERIAL
4.	I. R. Petersen, V.A. Ugrinovskii and A. V. Savkin, "*Robust Control Design using H- infinity Methods*", Springer, 2000.
5.	M. J. Grimble, "*Robust Industrial Control Systems: Optimal Design Approach for Polynomial Systems*", John Wiley and Sons Ltd., Publication, 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%**

15EE462E	Switched Mode Power Conversion			L	T	P	C
				3	0	0	3
Co-requisite:	NIL						
Prerequisite:	15EE301J						
Data Book / Codes/Standards	NIL						
Course Category	E	PROFESSIONAL ELECTIVE	ELECTRONICS				
Course designed by	Department of Electrical and Electronics Engineering						
Approval	32nd Academic Council Meeting , 2016						

PURPOSE	To acquire knowledge on the modeling and performance of various configurations of power converters							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Apply the concept of ideal and real characteristics of switching devices and design the reactive circuit elements for switched mode converters	a						
2.	Understand the operation and steady state analysis of Switching power converters	a	e					
3.	Develop the knowledge on analysis, modeling and performance functions of switching power converters.	a	e					
4.	Understand the Closed-loop control of switching power converters	a	e	h	j			
5.	Familiarize with the applications of Switched mode power converters.	a	e	h	j			

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: DC-DC CONVERTERS	**8**			
1.	Power semiconductor switches - Diode, Controlled Switches	1	C	1	1,3
2.	Issues related to switches	1	C	1	3,4
3.	Reactive components - Design of Inductor, Transformer, Capacitor	2	C	1	3
4.	Energy storage – Capacitor, Inductor.	1	C	1	3
5.	Primitive Converter-Non-Isolated converter	2	C	1	3
6.	Isolated converters	1	C	1	3
	UNIT II : CCM AND DCM OPERATION OF CONVERTERS	**10**			
7.	Principles of Steady State Converter Analysis -Inductor Volt-Second Balance, Capacitor Charge Balance	2	C	2	1,2,3
8.	Design of various converter and determining the component using Small-Ripple Approximation	2	C,D	2	1,2,3
9.	Boundary conduction, DC transformer model	2	C	2	1,2,3
10.	Steady state analysis of DC-DC converter in Continuous Conduction Mode(CCM) and Discontinuous Conduction Mode(DCM)	2	C	2	1,2,3
11.	Problems - Non-Isolated DC-DC converters	2	C	2	1,2,3
	UNIT III:MODELING OF DC-DC CONVERTERS	**10**			
12.	Modeling of converters - State space representation	2	C,D	3	1,3
13.	State Space Model of Boost Converter	1	C,D	3	1,3
14.	Circuit Averaging Modeling Technique	2	CD	3	1,3
15.	PWM switch modeling	1	C,D	3	1,3
16.	Current Injected Equivalent Circuit Averaging(CIECA)	1	C,D	3	1,3
17.	Dynamic Model of Converters Operating in DCM	2	C	3	1,3
18.	Review of control theory, analysis of converter transfer functions	1	C	3	1,3
	UNIT IV: CONTROLLER DESIGN	**9**			
19.	DC-DC converter controller, Controller Structure	2	C,D	4	1,3
20.	Implementation of PID controller for Buck and Boost Converter	2	C,D	4	1,3
21.	Pulse Width Modulator	1	C,D	4	1,3
22.	Controller design principles	2	C	4	1,3
23.	Problem- Closed loop control of switched mode power converters	2	C,D	4	1,3
	UNIT V: APPLICATION OF DC-DC CONVERTERS	**8**			
24.	Application of DC-DC Converters in Power conditioning system	2	C	5	1,3
25.	Hybrid Electric Vehicle (HEV) Application	1	C	5	1,3
26.	Space application	1	C	5	1,3
27.	Renewable Energy System (RES)	1	C	5	1,3

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
28.	Bidirectional power converters	1	C,D	5	1,3
29.	Multi-input converter Using High/Low Voltage Sources, Flux Additive DC-DC Converter	2	C,D	5	1,3
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Erickson, Robert W., *Fundamentals of Power Electronics*, Springer International edition, 6th edition, 2012.
2.	Slobodan Cuk, *Power Electronics: Advanced Topics and Design*, TESLAco, 2015.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	V. Ramanarayanan, *Course Material on Switched Mode Power Conversion*, Department of Electrical Engineering, Indian Institute of Science, Bangalore 560012. http://minchu.ee.iisc.ernet.in/new/people/faculty/vr/book.pdf
4.	Slobodan Cuk, "*Advances in Switched-Mode Power Conversion Part I & II*" IEEE Transactions on Industrial Electronics, Vol: IE-30, 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%**

15EE463E	Embedded Systems	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	E PROFESSIONAL ELECTIVE	INTELLIGENT SYSTEMS			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting , 2016				

PURPOSE	To acquire the concepts of Embedded system and its application.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Understand the Embedded hardware.	a						
2.	Comprehend the need and concepts of Real –Time Operating systems.	a	c	h	j	k		
3.	Realize the purpose of Processor and Software Architecture.	a						
4.	Learn about the development tools and debugging techniques.	a	k					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: EMBEDDED HARDWARE	**10**			
1.	Review of Microprocessors and Microcontrollers, Embedded hardware, Embedded system overview.	1	C	1	3
2.	Design challenges, processor- IC and design technology.	3	C	1	3
3.	Custom single purpose processors: combinational logic, sequential logic.	2	C	1	3
4.	Custom single purpose processors and RT level custom single purpose processor design, optimizing custom single processor.	2	C	1	3
5.	Designing of GCD and Fibonacci series custom single purpose processors.	2	C,D,I	1	3
	UNIT II: PROCESSOR ARCHITECTURE	**8**			
6.	General purpose processor: software, standard single purpose processor.	3	C	3	1
7.	Peripheral interrupts: microprocessor architecture.	2	C	3	1
8.	Interrupt -Basic-shared data problem-interrupt latency.	3	I	3	2
9.	**UNIT III: SYSTEM DEVELOPMENT ENVIRONMENTS**	**9**			
10.	The execution environment-memory organization.	2	C	4	1
	System space-code space-data space-unpopulated memory space.	1	C	4	1
11.	I/O space system start up interrupts response cycle.	1	C	4	1
12.	Function calls and stack frames.	1	C	4	1
13.	Run time environment-object placement.	2	C	4	1
14.	Case study: stepper motor control and DC motor control.	2	C,I	4	1
	UNITIV:SOFTWARE ARCHITECTURE AND DEVELOPMENT TOOLS	**10**			
15.	Software architecture: round – robin-round-robin with interrupts.	3	C	3	2
16.	Function queue – scheduling architecture.	2	I	3	2
	Real time operating system architecture.	3	I	2	2
17.	Development tools: target machines.	1	I	4	2
18.	Linker/locators for embedded software debugging techniques.	1	C	4	2
19.	**UNIT V: REAL TIME OPERATING SYSTEMS**	**8**			
20.	Introduction: task and task status.	1	C	2	2
21.	Tasks and data semaphore and shared data.	2	D,I	2	2
22.	More operating system services message queues.	1	D, I	2	2
23.	Mail boxes and pipes-timer functions, Events-memory management.	1	I	2	2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
24.	Interrupt routines in an RTOS environment. EMBEDDED SYSTEM APPLICATION DEVELOPMENT: Case Study of Washing Machine- Automotive Application- Smart card System Application.	3	C,D,I	2	2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Arnold S. Berger, "*Embedded systems design: An Introduction to processor, tools and techniques*", CMP media, 2002.
2.	David E.Simon,"*An Embedded software primer*", Pearson Education, 12th Indian reprint, 2005.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	Frank Vahid and Tony Givargis: "*Embedded system design: a unified Hardware/software approach*", Pearson Education Asia, 1999.
4.	Raj Kamal, "*Embedded Systems- Architecture, Programming and Design*", Tata McGraw Hill, 2006.
5.	Tammy Noergaard, "*Embedded System Architecture, A comprehensive Guide for Engineers and Programmers*", Elsevier, 2006.
6.	C.M. Krishna, Kang, G.Shin, "*Real Time Systems*", McGraw Hill, 1997.
7.	"ARM education weblink" {https://www.arm.com/resources/education/education-kits}

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%**

CUSTOMIZED TO OTHER DEPARTMENT

15EE231	Electrical Machines			L	T	P	C
				3	0	0	3
Co-requisite:	NIL						
Prerequisite:	NIL						
Data Book / Codes / Standards	NIL						
Course Category	P	PROFESSIONAL CORE	ELECTRICAL MACHINES				
Course designed by	Dept of Electrical and Electronics Engineering						
Approval	32 nd Academic Council Meeting, 2016						

PURPOSE	To acquire knowledge about different types of electrical machines.							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Gain knowledge about the construction, working, characteristics and applications of DC generators & DC motors.	a	e					
2.	Understand the construction, working, characteristics and testing of single phase transformers.	a	e					
3.	Comprehend the construction, principle of operation, characteristics of three phase induction motor, single phase induction motor, special machines and their application.	a	e					
4.	Analyze the constructions and performance of synchronous machines.	a	e					

Session	Description of Topic	Contact hours	C-D-I-O	IOs	References
	UNIT I: DC MACHINES	**9**			
1	Constructional details of DC machine	1	C	1	1,2
2	Working principle of DC generator	1	C	1	1,2
3	Types of Generators	1	C	1	1,2
4	EMF equation, no load and load characteristics.	2	C	1	1,2
5	Principle of operation of DC motors, Back emf	1	C	1	1,2
6	Torque equation	1	C	1	1,2
7	Characteristics of shunt, series and compound motors	2	C	1	1,2
	UNIT II: TRANSFORMER	**9**			
8	Principle of operation, Constructional features of single phase transformers	1	C	2	1,2
9	EMF equation	1	C	2	1,2
10	Transformer on no load and on load-phasor diagram	1	C	2	1,2
11	Effects to resistance and leakage reactance of the windings	1	C	2	1,2
12	Equivalent circuit, Voltage regulation	1	C	2	1,2
13	Testing of transformer: Load test	1	C	2	1,2
14	Testing of transformer: Open circuit and short circuit test	2	C	2	1,2
15	Testing of transformer: Sumpner's test.	1	C	2	1,2
	UNIT III: THREE PHASE INDUCTION MOTOR	**9**			1,2
16	Production of rotating magnetic field	1	C	3	1,2
17	Construction and types of three phase induction motor.	1	C	3	1,2
18	Principle of operation, slip, Torque equations, Starting torque equation	1	C	3	1,2
19	Torque slip characteristics	1	C	3	1,2
20	Power stages	1	C	3	1,2
21	No load & blocked rotor tests, Equivalent circuit	2	C	3	1,2
22	Methods of speed control	1	C	3	1,2
23	Need for starters, Various types of starters	1	C	3	1,2
	UNIT IV: SINGLE PHASE INDUCTION MOTOR & SPECIAL MACHINES	**9**			
24	Double revolving field theory, Torque speed characteristics	1	C	3	1,2

Session	Description of Topic	Contact hours	C-D-I-O	IOs	References
25	Equivalent circuit, No load Blocked rotor test (Qualitative treatment only)	1	C	3	1,2
26	Starting methods of Single phase motors	1	C	3	1,2
27	Construction, principle of operation and applications of linear induction motor, universal motor, stepper motor	3	C	3	1,2
28	Construction, principle of operation and applications of reluctance motor, repulsion motor, AC series Motor	3	C	3	1,2
	UNIT V: SYNCHRONOUS MACHINES	**9**			
29	Constructional features and types of synchronous machines	1	C	4	1,2
30	emf equation, armature reaction, alternator on load	2	C	4	1,2
31	Voltage regulation (EMF method only)	2	C	4	1,2
32	Working principle of synchronous motors	1	C	4	1,2
33	Types of excitation, constant load variable excitation, constant excitation variable load, phasor diagram	2	C	4	1,2
34	Starting methods	1	C	4	1,2
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1	Nagarath.I.J. and Kothari.D.P., "*Electric Machines*", T.M.H. Publishing Co Ltd., New Delhi, 4th edition 2010.
2	Thereja .B.L '*A Text book of Electrical Technology*,' Volume- II, S.Chand & Co Ltd, 2008
3	Mulukutla S.Sarma and Mukesh K.Pathak , "*Electric Machines*", Cengage Learning., New Delhi, 2012
	REFERENCE BOOKS / OTHER READING MATERIAL
4	Fitzgerald Kingsley and Umans, "*Electric Machinery*" McGraw Hill Books co., 7th Edition, New Delhi, 2013.
5	R.K.Srivastava, "*Electric Machines*", Cengage Learning., New Delhi, 2nd edition, 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%**

15EE231L	Electrical Machines Laboratory	L	T	P	C
		0	0	3	2
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	Nil				
Course Category	P PROFESSIONAL CORE	ELECTRICAL MACHINES			
Course designed by	Dept. of Electrical and Electronics Engineering				
Approval	32 nd Academic Council Meeting , 2016				

PURPOSE	To develop skills in conducting experiments for different types of electrical machines							
INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	Understand the characteristics and performance of DC, induction and synchronous machines.	a	b	e				
2.	Gain knowledge about speed control techniques of DC motor and induction motor.	a	b	e				
3.	Understand the working of single phase transformer.	a	b	e				

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	OCC and Load characteristics of DC Generator	6	I,O	1	1
2.	Load test on DC motor	6	I,O	1	1
3.	Speed control of DC Shunt motor.	3	I,O	1	1
4.	Load test on single phase transformer	3	I,O	2	1
5.	OC & SC test on single phase transformer	3	I,O	2	1
6.	Sumpner's test.	3	C	2	1
7.	Load test on induction motor	6	I,O	1	1
8.	No load and blocked rotor test on 3-phase induction motor: To draw equivalent circuit	3	I,O	1	1
9.	Voltage regulation of alternators by EMF method	3	I,O	1	1
10.	Determination of 'V' and inverted 'V' curves	3	I,O	1	1
11.	Speed control of squirrel cage induction motor by variable frequency	3	I,O	1	1
12.	Rotor Rheostat speed control of slip ring induction motor	3	I,O	1	1
	Total contact hours	**45**			

LEARNING RESOURCES	
Sl. No.	**REFERENCES**
1.	Laboratory Manual
2.	Nagarath.I.J. and Kothari.D.P., "*Electric Machines*", T.M.H. Publishing Co Ltd., New Delhi, 4th edition 2010.
3.	Gupta., "*Theory and Performance of Electrical Machines",*. Kataria and Sons, 14th edition 2009.

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%**

15EE232	Electrical Engineering And Control Systems	L	T	P	C
		3	0	0	3
Co-requisite:	NIL				
Prerequisite:	NIL				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	ELECTRICAL MACHINES			
Course designed by	Department of Electrical and Electronics Engineering				
Approval	32nd Academic Council Meeting , 2016				

PURPOSE	To give students, a fair knowledge on the working of various electrical machines and to provide sound knowledge in the basic concepts of control theory.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, the student will be able to								
1.	To understand the concepts of circuits.	a						
2.	To acquire in depth knowledge of operation, construction and characteristics of DC machines, single phase induction motor and some special machines.	a	c					
3.	To provide adequate knowledge in the time response of systems and steady state error analysis.	a						
4.	To study the stability in frequency domain	a						

Session	Description of Topic	Contact hours	C-D-I-O	IOs	Reference
1.	**UNIT I: ELECTRIC CIRCUITS (DC Circuits)**	09			
2.	Dependent and independent sources	1	C	1	1
3.	Thevenin's theorem - Norton's theorem	2	C	1	1
4.	Superposition - Maximum power transfer	1	C	1	1
5.	Graph of a network - Trees	2	C	1	1
6.	Chords and branches	1	C	1	1
7.	Tie-set and cut-set of a graph	2	C	1	1
	UNIT II: DC MACHINES (Qualitative Treatment only)	09			
8.	Constructional details and operating principle of D.C. generators	2	C	2	3
9.	Emf equation	2	C	2	3
10.	DC Generator Characteristic	1	C	2	3
11.	Principle of operation of D.C. motors	2	C	2	3
12.	DC motor Characteristic - Starting.	2	C	2	3
	UNIT III: AC MACHINES (Qualitative Treatment only)	09			
13.	Single-phase induction motor - double field revolving theory	2	C	2	1,3
14.	Constructional details of three phase induction motor	2	C	2	1,3
15.	Principles of single phase transformers - EMF equation.	2	C	2	1,3
16.	Servomotors - Stepper motor	1	C	2	1,3
17.	Universal motor - Applications	2	C	2	1,3
	UNIT IV: MATHEMATICAL MODELS OF PHYSICAL SYSTEMS	09			
18.	Definition and classification of system - terminology and structure of feedback control theory	2	C	3	2,4
19.	Differential equation of physical systems - hydraulic and pneumatic systems Steady state errors - error constants	2	C	3	2,4
20.	Block diagram algebra - Signal flow graphs	2	C	3	2,4
21.	Time response of first and second order system	1	C	3	2,4
22.	Stability by Routh-Harwitz criterion -Simple problems.	2	C	3	2,4

	UNIT V: TRANSFER FUNCTION and STATE VARIABLE ANALYSIS	09			
23.	Time Response analysis of II order system - Frequency response	2	C	4	2,4
24.	Bode plots	2	C	4	2,4
25.	Stability in frequency domain using Nyquist stability criterion	2	C	4	2,4
26.	Concept of state variable - State models for linear and continuous time systems.	3	C	4	2,4
	Total hours	**45**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Deshpande M.V, "Electrical Machines", PHI Learning Private Limited, New Delhi, 2015.
2.	Nagrath I J and Gopal.M., "Control Systems Engineering", Anshan Pub, 2013.
REFERENCE BOOKS	
3.	Nagarath.I.J, and Kothari.D.P, "Electrical Machines", Tata McGraw Hill Publishing Company, New Delhi, 2nd edition, 2008.
4.	Katsuhiko Ogata, "Modern Control Engineering"-fifth edition, Prentice Hall of India Private Ltd, New Delhi, 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%

15EE234J	Fundamentals Of Circuits And Networks	L	T	P	C
		3	0	2	4
Co-requisite:	NIL				
Prerequisite:	15EE101				
Data Book / Codes/Standards	NIL				
Course Category	P PROFESSIONAL CORE	MEDICAL ELECTRONICS			
Course designed by	Department of Biomedical Engineering				
Approval	32nd Academic Council Meeting, 2016				

PURPOSE	The purpose of learning this course on Fundamentals of Circuits & Networks for biomedical Engineering student is to acquire knowledge about the basics of circuit analysis, network theorems and AC circuits which can be used for design and development of medical devices.

INSTRUCTIONAL OBJECTIVES		**STUDENT OUTCOMES**						
At the end of the course, student will be able to								
1.	Apply the mesh & nodal analysis in a given electrical circuit.	a						
2.	Differentiate the various network theorems.	a						
3.	Analyze the AC circuits and coupled circuits.	a						
4.	Find the total responses of RL, RC & RLC circuits.	a	b	c				
5.	Analyze the two port network parameters.	a	c					

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
	UNIT I: NODAL AND MESH ANALYSIS	**9**			
1.	Relationship of circuit analysis to engineering, Kirchhoff's current Law, Kirchhoff's voltage law	1	C,D	1	1,3
2.	Voltage and Current sources	1	C	1	3
3.	Nodal analysis & super nodal analysis	2	C	1	1,2
4.	Mesh analysis & super mesh analysis	2	C	1	1,2
5.	Mesh equation & nodal equation by inspection method	3	C	1	1
	UNIT II: CIRCUIT ANALYSIS TECHNIQUES	**9**			
6.	Star-delta transformation, source transformation technique	2	C	2	1,2
7.	Thevenin's theorem, Norton's theorem	2	C,I	2	1,2
8.	Superposition theorem	2	C,I	2	1,2
9.	Maximum power transfer theorem	1	C,I	2	1,2
10.	Reciprocity theorem, compensation theorem	2	C,I	2	1,2
	UNIT III: AC CIRCUITS AND COUPLED CIRCUITS	**9**			
11.	Power & Power factor	1	C	3	1
12.	Series resonance-Q-factor, bandwidth	2	C,D	3	1
13.	Parallel resonance-Q-factor, bandwidth	2	C,D	3	1
14.	Self-inductance, Mutual inductance	1	C	3	1,2
15.	Modeling of coupled circuits	1	C,D	3	2
16.	Dot convention in coupled coils	1	C	3	1,2
17.	Series & parallel connection of coupled coils	1	C	3	1,2
	UNIT IV: TRANSIENT ANALYSIS	**9**			
18.	Circuit analysis using Laplace transform technique	1	C	4	2
19.	Transient response of passive circuits (RC, RL and RLC) for DC excitations	3	C	4	2
20.	Transient response of passive circuits (RC & RL) for AC with sinusoidal excitations	2	C	4	2
21.	Transient response of RLC circuits for AC with sinusoidal excitations	2	C	4	2
22.	Practical perspective: artificial pacemaker	1	C	4	4
	UNIT V: TWO PORT NETWORKS	**9**			
23.	Network functions of one port and two port networks	1	C	5	1
24.	Poles and Zeros of network functions	1	C	5	1

Session	Description of Topic (Theory)	Contact hours	C-D-I-O	IOs	Reference
25.	Two port parameters: Z, Y, h (derivation & problems)	3	C,D	5	1,2
26.	Two port parameters: inverse h, ABCD (derivation & problems)	2	C,D	5	1,2
27.	Practical perspective: Characterizing an unknown circuit	2	C	5	4
	Total contact hours	**45**			

Sl. No.	Description of experiments	Contact hours	C-D-I-O	IOs	Reference
1.	Verification of KVL & KCL	2	I	1,2	5
2.	Verification of Thevenin's theorem	2	I	1,2	5
3.	Verification of Norton's theorem	2	I	1,2	5
4.	Verification of Superposition theorem	2	I	1,2	5
5.	Verification of Reciprocity theorem	2	I	1,2	5
6.	Verification of Compensation theorem	2	I	1,2	5
7.	Verification of Maximum power transfer theorem	2	I	1,2	5
8.	Verification of Millman's theorem	2	C,I	1,2	5
9.	Verification of KVL, KCL and all theorems using simulation approach	8	D,I	3	5
10.	Series resonant circuit using simulation approach	2	D,I	3	5
11.	Parallel resonant circuit using simulation approach	2	D,I	3	5
12.	Transients using simulation approach	2	I	4	5
	Total contact hours	**30**			

LEARNING RESOURCES	
Sl. No.	**TEXT BOOKS**
1.	Sudhakar.A and Shyammohan S P, "*Circuits and networks- analysis and synthesis"*, Tata McGraw Hill, 5th edition, 2015.
2.	Salivahanan S and Pravin Kumar S, "*Circuit theory*", Vikas Publishing House Pvt Limited, 1st edition, 2014.
	REFERENCE BOOKS/OTHER READING MATERIAL
3.	William H Hayt, Jr., Jack E Kemmerly& Steven M Durbin, "*Engineering circuit analysis"*, McGraw Hill, 8th edition, 2012.
4.	James W Nilsson and Susan A Riedel, "*Electric circuits*", Pearson Education, 10th edition, 2014.
5.	Fundamentals of circuits & networks 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%**