VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY

(Autonomous)

THINDAL, ERODE - 638 012

(Approved by AICTE, New Delhi, Affiliated to Anna University, Chennai)
(Accredited by NAAC with 'A+' grade)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
Accredited by NBA

AUTONOMOUS

CURRICULUM AND SYLLABUS

OF

B.E. – ELECTRICAL AND ELECTRONICS ENGINEERING

REGULATION 2018 (Ver-4)

Chairperson - BoS
Dept. of EEE - VCET

	VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY (Autonomous)
Department	Electrical and Electronics Engineering
Programme	BE- Electrical and Electronics Engineering
Regulations	2018 (Ver-4)

SUMMARY OF CREDITS

S. No	Course Category	Credits per Semester								Total Credits	Credits in %	Credits as per AICTE Model Curriculum
		1	2	3	4	5	6	7	8			
1	HS	3	3					3		09	5.52	12
2	BS	14	8	4	4					30	18.40	25
3	ES	06	8		4					18	11.04	24
4	PC			16	16	12	13	07		64	39.26	48
5	PE					06	06	06		18	11.04	18
6	OE					03	03	03		9	05.54	18
7	EC							03	12	15	09.20	15
8	MC	✓	✓	✓	✓	✓	✓	✓		-		-
9	VC	✓								-		-
10	OC, SC, AC	✓								-		-
Total Credits / Sem		23	19	20	24	21	22	22	12	163		160

HS - Humanities and Social Science
BS - Basic Science
ES - Engineering Science
PC - Professional Core
PE - Professional Elective
OE - Open Elective
EC - Employability Enhancement Course (Project, Seminar, Internship, etc.)
MC - Mandatory Course
VC - Value added course (If three or more credits earned, then one elective course may be exempted)
OC - Online Course (If six or more credits earned, then two elective courses may be exempted)
SC - Self Study course
AC - Audit Course

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	VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY (Autonomous)	CURRICULUM UG R - 2018, Ver-4
Department	Electrical and Electronics Engineering	
Programme	B.E - EEE	
Semester	1	

Sl.No	Category	Course Code	Course Title	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY										
1	HS	21 EN T 1 1	Communicative English - I	3	0	0	3	40	60	100
2	BS	21 MA T 1 1	Engineering Mathematics – I	3	1	0	4	40	60	100
3	BS	21 PH T 1 1	Engineering Physics	3	0	0	3	40	60	100
4	BS	21 CY T 1 1	Engineering Chemistry	3	0	0	3	40	60	100
5	ES	21 CS T 1 3	Python Programming	3	0	0	3	40	60	100
6	ES	21 ME C 1 1	Engineering Graphics	2	0	4	4	40	60	100
PRACTICALS										
7	BS	21 PH L 1 1	Physics and Chemistry Laboratory - I	0	0	3	1	60	40	100
8	ES	21 CS L 1 3	Python Programming Laboratory	0	0	3	1	60	40	100
9	ES	21 ME L 1 1	Workshop Practices Laboratory	0	0	3	1	100	0	100
			Total credits for Sem	**1**			**23**			

Semester	2

Sl.No	Category	Course Code	Course Title	Hours / Week			Credit	Max. Marks		
				L	T	P		CA	SE	Tot.
THEORY										
1	HS	21 EN T 2 1	Communicative English – II	3	0	0	3	40	60	100
2	BS	21 MA T 2 1	Engineering Mathematics – II	3	1	0	4	40	60	100
3	BS	21 PH T 2 3	Physics for Electrical Sciences	3	0	0	3	40	60	100
4	MC	21 MC T 0 2	Environmental Science and Engineering	2	0	0	0	100	0	100
5	ES	21 CE T 2 1	Basics of Civil and Mechanical Engineering	3	0	0	3	40	60	100
6	ES	21 EE T 2 2	Electric Circuit Theory	3	1	0	4	40	60	100
PRACTICALS										

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7	MC	21	MC	L	1	1	Universal Human Values	1	0	1	0	100	0	100
8	BS	21	PH	L	2	1	Physics and Chemistry Laboratory – II	0	0	3	1	60	40	100
9	ES	21	EE	L	2	1	Electric Circuits Laboratory	0	0	3	1	60	40	100
							Total credits for Sem	**2**			**19**			

Semester **3**

Sl.No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
							THEORY							
1	BS	21	MA	T	3	1	Transforms and Partial Differential Equations	3	1	0	4	40	60	100
2	PC	21	EE	T	3	1	Electromagnetic Theory	3	1	0	4	40	60	100
3	PC	21	EE	T	3	2	Electron Devices and Circuits	3	0	0	3	40	60	100
4	PC	21	EE	T	3	3	Electrical Machines - I	3	1	0	4	40	60	100
5	PC	21	EE	T	3	4	Measurements and Instrumentation	3	0	0	3	40	60	100
							PRACTICALS							
6	PC	21	EE	L	3	1	Electrical Machines Laboratory - I	0	0	3	1	60	40	100
7	PC	21	EE	L	3	2	Electron Devices and Circuits Laboratory	0	0	3	1	60	40	100
8	MC	21	MC	L	0	3	Essential English for Professionals	0	0	2	0	100	0	100
							Total credits for Sem	**3**			**20**			

Semester **4**

Sl.No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
							THEORY							
1	BS	21	MA	T	4	3	Numerical Methods	3	1	0	4	40	60	100
2	PC	21	EE	T	4	1	Digital Logic Circuits Design	3	1	0	4	40	60	100
3	PC	21	EC	T	4	2	Linear Integrated Circuits and Applications	3	0	0	3	40	60	100
4	PC	21	EE	T	4	3	Electrical Machines - II	3	1	0	4	40	60	100
5	PC	21	EE	T	4	4	Transmission and Distribution	3	0	0	3	40	60	100
6	ES	21	IT	T	4	3	Data Structures using Object Oriented Programming	3	0	0	3	40	60	100

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PRACTICALS														
7	PC	21	EE	L	4	1	Electrical Machines Laboratory - II	0	0	3	1	60	40	100
8	PC	21	EE	L	4	2	Linear and Digital Integrated Circuits Laboratory	0	0	3	1	60	40	100
9	ES	21	IT	L	4	2	Data Structures using Object Oriented Programming Laboratory	0	0	3	1	60	40	100
10	MC	21	MC	L	0	4	Professional Communication	0	0	2	0	100	0	100
							Total credits for Sem	**4**			**24**			

Semester	**5**

Sl.No	**Category**	**Course Code**					**Course Title**	**Hours / Week**			**Credit**	**Max. Marks**		
								L	**T**	**P**		**CA**	**SE**	**Tot.**
THEORY														
1	PC	21	EE	T	5	1	Power Electronics	3	0	0	3	40	60	100
2	PC	21	EE	T	5	2	Microprocessor and Microcontroller	3	0	0	3	40	60	100
3	PC	21	EE	T	5	3	Control Systems	3	1	0	4	40	60	100
4	PE						Professional Elective - 1	3	0	0	3	40	60	100
5	PE						Professional Elective - 2	3	0	0	3	40	60	100
6	OE						Open Elective -1	3	0	0	3	40	60	100
7	MC	21	MC	T	0	5	Aptitude and Logical Reasoning	2	0	0	0	100	0	100
PRACTICALS														
8	PC	21	EE	L	5	1	Microprocessor and Microcontroller Laboratory	0	0	3	1	60	40	100
9	PC	21	EE	L	5	2	Control Systems and Instrumentation Laboratory	0	0	3	1	60	40	100
10	MC	21	MC	L	0	8	Communication Skills Laboratory	0	0	2	0	100	0	100
							Total credits for Sem	**5**			**21**			

Semester	**6**

Sl.No	**Category**	**Course Code**					**Course Title**	**Hours / Week**			**Credit**	**Max. Marks**		
								L	**T**	**P**		**CA**	**SE**	**Tot.**
THEORY														
1	PC	21	EE	T	6	1	Solid State Drives	3	0	0	3	40	60	100
2	PC	21	EE	T	6	2	Power System Analysis	3	1	0	4	40	60	100

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3	PC	21	EE	T	6	3	Discrete Time Signal Processing	3	1	0	4	40	60	100
4	PE						Professional Elective - 3	3	0	0	3	40	60	100
5	PE						Professional Elective - 4	3	0	0	3	40	60	100
6	OE						Open Elective -2	3	0	0	3	40	60	100
7	MC	21	MC	T	0	6	Arithmetic and Analytical Ability	2	0	0	0	100	0	100
PRACTICALS														
8	PC	21	EE	L	6	1	Power Electronics and Drives Laboratory	0	0	3	1	60	40	100
9	PC	21	EE	L	6	2	Discrete Time Signal Processing Laboratory	0	0	3	1	60	40	100
							Total credits for Sem	**6**			**22**			

Semester	**7**

Sl.No	**Category**	**Course Code**					**Course Title**	**Hours / Week**			**Credit**	**Max. Marks**		
								L	**T**	**P**		**CA**	**SE**	**Tot.**
THEORY														
1	PC	21	EE	T	7	1	Protection and Switch Gear	3	0	0	3	40	60	100
2	PC	21	IT	T	7	1	Economics and Management for Engineers	3	0	0	3	40	60	100
3	PE						Professional Elective - 5	3	0	0	3	40	60	100
4	PE						Professional Elective - 6	3	0	0	3	40	60	100
5	OE						Open Elective -3	3	0	0	3	40	60	100
6	HS	21	MC	T	7	1	Universal Human Values and Professional Ethics.	2	0	1	3	100	0	100
7	MC	21	MC	T	0	7	Indian Constitution and Traditional Knowledge	2	0	0	0	100	0	100
PRACTICALS														
8	PC	21	EE	L	7	1	Power System Simulation and Renewable Energy Systems Laboratory	0	0	3	1	60	40	100
9	EC	21	EE	L	7	2	Mini Project	0	0	6	3	60	40	100
							Total credits for Sem	**7**			**22**			

Semester	**8**

Sl.No	**Category**	**Course Code**					**Course Title**	**Hours / Week**			**Credit**	**Max. Marks**		
								L	**T**	**P**		**CA**	**SE**	**Tot.**
PRACTICALS														

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1	EC	21	EE	L	8	1	Internship	-	-	-	2	100	0	100
2	EC	21	EE	L	8	2	Project Work	0	0	20	10	40	60	100
Total credits for Sem								**8**			**12**			
Total credits from I sem to 8 sem											**163**			

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PROFESSIONAL ELECTIVE COURSES: VERTICALS

Vertical 1 Power Engineering	Vertical 2 Converters and Drives	Vertical 3 Embedded System	Vertical 4 Instrumentation Engineering	Vertical 5 Electric Vehicle Technology	Vertical 6 Diversified Courses
Under Ground Cable Engineering	Design of Electrical Machines	Embedded Systems	Biomedical Instrumentation	Electric Vehicle Architecture	Energy Storage Systems
Power System Transients	Special Electrical Machines	Embedded C Programming	Principles of Robotics	Design of Motor and Power Converters for Electric Vehicle	Hybrid Energy Technology
Flexible AC Transmission Systems	Modern Power Converters	Embedded Processors	Sensors and Transducers	Electric Vehicle Design, Mechanics and control	Design and Modelling of Renewable Energy Systems
Power Quality	Artificial Intelligence in Electrical Drives	Embedded control for electric drives	PLC and Automation	Design of Electric Vehicle charging system	Electrical Energy Management and Auditing
Utilization and Conservation of Electrical Energy	Power Electronics for Renewable Energy Systems	Smart System Automation	Virtual Instrumentation	Testing of Electric Vehicle	Grid integrating Techniques and challenges
High Voltage Engineering	Power System Operation and Control	Embedded system for automotive applications	Advanced Control System	Grid Integration of Electric Vehicle	Power Plant Instrumentation and Control
Smart Grid	Multilevel Power Converters	Soft Computing Techniques	Digital Image Processing	Intelligent control of Electric Vehicles	SMPS and UPS

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of coursesexplained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2022

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VERTICALS FOR MINOR DEGREE

(In addition to all the verticals of other programmes)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor Degree.For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticalsalso.

Vertical I Fintech and Block Chain	**Vertical II Entrepreneurship**	**Vertical III Public Administration**	**Vertical IV Business DataAnalytics**	**Vertical V Environmental and Sustainability**	**Vertical VIArtificial Intelligence**
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics for Management	Sustainable infrastructureDevelopment	Introduction to Data Science
Fundamentals of Investment	Team Building & Leadership Management for Business	Constitution of India	Data mining for Business Intelligence	Sustainable Agriculture and Environmental Management	Principles of Artificial Intelligence
Banking, Financial Services andInsurance	Creativity & Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable BioMaterials	Neural Networks
Introduction to Block chain and its applications	Principles of Marketing Management For Business	Administrative Theories	Digital Marketing and Social Network Analytics	Materials for EnergySustainability	Machine Learning Techniques
Fintech Personal Finance andPayments	Human Resource Management for Entrepreneurs	Indian Administrative System	Supply Chain Analytics	Green Technology	Expert Systems
Introduction toFintech	Financing New Business Ventures	Public Policy Administration	FinancialAnalytics	Environmental Quality Monitoring and Analysis	Cognitive Science
-	-	-	-	Integrated EnergyPlanning for Sustainable Development	Game Theory
-	-	-	-	Energy Efficiency forSustainable Development	-

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Sl.No	Category	Course Code					Course Title	Hours / Week			Credit	Max. Marks		
								L	T	P		CA	SE	Tot.
VERTICAL I: POWER ENGINEERING														
1	PE	21	EE	E	0	1	Under Ground Cable Engineering	3	0	0	3	40	60	100
2	PE	21	EE	E	0	2	Power System Transients	3	0	0	3	40	60	100
3	PE	21	EE	E	0	3	Flexible AC Transmission Systems	3	0	0	3	40	60	100
4	PE	21	EE	E	0	4	Power Quality	3	0	0	3	40	60	100
5	PE	21	EE	E	0	5	Utilization and Conservation of Electrical Engineering	3	0	0	3	40	60	100
6	PE	21	EE	E	0	6	High Voltage Engineering	3	0	0	3	40	60	100
7	PE	21	EE	E	0	7	Smart Grid	3	0	0	3	40	60	100
VERTICAL II: CONVERTERS AND DRIVES														
1	PE	21	EE	E	0	8	Design of Electrical Machines	3	0	0	3	40	60	100
2	PE	21	EE	E	0	9	Special Electrical Machines	3	0	0	3	40	60	100
3	PE	21	EE	E	1	0	Modern Power Converters	3	0	0	3	40	60	100
4	PE	21	EE	E	1	1	Artificial Intelligence in Electrical Drives	3	0	0	3	40	60	100
5	PE	21	EE	E	1	2	Power Electronics for Renewable Energy Systems	3	0	0	3	40	60	100
6	PE	21	EE	E	1	3	Power System Operation and Control	3	0	0	3	40	60	100
7	PE	21	EE	E	1	4	Multilevel Power Converters	3	0	0	3	40	60	100
VERTICAL III: EMBEDDED SYSTEM														
1	PE	21	EE	E	1	5	Embedded Systems	3	0	0	3	40	60	100
2	PE	21	EE	E	1	6	Embedded C Programming	3	0	0	3	40	60	100
3	PE	21	EE	E	1	7	Embedded Processors	3	0	0	3	40	60	100
4	PE	21	EE	E	1	8	Embedded control for electric drives	3	0	0	3	40	60	100
5	PE	21	EE	E	1	9	Smart System Automation	3	0	0	3	40	60	100
6	PE	21	EE	E	2	0	Embedded system for automotive applications	3	0	0	3	40	60	100
7	PE	21	EE	E	2	1	Soft Computing Techniques	3	0	0	3	40	60	100
VERTICAL IV: INSTRUMENTATION ENGINEERING														

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1	PE	21	EE	E	2	2	Biomedical Instrumentation	3	0	0	3	40	60	100
2	PE	21	EE	E	2	3	Principles of Robotics	3	0	0	3	40	60	100
3	PE	21	EE	E	2	4	Sensors and Transducers	3	0	0	3	40	60	100
4	PE	21	EE	E	2	5	PLC and Automation	3	0	0	3	40	60	100
5	PE	21	EE	E	2	6	Virtual Instrumentation	3	0	0	3	40	60	100
6	PE	21	EE	E	2	7	Advanced Control System	3	0	0	3	40	60	100
7	PE	21	EE	E	2	8	Digital Image Processing	3	0	0	3	40	60	100
ERTICAL V: ELECTRIC VEHICLE TECHNOLOGY														
1	PE	21	EE	E	2	9	Electric Vehicle Architecture	3	0	0	3	40	60	100
2	PE	21	EE	E	3	0	Design of Motor and Power Converters for Electric Vehicle	3	0	0	3	40	60	100
3	PE	21	EE	E	3	1	Electric Vehicle Design, Mechanics and control	3	0	0	3	40	60	100
4	PE	21	EE	E	3	2	Design of Electric Vehicle charging system	3	0	0	3	40	60	100
5	PE	21	EE	E	3	3	Testing of Electric Vehicle	3	0	0	3	40	60	100
6	PE	21	EE	E	3	4	Grid Integration of Electric Vehicle	3	0	0	3	40	60	100
7	PE	21	EE	E	3	5	Intelligent control of Electric Vehicles	3	0	0	3	40	60	100
VERTICAL VI: DIVERSIFIED COURSES														
1	PE	21	EE	E	3	6	Energy Storage Systems	3	0	0	3	40	60	100
2	PE	21	EE	E	3	7	Hybrid Energy Technology	3	0	0	3	40	60	100
3	PE	21	EE	E	3	8	Design and Modelling of Renewable Energy Systems	3	0	0	3	40	60	100
4	PE	21	EE	E	3	9	Electrical Energy Management and Auditing	3	0	0	3	40	60	100
5	PE	21	EE	E	4	0	Grid integrating Techniques and Challenges	3	0	0	3	40	60	100
6	PE	21	EE	E	4	1	Power Plant Instrumentation and Control	3	0	0	3	40	60	100
7	PE	21	EE	E	4	2	SMPS and UPS	3	0	0	3	40	60	100

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VERTICALS FOR MINOR DEGREE										
S. No	Course Code	Course Title	Category	Periods / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
VERTICAL 1: Fintech and Block Chain										
1	21ITM11	Financial Management	PE	3	0	0	3	40	60	100
2	21ITM12	Fundamentals of Investment	PE	3	0	0	3	40	60	100
3	21ITM13	Banking, Financial Services and Insurance	PE	3	0	0	3	40	60	100
4	21ITM14	Introduction to Block chain and its Applications	PE	3	0	0	3	40	60	100
5	21ITM15	Fintech Personal Finance and Payments	PE	3	0	0	3	40	60	100
6	21ITM16	Introduction to Fintech	PE	3	0	0	3	40	60	100
VERTICAL 2: Entrepreneurship										
1	21MEM21	Foundations of Entrepreneurship	PE	3	0	0	3	40	60	100
2	21MEM22	Team Building & Leadership Management for Business	PE	3	0	0	3	40	60	100
3	21MEM23	Creativity & Innovation in Entrepreneurship	PE	3	0	0	3	40	60	100
4	21MEM24	Principles of Marketing Management For Business	PE	3	0	0	3	40	60	100
5	21MEM25	Human Resource Management for Entrepreneurs	PE	3	0	0	3	40	60	100
6	21MEM26	Financing New Business Ventures	PE	3	0	0	3	40	60	100
VERTICAL 3: Public Administration										
1	21ECM31	Principles of Public Administration	PE	3	0	0	3	40	60	100
2	21ECM32	Constitution of India	PE	3	0	0	3	40	60	100
3	21ECM33	Public Personnel Administration	PE	3	0	0	3	40	60	100
4	21ECM34	Administrative Theories	PE	3	0	0	3	40	60	100
5	21ECM35	Indian Administrative System	PE	3	0	0	3	40	60	100
6	21ECM36	Public Policy Administration	PE	3	0	0	3	40	60	100
VERTICAL 4: Business Data Analytics										
1	21CSM41	Statistics for Management	PE	3	0	0	3	40	60	100
2	21CSM42	Data mining for Business Intelligence	PE	3	0	0	3	40	60	100
3	21CSM43	Human Resource Analytics	PE	3	0	0	3	40	60	100
4	21CSM44	Digital Marketing and Social Network Analytics	PE	3	0	0	3	40	60	100
5	21CSM45	Supply Chain Analytics	PE	3	0	0	3	40	60	100
6	21CSM46	Financial Analytics	PE	3	0	0	3	40	60	100
VERTICAL 5: Environmental and Sustainability										
1	21CEM51	Sustainable infrastructure Development	PE	3	0	0	3	40	60	100
2	21CEM52	Sustainable Agriculture and Environmental Management	PE	3	0	0	3	40	60	100
3	21CEM53	Sustainable Bio Materials	PE	3	0	0	3	40	60	100
4	21CEM54	Materials for Energy Sustainability	PE	3	0	0	3	40	60	100
5	21CEM55	Green Technology	PE	3	0	0	3	40	60	100

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6	21CEM56	Environmental Quality Monitoring and Analysis	PE	3	0	0	3	40	60	100
7	21CEM57	Integrated Energy Planning for Sustainable Development	PE	3	0	0	3	40	60	100
8	21CEM58	Energy Efficiency for Sustainable Development	PE	3	0	0	3	40	60	100
VERTICAL 6: Artificial Intelligence										
1	21CSM61	Introduction to Data Science	PE	3	0	0	3	40	60	100
2	21CSM62	Principles of Artificial Intelligence	PE	3	0	0	3	40	60	100
3	21CSM63	Data Warchousing and Data Mining	PE	3	0	0	3	40	60	100
4	21CSM64	Machine Learning Techniques	PE	3	0	0	3	40	60	100
5	21CSM65	Expert Systems	PE	3	0	0	3	40	60	100
6	21CSM66	Cognitive Science	PE	3	0	0	3	40	60	100
7	21CSM67	Gamification	PE	3	0	0	3	40	60	100

LIST OF OPEN ELECTIVES OFFERED BY THE DEPARTMENTS														
S. No	**Category**	**Course Code**					**Course Title**	**Hours / Week**			**Credit**	**Max. Marks**		
								L	**T**	**P**		**CA**	**SE**	**Tot**
OFFERED BY DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING														
1	OE	21	EE	O	0	1	PLC and SCADA	3	0	0	3	40	60	100
2	OE	21	EE	O	0	2	Renewable Energy Sources	3	0	0	3	40	60	100
3	OE	21	EE	O	0	3	Embedded Real Time System	3	0	0	3	40	60	100
4	OE	21	EE	O	0	4	Energy Auditing and Conservation	3	0	0	3	40	60	100
5	OE	21	EE	O	0	5	Electric Vehicles	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF BIO MEDICAL ENGINEERING														
1	OE	21	BM	O	0	1	Biotelemetry	3	0	0	3	40	60	100
2	OE	21	BM	O	0	2	Virtual Instrumentation	3	0	0	3	40	60	100
3	OE	21	BM	O	0	3	Biometric systems and their applications	3	0	0	3	40	60	100
4	OE	21	BM	O	0	4	Medical Robotics	3	0	0	3	40	60	100
5	OE	21	BM	O	0	5	Healthcare Management Systems	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF CIVIL ENGINEERING														
1	OE	21	CE	O	0	1	Civil and Infrastructure Engineering	3	0	0	3	40	60	100
2	OE	21	CE	O	0	2	Environmental Pollution and waste management	3	0	0	3	40	60	100
3	OE	21	CE	O	0	3	Disaster Management and Mitigation	3	0	0	3	40	60	100
4	OE	21	CE	O	0	4	Building Services	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING														
1	OE	21	CS	O	0	1	Cyber Security	3	0	0	3	40	60	100
2	OE	21	CS	O	0	2	Web Designing	3	0	0	3	40	60	100
3	OE	21	CS	O	0	3	Knowledge Management	3	0	0	3	40	60	100

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4	OE	21	CS	O	0	4	Green Computing	3	0	0	3	40	60	100
5	OE	21	CS	O	0	5	Principles of Artificial Intelligence	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING														
1	OE	21	EC	O	0	1	Automotive Electronics	3	0	0	3	40	60	100
2	OE	21	EC	O	0	2	SCILAB for Engineers	3	0	0	3	40	60	100
3	OE	21	EC	O	0	3	Satellite Applications	3	0	0	3	40	60	100
4	OE	21	EC	O	0	4	Consumer Electronics	3	0	0	3	40	60	100
5	OE	21	EC	O	0	5	Principles of Communication Engineering	3	0	0	3	40	60	100
6	OE	21	EC	O	0	6	Microcontroller based System Design	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF MECHANICAL ENGINEERING														
1	OE	21	ME	O	0	1	Industrial Instrumentation	3	0	0	3	40	60	100
2	OE	21	ME	O	0	2	Product Design and Development	3	0	0	3	40	60	100
3	OE	21	ME	O	0	3	Sustainable Manufacturing	3	0	0	3	40	60	100
4	OE	21	ME	O	0	4	Entrepreneurship Development	3	0	0	3	40	60	100
5	OE	21	ME	O	0	5	Fundamentals of Ergonomics	3	0	0	3	40	60	100
6	OE	21	ME	O	0	6	Principles of Management and Industrial Psychology	3	0	0	3	40	60	100
7	OE	21	ME	O	0	7	Safety Measures for Engineers	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF SCIENCE AND HUMANITIES														
1	OE	21	GE	O	0	1	National Cadet Corps Studies – I	3	0	0	3	40	60	100
2	OE	21	GE	O	0	2	National Cadet Corps Studies – II	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF INFORMATION TECHNOLOGY														
1	OE	21	IT	O	0	1	Basics of Java Programming	3	0	0	3	40	60	100
2	OE	21	IT	O	0	2	Ethical Hacking	3	0	0	3	40	60	100
3	OE	21	IT	O	0	3	E-Commerce and Applications	3	0	0	3	40	60	100
4	OE	21	IT	O	0	4	Basics of Android Application Development	3	0	0	3	40	60	100
5	OE	21	IT	O	0	5	Principles of Data Science	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF MEDICAL ELECTRONICS														
1	OE	21	MD	O	0	1	Introduction to Medical Electronics	3	0	0	3	40	60	100
2	OE	21	MD	O	0	2	Hospital Waste Management	3	0	0	3	40	60	100
3	OE	21	MD	O	0	3	Hospital Information System	3	0	0	3	40	60	100
4	OE	21	MD	O	0	4	IoT Applications in Healthcare	3	0	0	3	40	60	100

MANDATORY COURSES											
S. No	**Course Code**	**Course Title**	**Category**	**Periods / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
1	21MCL11	Universal Human Values	MC	1	0	1	0	100	0	100
2	21MCT02	Environmental Science and Engineering	MC	2	0	0	0	100	0	100

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3	21MCL03	Essential English for Professionals	MC	0	0	2	0	100	0	100
4	21MCL04	Professional Communication	MC	0	0	2	0	100	0	100
5	21MCT05	Aptitude and Logical Reasoning	MC	0	0	2	0	100	0	100
6	21MCL08	Communication Skills Laboratory	MC	2	0	0	0	100	0	100
7	21MCT06	Arithmetic and Analytical Ability	MC	2	0	0	0	100	0	100
8	21MCT07	Indian Constitution and Traditional Knowledge	MC	2	0	0	0	100	0	100

VALUE ADDED COURSES

S. No	Course Code	Course Title	Category	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
1	21ECV01	Hands on Training on Design of Controllers for Power Converters	VC	0	0	2	1	100	0	100
2	21VAC02	Automotive Embedded Hardware Development	VC	0	0	2	1	100	0	100
3	21VAC03	Automotive Embedded Software Development	VC	0	0	2	1	100	0	100
4	21VAC04	Design of Solar UPS for Home	VC	0	2	1	100	0	100	0
5	21VAC04	Design of Solar PV System for Industries	VC	0	2	1	100	0	100	0

L - Lecture Period
T - Tutorial Period
P - Practical Period

CA - Continuous Assessment
SE - Semester Examination
Tot - Total

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21ENT11	COMMUNICATIVE ENGLISH-I	L T P C 3 0 0 3

Preamble:
Communicative English is a life skill necessary for all students of Engineering and Technology. The course Communicative English-I aims at developing Communication Skills in English essential for the learner to handle English language for a variety of everyday purposes through acquisition of basic grammar and vocabulary along with necessary listening, speaking, reading and writing skills.

Course Outcomes: Upon completion of the course, students will be able to

1. Use a wide range of vocabulary in oral and written communication.
2. Use correct grammatical structures in speaking and writing.
3. Write clear and coherent informal Passages.
4. Follow different kinds of spoken excerpts and distinguish relevant from irrelevant information, grasp proper sentence pattern and vocabulary through reading
5. Give short informal presentations and participate in classroom discussions

UNIT 1 VOCABULARY 6

Synonyms and Antonyms- Single Word Substitutes - Use of Abbreviations and Acronyms-Homonyms and Homophones- Business Vocabulary - Commonly Confused Words- Collocation - British and American Vocabulary-Word formation

UNIT 2 GRAMMAR 9

Comparative Adjectives - Modals -Phrasal Verbs -Tenses – Connectives-Impersonal Passive Voice -Types of Questions -Mechanics of Writing (Editing) -Direct and Indirect Speech- Numerical Adjectives - Gerunds and Infinitives-Expressions of Purpose- Conditional Sentences- Same Word Used as Different Parts of Speech –Subject Verb Agreement

UNIT 3 INFORMAL WRITING 5

Letter Writing - Informal Letters - Dialogue Writing -Informal Dialogues – Essay Writing-Informal Essays Movie/ Book Reviews

UNIT 4 LANGUAGE ENHANCEMENT THROUGH LISTENING& READING 9

Listening Comprehension -Listening for General Ideas- Listening to You Tube Documentaries - Listening for Specific Information- Listening for Details-Listening for Vocabulary-BBC Learn English Videos -Reading Comprehension- Understanding General and Specific Information -Sign Post Words-Jumbled Sentences - Finding Topic Sentences and Supporting Arguments - Reading for Vocabulary-Reading News Papers

UNIT 5 LANGUAGE ENHANCEMENT THROUGH SPEAKING 16

Introduction to IPA-Syllable, Stress, Intonation, etc., -Conversation Starters- Describing Places, People, Things and Pictures -Self Introduction - Narrating Personal Experiences and Incidents-Informal Group Discussions

TOTAL:45PERIODS

TEXT BOOKS:

1. Sanjay Kumar and PushpaLata, "Communication Skills" 2nd Edition, Oxford University Press, New Delhi, 2017
2. Raman, Meenakshi and Sangeetha Sharma, "Technical Communication: English Skills for Engineers", 1st Edition, Oxford University Press, New Delhi. 2008.

REFERENCES:

1. Department of English, Anna University, "Mindscapes: English for Technologists and Engineers", 1st Edition, Orient Black Swan, Chennai. 2012
2. Dhanavel, S.P, "English and Communication Skills for Students of Science and Engineering", 1st Edition, Orient Black Swan, Chennai. 2011
3. Rizvi, Ashraf. M, "Effective Technical Communication", 2st Edition, Tata McGraw-Hill, New Delhi,2018.

e-RESOURCES:

1. http://www.usingenglish.com
2. https://www.khanacademy.org/humanities/grammar

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21MAT11	ENGINEERING MATHEMATICS I (Common to ALL B.E/B.TECH Programmes in First Semester)	L T P C 3 1 0 4

Preamble:
The course aims at achieving conceptual understanding of topics such as Matrix Algebra and Calculus. The syllabus is designed to provide the skills for modeling engineering problems and understand the role of single variable and multivariables in the discipline of engineering and computer science.

Course Outcomes: Upon completion of the course, students will be able to

1. Evaluate Eigenvalues, eigenvectors and diagonalization of symmetric matrices.
2. Use limit definition, understand differentiation and integration methods.
3. Compute curvature, centre of curvature, evolute and envelope of curves.
4. Express functions of two variables in Taylor's series and compute Jacobians, maximum and minimum values.
5. Apply multiple integrals to determine area in cartesian and polar coordinates and volume in cartesian coordinates.

UNIT 1 MATRICES **9+3**

Characteristic equation – Eigen values and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors – Statement and application of Cayley Hamilton Theorem – Orthogonal transformation of a symmetric matrix to diagonal form – Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT 2 CALCULUS **9+3**

Representation of functions – Mathematical Models – New Functions from Old Functions – Graphing Calculators and Computers – The Limit of a Function – Calculating Limits Using the Limit Laws – Continuity – Exponential Growth and Decay – Hyperbolic Functions – Areas and Distances – The Definite Integral – The Fundamental Theorem of Calculus – Improper Integrals.

UNIT 3 GEOMETRICAL APPLICATIONS OF DIFFERENTIAL CALCULUS **9+3**

Curvature – Radius, Centre and Circle of curvature in Cartesian and Parametric form - Evolute – Envelope of family of curves with one and two parameters – Evolute as the envelope of normals – Properties of Evolute and Envelope.

UNIT 4 FUNCTIONS OF SEVERAL VARIABLES **9+3**

Partial derivatives – Total derivative – Differentiation of implicit functions – Jacobian- Properties – Taylor's series expansion for functions of two variables – constrained Maxima and Minima – Lagrange's multipliers with single constraint.

UNIT 5 MULTIPLE INTEGRALS **9+3**

Double integrals in Cartesian and Polar coordinates- Change of order of Integration – Change of variables from Cartesian to Polar coordinates – Area as a double integral in Cartesian and Polar form – Volume as a triple integral in Cartesian co ordinates

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics" 43rd Edition, Khanna Publishers, New Delhi, 2014.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Edition, New Delhi, 2015. [Sections 1.1, 1.2, 1.3, 1.4, 2.2, 2.3, 2.5, 3.8, 3.11, 5.1, 5.2, 5.3 and 7.8].

REFERENCES:

1. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, 26th Reprint, New Delhi, 2016
2. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
3. N.P. Bali, Manish Goyal, "Engineering Mathematics", Lakshmi Publications (Pvt) Ltd,4th edition,2014

e-RESOURCES:

1. http://nptel.ac.in/courses/111105035/, "Advanced Engineering Mathematics", Prof. Pratima Panigrahi, Indian Institute of Technology, Kharagpur
2. http://nptel.ac.in/courses/122104017/, "Mathematics-I", Prof. S.K. Ray, Indian Institute of Technology, Kanpur

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21PHT11	ENGINEERING PHYSICS	L T P C
		3 0 0 3

Preamble:
Ultrasonics forms the basis of Sonar and in the field of medicine for both diagnostics and therapeutic applications. Mechanical properties of Engineering materials are explored for industrial applications such as construction of bridges and railway wagons. Particle and wave nature of quantum particles form the basis of quantum computers. The virtues of lasers are explored in applications such as holography, computers, space satellites and medicines.

Course Outcomes: Upon completion of the course, students will be able to:

1 Demonstrate the knowledge of wave optics in propagation of light waves in optical fibers in communications system.
2 Explain the production of Ultrasonics and its NDT techniques in scanning methods, medical applications.
3 Describe the Elastic property of solid materials and thermal conductivity of solids in industrial applications.
4 Explore the dual nature of light waves with quantum theory on Black body radiation and Schrodinger's wave equations.
5 Demonstrate the knowledge on Nd-YAG, CO_2, Semiconductor lasers in industrial applications of welding, heat treatment, cutting, medical treatment and holography.

UNIT 1 WAVES AND OPTICS **9**

Classification of waves-wave equation-(qualitative)-Typical and General wave equation-qualitative analysis of phase and group velocities of waves-Differential equation of simple harmonic motion-Forced oscillations –analysis and classification of damped oscillations through differential equations-coherent sources and incoherent sources.

Superposition principle of Waves- Illustrations-Principle and propagation of light in optical fibers-numerical aperture and acceptance angle-Types of optical fibers (material, refractive index, mode-Application of optical fibers.

UNIT 2 ULTRASONICS **9**

Introduction – Production techniques– Magnetostriction effect– Piezoelectric effect - Piezoelectric generator- detection of ultrasonic waves - properties – cavitations - velocity measurement – acoustic grating - Industrial applications – drilling, welding, soldering and cleaning – SONAR - nondestructive testing – pulse echo system, through transmission and reflection modes - A, B and C scan - medical applications - sonograms.

UNIT 3 MECHANICAL AND THERMAL PROPERTIES **9**

Elasticity – Stress-strain diagram and its uses – factors affecting elastic modulus and tensile strength. Torsional stress and deformations – twisting couple – torsion pendulum: theory and experiment – bending of beams. Bending moment – cantilever, Young's Modulus by Uniform and non-uniform bending: theory and experiment – I-shaped girders.

Modes of heat transfer -thermal conductivity- Specific heat-Newton's law of cooling - Forbe's and Lee's disc method: theory and experiment– thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters

UNIT 4 MODERN PHYSICS **9**

Wave- particle duality, de-Broglie matter waves, Davisson-Germer experiment, Heisenberg uncertainty principle and its applications, Black body radiation – Planck's theory (derivation) – deduction of Wien's displacement law and Rayleigh – Jeans' law from Planck's theory — Matter waves – concept of operator-Eigen value and Eigen function- Physical significance of wave function -Schrodinger's time independent wave equation — Particle in a one dimensional box ,qualitative explanation on wave equation and energy value in three dimensional box.

UNIT 5 LASER **9**

Introduction – principle of spontaneous emission and stimulated emission, population inversion, pumping. Einstein's coefficients - derivation. Types of lasers- Nd-YAG-CO_2, Semiconductor lasers (homojunction & heterojunction) – Industrial applications - lasers in welding, heat treatment, cutting- medical applications- holography-construction and reconstruction-Safety classes of laser.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Gaur R.K. and Gupta S.L., "Engineering Physics", 8th Edition, Dhanpat Rai publishers, 2009.
2. Mani Naidu S., "Engineering Physics", 2nd Edition, Pearson Publishing, 2011.

REFERENCES

1. Serway and Jewett, "Physics for Scientists and Engineers with Modern Physics", 9th Edition, Thomson Brooks Cole, 2013
2. Young H.D., Freedman R.A. and Ford A.L., "Sears and Zemansky's University Physics with Modern Physics", 13th Edition, Pearson India, 2013.
3. Tipler P.A. and Mosca G.P., "Physics for Scientists and Engineers with Modern Physics", 6th Edition, W.H. Freeman, 2007.

e-RESOURCES:

1. http://nptel.ac.in/courses/115101003, "Atomic and Molecular Physics" – Dr. T. Kundu, IIT Bombay.
2. https://www.khanacademy.org/science/physics/quantum-physics.

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21CYT11	ENGINEERING CHEMISTRY	L T P C
		3 0 0 3

Preamble:

The study of water technology enables engineers to acquire skills to make the simple design calculation of drinking water as well as industrial water treatment. Electrochemistry and corrosion explain the fundamentals, corrosion prevention, identification and implementation for solving electrochemical and corrosion problems. The study of energy storage devices exposes some of the most commonly used energy storage technologies. Instrumental methods and analysis describe basic concepts and promote to solve real analytical problems. Studies of Nano chemistry span many areas as assemblies' significant new structures like nanowire, nanotube and lab-in-chip devices.

Course Outcomes: Upon completion of the course, students will be able to:

1. Evaluate the process to purify hard water using ion-exchange, zeolite and reverse osmosis methods.
2. Compare and contrast corrosion control methods and analyze the performance of alkaline, lead acid and fuel cells.
3. Analyze the metal ion concentration for solid and liquid samples with the aid of flame photometry, colorimetry, UV and IR spectroscopy.
4. Categorize different types of polymers to select injection or compression fabrication method.
5. Analyze the synthesis of nanoparticles using top down and bottom-up process.

UNIT 1 WATER TECHNOLOGY 9

Hardness – types, estimation by EDTA method, Boiler troubles – scale, sludge, priming, foaming, caustic embrittlement and boiler corrosion, Internal conditioning - carbonate, phosphate and Calgon conditioning, External conditioning – zeolite and demineralisation process, Desalination – reverse osmosis method.

UNIT 2 ELECROCHEMISTRY AND CORROSION 9

Electrochemistry –cell terminology, EMF series. Corrosion – chemical (corrosion by O_2, H_2 and liquid-metal) and electrochemical corrosion (H_2 evolution and absorption of O_2), Corrosion control – sacrificial anode, Impressed current method and electroless plating. Application of electrochemistry-primary battery (alkaline battery), secondary battery (lead acid battery) and fuel cell (H_2-O_2 fuel cell)

UNIT 3 INSTRUMENTAL METHODS AND ANALYSIS 9

Basic principles – Beer-lamberts law, instrumentation with block diagram and applications of calorimetry (estimation of Fe^{2+}), UV-Visible spectroscopy, infrared spectroscopy and flame photometry (estimation of sodium).

UNIT 4 HIGH POLYMERS 9

Polymers – classification (based on molecular forces-thermoplastics and thermosetting plastics), polymerisation – types, mechanism (Free radical only), Compounding and fabrication – compression, injection, Composites-definition, types, polymer matrix composites-FRP only. Real time applications of thermoplastics (PVC, Teflon), thermosetting plastics (nylon, epoxy resin)

UNIT 5 NANOCHEMISTRY 9

Basics – distinction between molecules, nanoparticles and bulk materials, Nanoparticles – nano cluster, nano rod, nanotube (CNT) and nanowire, Synthesis – top-down process (laser ablation and electro-deposition), bottom-up process (thermolysis – hydrothermal, solvothermal), Nanoparticles –properties and applications.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. P.C Jain and Monika Jain, "Engineering Chemistry", 16th Edition, Dhanpat Rai publishing company (P) Ltd, New Delhi, 2015
2. N. Krishnamurthy, P. Vallinayagam and D. Madhavan, "Engineering Chemistry", 3rd edition. PHI Learning PVT., LTD, New Delhi, 2014.

REFERENCES:

1. S.S. Dara, "A Text book of Engineering Chemistry", 12th Edition, S. Chand & Company Ltd., New Delhi, 2010.
2. "Engineering chemistry", 2nd edition, Wiley India private Ltd. New Delhi, 2014.
3. V.R. Gowariker, N.V. Viswanathan and Jayadev Sreedhar, "Polymer Science" 2nd edition, New age International publishers, New Delhi, 2015.

e-RESOURCES:

1. http://nptel.ac.in/courses/113104061/, "Environmental Degradation of Materials" - Dr. Kallol Mondal, Department of Metallurgy and Material Science, IIT Kanpur
2. http://nptel.ac.in/courses/113105028/, "Science and Technology of Polymers"- Prof. B. Adhikari, Department of Metallurgical & Materials Engineering, IIT, Kharagpur

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21CST13	PYTHON PROGRAMMING Common to BE / B.Tech. BM, CS, EC, EE, IT & MDE	L T P C 3 0 0 3

Preamble:
Python is easy to use, powerful, and versatile, making it a great choice for beginners and experts alike. Python's readability makes it a great first programming language — it allows you to think like a programmer and not waste time understanding the mysterious syntax that other programming languages can require. The syntax in Python helps the programmers to do coding in fewer steps. Python is widely used in bigger organizations because of its multiple programming paradigms.

Course Outcomes: Upon completion of the course, students will be able to

1. Develop algorithms, flowcharts and write Python programs using decision control statements for solving given problems.
2. Apply list, set for solving a given problem using functions in python.
3. Develop modules and packages for solving problems using tuple and dictionary data structures in python.
4. Write python program using string handling features and object-oriented programming concepts
5. Identify the essential concepts involved in the design of a database and accessing, manipulating data in the file using SQL.

UNIT 1 COMPUTING & PYTHON PROGRAMMING **12**

Introduction to digital computer - Problem Solving Strategies: Problem Analysis – Algorithms – Flowcharts – Examples of algorithms and flowcharts- Introduction to Python: Python Overview – Comments – Python Identifiers –Reserved Keywords – Variables – Standard Data Types – Operators – Statement and Expressions –Control Statements – Iteration – While statements - Input from keyboard.

UNIT 2 FUNCTIONS, LIST AND SET **9**

Introduction – Built-in functions – Composition of functions – User defined functions – Parameters and Arguments – Function calls – The return statement – Recursive functions – The anonymous functions. Lists-creating lists, traversing a list, Deleting elements from list, cloning list, list operations, list methods. Sets-creating sets, set operations.

UNIT 3 TUPLES, DICTIONARY, MODULES AND PACKAGES **6**

Tuples- creating tuples, accessing values, tuple assignment, tuple as return values, operations on tuples, built-in tuple functions. Dictionary-creating, accessing, updating, Deleting elements from dictionary, operations and methods. Modules – Packages in Python – Standard library modules.

UNIT 4 STRINGS AND OOP Concepts **9**

Strings: String Operations – Compound Data type – len function –String Slices – Strings are immutable – String Traversal – Escape Characters – String formatting operator – String formatting functions. Classes and objects: Overview of OOP – Class definition – creating objects – objects as arguments – objects as return values- Built-in class attributes – inheritance – method overriding – data encapsulation – data hiding.

UNIT 5 FILES AND BASIC DATABASE OPERATIONS **9**

File: Types of files – opening, closing, reading and writing files. Purpose of database system - Data model - Creating DB-making table - Adding Data - Querying DB - Database in the real world - Using SQL in Databases - Sorting – Getting unique item - updating records - Deleting records.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. E. Balagurusamy, "Problem Solving and Python Programming", McGraw Hill Education, 2018
2. Katie Cunningham, "Teach yourself python", Pearson Education,2014

REFERENCES:

1. Reema Thareja, "Python Programming using Problem Solving Approach", Oxford University Press, 2017.
2. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist", 2nd edition, Updated for Python 3, Shroff O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
3. Guido van Rossum and Fred L. Drake Jr, "An Introduction to Python – Revised and updated for Python 3.2", Network theory Ltd., 2011.
4. John V Guttag, "Introduction to Computation and Programming Using Python", Revised and expanded Edition, MIT Press, 2013.
5. Robert Sedgewick, Kevin Wayne, Robert Dondero, "Introduction to Programming in Python: An Inter-disciplinary Approach", Pearson India Education Services Pvt. Ltd., 2016.

e-RESOURCES:

1. https://swayam.gov.in/course/4178-spoken-tutorial-python-english, "Introduction to Python", Prof. Prabhu Ramachandran, IIT Bombay.
2. https://onlinecourses.nptel.ac.in/noc18_cs21, "Programming, Data Structures and Algorithms Using Python", Prof. Madhavan Mukund, IIT-Bombay.

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21MEC11	ENGINEERING GRAPHICS	L T P C
		2 0 4 4

Preamble:
The knowledge of Engineering graphics is essential for the Engineering graduates in proposing new product designs through drawings and interpreting data from existing drawings. Engineering Design inculcates into an Engineer the creativity and knowledge on various aspects to be considered while designing and realizing the functional products and processes. This course deals with Engineering curves, orthographic and pictorial projections, sectional views and development of surfaces.

Course Outcomes: Upon completion of the course, students will be able to

1. Draw the various conic sections and Engineering curves.
2. Sketch the orthographic views from given pictorial views and projections of lines.
3. Draw the projections of planes and solids kept in various positions.
4. Sketch sectioned views of solids and development of surfaces.
5. Draw the isometric and perspective projections of simple solids.

UNIT 1 INTRODUCTION AND PLANE CURVES **12**

Importance of graphics in Engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lines, lettering and dimensioning-Basic geometrical constructions. (PRACTICE ONLY AND NOT FOR EXAMINATIONS).

Curves used in Engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – Construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

UNIT 2 PROJECTION OF POINTS, LINES AND FREE HAND SKETCHING **12**

Orthographic projection- principles-Principal Planes-First angle projection- Projection of points in four quadrants - End point projection of straight lines (only First angle projections) inclined to both the principal planes -Determination of true lengths and true inclinations by rotating line method. Visualization concepts- Free hand sketching – Conversion of Isometric view to orthographic views.

UNIT 3 PROJECTION OF PLANE SURFACES AND SOLIDS **12**

Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method. Projection of simple solids- Cube, prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane and parallel to the other by rotating object method.

UNIT 4 SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES **12**

Sectioning of above solids in simple vertical position when cut by a cutting plane which is inclined to one of the reference planes and perpendicular to the other – Obtaining true shape of section.

Development of lateral surfaces of simple and truncated solids in simple vertical position – Cube, prisms, pyramids, cylinder and cone.

UNIT 5 ISOMETRIC AND PERSPECTIVE PROJECTIONS **12**

Principles of isometric projection – Isometric scale –Isometric projections of simple solids - Prisms, pyramids, cylinder and cone- Combination of two solid objects in simple vertical position.

Perspective projection of simple solids-Cube, prisms, pyramids, cylinder and cone, by visual ray method when axis is either parallel or perpendicular to ground plane.

TOTAL: 60 PERIODS

TEXT BOOKS:

1 Venugopal K and Prabhu Raja V., "Engineering Graphics", New Age International (P) Ltd, 13th Edition, 2015.

2 Jeyapoovan T., "Engineering Graphics with AUTOCAD", Vikas Publishing House Pvt., Ltd., 7th Edition, 2015.

REFERENCES:

1 Bhatt N.D., Panchal, V.M. and Ingle P.R., "Engineering Drawing", Charotar Publishing House Pvt. Ltd., 53rd Edition, 2014.

2 Parthasarathy N.S. and Vela Murali, "Engineering Drawing", Oxford University Press, 1st Edition, Second Impression 2015.

3 Luzzader W. J. and Duff J.M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production", Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.

e-RESOURCES:

1. http://nptel.ac.in/courses/105104148, "Engineering Graphics" - Dr. Nihar Ranjan Patra, IIT Kanpur
2. http://cfd.annauniv.edu/webcontent.htm, "Engineering Graphics" - Dr. Velamurali

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21PHL11	PHYSICS AND CHEMISTRY LABORATORY -I	L T P C 0 0 3 1

Preamble:

In the present course related to the lab, understanding of physics concepts applied in optics, thermal and properties of matter has been developed. The necessary practical skills in the determination of water quality parameters and strength of acid have been explored.

Course Outcomes:

1. Experiment and determine the physical characteristics of given solid materials.
2. Experiment and determine the velocity of ultrasonic waves through water medium.
3. Experiment and determine the optical property of light sources.
4. Experiment and estimate hydroxyl, carbonate and bicarbonate alkalinity using HCl in water sample.
5. Experiment and determine the amount of total, temporary, permanent hardness of water using EDTA by complexometric titration.
6. Experiment and determine the amount of iron content present in the given sample using potentiometer, spectrophotometer and strength of acid using conductivity meter.

PHYSICS LABORATORY – I

(Any Five Experiments)

LIST OF EXPERIMENTS

1. a) Determination of Wavelength, and particle size using Laser
   b) Determination of acceptance angle in an optical fiber.
2. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer.
3. Determination of wavelength of mercury spectrum – spectrometer grating
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of Young's modulus by non-uniform bending method
6. Determination of Planck's constant by photocell method

CHEMISTRY LABORATORY – I

LIST OF EXPERIMENTS

1. Determination of alkalinity in water sample.
2. Determination of total, temporary and permanent hardness of water by EDTA method.
3. Determination of iron content of the water sample using spectrophotometer (1,10-phenanthroline/thiocyanate method).
4. Determination of iron content of the given solution using a potentiometer.
5. Determination of strength of acid using conductivity meter.

TOTAL: 30 PERIODS

- **Laboratory classes on alternate weeks for Physics and Chemistry.**

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21CSL13	PYTHON PROGRAMMING LABORATORY Common to BE / B.Tech. BM, CS, EC, EE, IT & MDE	L T P C 0 0 3 1

Preamble:
Python is a dynamic and powerful programming language that focuses on code readability. The Python language has diversified application in the software development companies such as in gaming, web frameworks and applications, language development, prototyping, graphic design applications, etc. This provides the language a higher plethora over other programming languages used in the industry.

Course Outcomes: Upon completion of the course, students will be able to

1. Create documents, presentation slides and perform data manipulations using Libre Office packages. Design flowcharts using Raptor.
2. Develop programs using expressions and Control statements in Python.
3. Apply suitable data structure in Python for a real-world problem.
4. Develop programs using functions, OOP concepts, modules and packages for a given problem.
5. Create and manipulate files and database connectivity using Python.

LIST OF EXPERIMENTS

1. Creating document, presentation slides and performing mathematical calculations using Libre Office packages.
2. Design flowchart using Raptor for the following problems:
   - Solving problems using algorithm and flowchart.
   - To find if a given year is a leap year or not. Any year which is divisible by 4 and not by 100 are leap years. Otherwise, any year which is divisible by 400 is also a leap year.
   - To find the sum of numbers divisible by 4. The flowchart must allow the user to accept a number and add it to the sum if it is divisible by 4. It should continue accepting numbers as long as the user wants to provide an input and should display the final sum.
3. Write a python program for solving the problems:
   - All decision control statements.
   - An organization has decided to provide salary hike to its employees based on their job level. Employees can be in job levels 3, 4 or 5. In case of invalid job level, consider hike percentage to be 0. Given the current salary and job level, write a python program to find and display the new salary for 10 employees in the organization. Hike percentage based on job levels are given below:

Job level	Hike Percentage
3	15
4	7
5	5

4. Write a python program to find the list of 'n' prime numbers using functions.
5. Write a python program to implement list, set, tuple and dictionary.
6. Write a python program by defining a user defined module **leap**. Import the module and find whether a given year is leap year or not.
7. Write a python program to perform the arithmetic operations using packages.
8. Write a python Program to implement string handling functions.
9. Write a python program to implement object-oriented concepts.
10. Write a python program to implement database connectivity.

SOFTWARES

- Python 3 interpreter / open-source IDE
- Raptor Tool
- Libre Office Packages

TOTAL: 45 PERIODS

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21MEL11	WORKSHOP PRACTICES LABORATORY	L T P C 0 0 3 1

Preamble:
Workshop practices give hands-on training practice to Engineering students. This course includes carpentry, plumbing, welding, sheet metal forming and welding exercises. Also, this course will inculcate in the students the habit of selecting right tools, planning the job and its execution.

Course Outcomes: Upon completion of the course, students will be able to

1. Fabricate various joints by carpentry and to prepare plumbing line assemblies.
2. Fabricate various joints through arc welding and gas welding processes.
3. Perform metal forming and basic machining operations.
4. Construct various types of domestic wiring and measure the various electrical parameters.
5. Develop and test circuits with active elements and verify truth table of logic gates.

GROUP A

CIVIL 9

PLUMBING WORKS:

- Study of plumbing tools, pipeline joints, its location, functions and safety aspects.

1. a. Distribution of water from sump to overhead tank and return to home tap with bye pass connection.
   b. Distribution of water in mixed pipes.

CARPENTRY USING POWER TOOLS ONLY:

- Study of the carpentry tools, joints and processes in roofs, doors, windows and furniture and safety precautions.

HANDS-ON-EXERCISE: 1. Tee, Lap joint 2. Dove tail joint

MECHANICAL 15

WELDING:

1. Arc welding - Lap joint
2. Arc welding - Tee joint

BASIC MACHINING:

3. Simple Turning and Facing
4. Drilling and Tapping

SHEET METAL WORK- FORMING & BENDING:

5. Model making - Tray / Funnel

STUDY EXPERIMENTS:

a) Study of centrifugal pump
b) Study of air conditioner

DEMONSTRATION:

- Gas welding practice

GROUP B

ELECTRICAL 12

1. Residential house wiring using switches, fuse, indicator and lamps.
2. Fluorescent lamp wiring.
3. Stair case wiring.
4. Reading of voltage, current, power, energy and other parameters with 1 phase digital energy meter.
5. Measurement of earth resistance.

ELECTRONICS 9

1. Identification and Study of Electronic components and equipment's – Resistors, capacitors, inductors, colour coding and measurement.
2. Measurement of AC signal parameters (peak-peak, RMS value, period, frequency) using CRO.
3. Verification of the truth tables of logic gates: AND, OR, XOR and NOT.
4. Construction of Half Wave and Full Wave Rectifiers and study their output waveforms.
5. Soldering practice – Using general purpose PCB.

TOTAL: 45 PERIODS

REFERENCES: Manual prepared by the faculty of Mechanical Engineering Department, VCET.
e-RESOURCES: http://vlabs.iitkgp.ernet.in/be/#

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21ENT21	COMMUNICATIVE ENGLISH-II	L T P C 3 0 0 3

Preamble:

Communicative English is a life skill necessary for all students of Engineering and Technology. The course Communicative English-II aims at developing Communication Skills in English essential for expressing the ideas through speaking and writing in different social, academic and professional contexts.

Course Outcomes: Upon completion of the course, students will be able to:

1. Start, maintain and close a conversation in a variety of contexts including formal/informal and telephonic conversation.
2. Use structurally correct expressions and conversations.
3. Speak fluently using phrasal verbs and Idiomatic Expressions by recognizing and rectifying own pronunciation and intonation problems.
4. Speak fluently using a wide range of vocabulary.
5. Communicate effectively by using business correspondence structures.

UNIT 1 EFFECTIVE SPEAKING -BASIC LANGUAGE CHUNKS **10**

Conversational Starters – Closing a Conversation - Greeting and Leave Taking - Introducing Oneself - Introducing Others - Making Request - Offering Help - Expressing Gratitude -Extending Invitation - – Conveying Wishes – Encouraging Words -Seeking Permission – Granting Permission-Making Complaints - Seeking Apology - Making Interruption - Expressing Possibility- Expressing Agreement and Disagreement - Expressing Hesitation -Asking for Directions and Giving Directions - Giving Instructions- Questions and Expressions with Time – Checking for Understanding -Showing Interest -Expressing Likes and Dislikes

UNIT 2 EFFECTIVE SPEAKING –ADVANCED LANGUAGE CHUNKS **10**

Expressing Personal Opinion - Expressing Feelings - Accepting Responsibility - Giving Clarifications - Tag Questions - Giving Comments – Giving Advice – Making Suggestions – Making Comparisons – Analyzing Problems- Exploring Options – Making Classifications and Elaborations - Speaking Hypothetically-- Discussing Plans-Making Negotiations-Making Presentations-Telephone Etiquette - Telephone Conversation

UNIT 3 EFFECTIVE SPEAKING - PHRASAL VERBS AND IDIOMATIC EXPRESSIONS **3**

Most useful Phrasal Verbs related to Self-Introduction-Idiomatic Expressions related to Person, Time and Action

UNIT 4 EFFECTIVE SPEAKING – VOCABULARY ENRICHMENT **10**

Talking about Abilities – Travel – Shopping – Climate -Commuting – Distance – Food – Occupation – Parties and Festivals – Daily Routine – Clothing – Hobbies – Favorites- Family – Buying and Selling- Schedules and Plans

NIT 5 BUSINESS WRITING **12**

Writing Instructions - Recommendations - Checklist - Tour Itinerary -Writing Slogans - E- mail Writing - Single Line Definitions - Process Description – SMS - Transcoding Graphics - Bar Chart, Flow Chart, Pie Chart and Tables - Business Letters - Calling for Quotations, Placing Orders, Letter of Complaint, Letter of Clarification - Agenda and Meeting Minutes - Cover Letter with Résumé - Report Writing - Accident Report, Industrial Visit Report, Survey Report and Feasibility Report- Summary Writing.

TOTAL: 45PERIODS

TEXT BOOKS:

1. Sanjay Kumar and PushpaLatha, "Communication Skills" 2nd Edition, Oxford University Press, New Delhi.2017.
2. J.K. Gangal, "A Practical Course in Spoken English" 1st Edition PH1 Learning Private Limited, Delhi,2014.

REFERENCES:

1. Dr K Elango, Dr. Veena Selvam, Dr. Sujatha Priyadarshini, "Resonance English for Engineers and Technologists". Cambridge University Press, 1st Edition, Foundation Books, New Delhi, 2013.
2. Dr. Mahendra Sarawat, "Speak English Fluently" Upkar Prakashan Publishers, 1st Edition, Agra,2010.
3. S. Sumant, Joyce Pereira, "Technical English", Vijay Nicole imprints Private Limited,1st Edition Chennai, 2017.

e-RESOURCES:

1. https://www.fluentu.com/Blog/english/english-small-talk/
2. http://www.britishcouncil.com

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21MAT21

~~18MAT21~~ **ENGINEERING MATHEMATICS – II** **L T P C**

(Common to ALL B.E/B.TECH programmes in Second Semester) **3 1 0 4**

Preamble:

Vector calculus is a form of mathematics that is focused on the integration of vector fields. An Engineer should know the Transformations of the Integrals, as Transformation of Line Integral to surface and then to volume integrals. Complex Integration approach is very useful to evaluate many improper integrals of a real variable. Laplace transform method is a powerful method for solving linear ODEs and corresponding initial value problems as well as systems of ODEs arising in Engineering. The knowledge of transformations is to create a new domain in which it is easier to handle the problem that is being investigated.

Course Outcomes: Upon completion of the course, students will be able to:

1. Compute gradient, directional derivative by vector differentiation and determine line integrals, surface integrals and volume integrals by vector integration.
2. Construct analytic functions and transforms the analytic functions from one domain to another using conformal mapping.
3. Classify the singularities, find Laurent's series for analytic functions and compute complex integrals using Cauchy's integral theorem and Cauchy's Residue theorem.
4. Solve linear higher order differential equations with constant and variable coefficients
5. Solve linear second order ordinary differential equations with constant coefficients using the properties of Laplace Transforms.

UNIT 1 VECTOR CALCULUS **9+3**

Vector Differentiation: Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector integration: Line, Surface and Volume Integrals -Green's theorem in a plane, Gauss Divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving squares, rectangles, cubes and rectangular parallelepipeds.

UNIT 2 ANALYTIC FUNCTIONS **9+3**

Functions of a complex variable – Analytic functions: Necessary conditions – Cauchy-Riemann equations and sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions by Milne's method – Conformal mapping: $w = z+k$, kz, $1/z$ and bilinear transformation.

UNIT 3 COMPLEX INTEGRATION **9+3**

Statement and applications of Cauchy's integral theorem and Cauchy's integral formula (excluding proof) – Taylor's and Laurent's series expansions – Singularities – Residues – Cauchy's residue theorem (excluding proof) – Application of residue theorem to evaluate real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis).

UNIT 4 ORDINARY DIFFERENTIAL EQUATIONS **9+3**

Linear higher order differential equations with constant coefficients – Method of variation of Parameters – Cauchy's and Legendre's linear differential equations – Simultaneous first order linear differential equations with constant coefficients.

UNIT 5 LAPLACE TRANSFORMS **9+3**

Laplace transform: Sufficient conditions – Transform of elementary functions – Basic Properties – Transforms of derivatives and integrals of functions — Transform of periodic functions

Inverse Laplace transform: Standard results – Statement of Convolution theorem and its applications – Initial and final value theorems – Solution of linear second order ODE with constant coefficients using Laplace transformation techniques.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics'', Khanna Publishers, 43rd Edition, New Delhi, 2014.
2. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, 26th Reprint, New Delhi, 2016

REFERENCES:

1. Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Veerarajan T., "Engineering Mathematics (I Year)", 3 rd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2012.
3. P.Kandasamy, K.Thilagavathy, K.Gunavathy, "Higher Engineering Mathematics", S. Chand & Company Limited, Chennai,2016.

e-RESOURCES:

1. http://nptel.ac.in/courses/122107036/ "Mathematics-II", Prof. Tanuja Srivastava, Department of Mathematics, Indian Institute of Technology, Roorkee.
2. http://nptel.ac.in/courses/122107037/ "Mathematics – III", Prof. Dr. P. N. Agrawal , Indian Institute of Technology, Roorkee

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PO-CO mapping

PO PO4
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21PHT23	PHYSICS FOR ELECTRICAL SCIENCES	L T P C
		3 0 0 3

Preamble:

A Knowledge about the electronic structure of metals, semiconductors and dielectrics has manifested as a technology to design materials of desired properties. The properties of magnetic materials, superconductors and nonlinear optical materials have emerged as a technology, contributing the field of medicine, electronics and experimental sciences.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the behaviour of conducting materials based on classical and Quantum theory.
2. Demonstrate the knowledge of semiconductors with their carrier concentration and hall effect.
3. Describe the types of magnetic material and applications of superconducting materials.
4. Discuss the types of polarization, behaviour of dielectrics in an alternating field and the applications of dielectric materials, and classification of ferroelectric materials
5. Exposure to advanced materials and sensors and their applications.

UNIT 1 CONDUCTING MATERIALS 9

Conductors – Classical free electron theory of metals – Electrical and thermal conductivity -Wiedemann – Franz law – Lorentz number – Draw backs of classical theory – Quantum theory –Fermi distribution function – Effect of temperature on Fermi function – Density of energy states –Carrier concentration in metals.

UNIT 2 SEMICONDUCTING MATERIALS 9

Intrinsic semiconductor – Carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – Electrical conductivity – Band gap determination –Types of semiconductors- Derivation of carrier concentration in n-type and p-type semiconductor– Variation of Fermi level with temperature and impurity concentration — Hall effect – Determination of Hall coefficient – Applications.

UNIT 3 MAGNETIC AND SUPERCONDUCTING MATERIALS 9

Origin of magnetic moment – Bohr magneton – Comparison of dia, Para and Ferro magnetism –Domain theory – Hysteresis – Soft and hard magnetic materials – Antiferromagnetic materials.

Superconductivity Properties – Type I and type II superconductors –BCS theory of superconductivity(qualitative) – High Tc superconductors – Applications of superconductors – SQUID, cryotron, magnetic levitation.

UNIT 4 DIELECTRIC AND FERROELECTRIC MATERIALS 9

Macroscopic description of the static dielectric constant. The electronic and ionic polarizabilities of molecules – orientational polarization – Measurement of the dielectric constant of a solid. The internal field – Lorentz, Clausius-Mosotti relation. Behaviour of dielectrics in an alternating field, elementary ideas on dipole relaxation – Piezo, pyro and ferroelectric properties of crystals -classification of ferroelectric crystals – BaTiO3 and KDP.

UNIT 5 ADVANCED MATERIALS 9

Light waves in a homogeneous medium – refractive index – dispersion: refractive index-wave-length behaviour – group velocity and group index – complex refractive index and light absorption – Luminescence, phosphors and white LEDs – Polarization – optical anisotropy: uniaxial crystals, birefringence, dichroism (qualitative) – Electro-optic effect and amplitude modulators- electro-absorption-Classification of transducers-applications-Introduction-Biomaterials

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Palanisamy P.K, "Materials Science", 2nd Edition, SciTech publications (India) Pvt. Ltd., Chennai, 2007.
2. S.O. Pillai "Solid State Physics",6th Edition, New Age International(P) Ltd, Publishers New Delhi,2010.

REFERENCES:

1. Balasubramaniam R, "Callister's Materials Science and Engineering", 2nd Edition, Wiley-India 2014.
2. Donald. A. Neamen., "Semiconductor physics and devices: basic principles", 3rd Edition, Tata McGraw-Hill 2012.
3. Richard J. D. Tilley, "Understanding Solids",2nd Edition, John Wiley & Sons –India, 2013

e-RESOURCES:

1. http://nptel.ac.in/courses/122102008, "Materials Science" – Dr. S. K. Gupta, IIT Delhi
2. https://www.khanacademy.org/science/physics/magnetic-forces-and-magnetic-fields

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21MCT02	ENVIRONMENTAL SCIENCE AND ENGINEERING	L T P C
		2 0 0 0

Preamble:

The study of biodiversity reflects the extent of the interest of a nation in its natural resources and heritage, which is considered as a crucial portion of the national wealth. Since India is one of the twelve mega-diversity center of the earth, much emphasis should be put on understanding, preserving and utilizing the biodiversity of our biotic resources. Environmental protection is an important issue for society today as scientific research provides evidence of increasing global warming, ozone depletion and higher levels of pollution. Engineers should learn how to design, develop and evaluate structures, equipment and systems to provide practical solutions to problems caused by pollution, exploitation of natural resources and population explosion.

Course Outcomes: Upon completion of the course, students will be able to:

1. Compare and contrast structure and function of forest and marine ecosystem to conserve biodiversity
2. Analyze the sources, effects, control measures of air and water, solid waste management to maintain green environment.
3. Describe overexploitation of forest, overutilization of water and environmental impacts related to food resources to preserve environment.
4. Explain human health, environment and disaster management through information technology.
5. Discuss air and water act to solve environmental issues of climatic change.

UNIT 1 ECOSYSTEM AND BIODIVERSITY MANAGEMENT *6*

Importance of environmental studies-Ecosystem-Definition, Characteristics, structure and functions of Forest and Ocean ecosystem. Biodiversity-Definition, Significance, Values of biodiversity, Threats to biodiversity-Habitat loss and poaching, Biodiversity conservation-In-situ (Biosphere and National Park), Ex-situ (Gene bank and Seed bank)

UNIT 2 ENVIRONMENTAL POLLUTION *6*

Pollution- Definition causes and effects of Air and Water. Control strategies-Air pollution- (Catalytic converter, Cyclone separator). Water pollution-waste water treatment (Primary, Secondary and Tertiary Treatment). Solid waste-Source and generation of solid waste, Methods of disposal- Sanitary land fill, Incineration and composting.

UNIT 3 NATURAL RESOURCES *6*

Forest Resources: Functions of forest, deforestation-causes, consequences and steps to prevent deforestation.
Water Resources: over-exploitation of surface and ground water, benefits and problems of dams on forests and tribal people. Food Resources: Environmental impacts related to food resources –Effects of modern agriculture (fertilizer and pesticide problems), water logging and salinity.

UNIT 4 ROLE OF IT AND DISASTER MANAGEMENT *6*

Role of IT in environment-Remote Sensing and GIS application, Global positioning system, Environmental data base. Role of IT in human health – EHR, Medical Transcription, Endoscopy, Automated dispensing machine (ADM), Teleconference, Picture achieving and Communication System (PACS) method. Disaster management-Cause, effects and mitigation of Flood, Cyclone, Earthquake, Tsunami

UNIT 5 SOCIAL ISSUES AND ENVIRONMENTAL LEGISLATION *6*

Social Issues: Climate change- Global warming, Ozone layer depletion, Water conservation-Rain water harvesting (Roof top method). Legislation- Function of State and Central pollution control Board (Air and Water).

TOTAL: 30PERIODS

TEXT BOOKS:

1. Dr. Arun Luiz T, 'Environmental Science and Engineering', 1st edition (2017), VK publications.
2. P. Yugananth&Dr. R. Kumaravelan, 'Environmental Science and Engineering', 2nd edition, reprint (2017), SciTech Publication (India) Pvt. Ltd., Chennai.

REFERENCES:

1. Benny Joseph, 'Environmental Science and Engineering', 3rd reprint (2015), McGraw Hill Education (India) Pvt. Ltd., New Delhi.
2. Gilbert M. Masters, 'Introduction to 'Environmental Engineering and Science', 2nd edition (2004), Prentice Hall of India Pvt. Ltd.

e-RESOURCES:

1. https://nptel.ac.in/courses/105104099/4 "Types and forms of Air Pollutants" – Prof. Mukesh Sharma, Department of Civil Engineering, IIT Kanpur.
2. https://nptel.ac.in/courses/105104183/8 - "Introduction to natural hazards (Flood and Tsunami)- Prof. Javed Malik, Department of Civil Engineering, IT Kanpur.

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21CET21 BASICS OF CIVIL AND MECHANICAL ENGINEERING L T P C
3 0 0 3

Preamble:
This course will create awareness on fundamental knowledge on various building materials, building construction, hydraulic structures, energy engineering, moulding and metal joining process.

Course Outcomes: Upon completion of the course, students will be able to

1. **Identify** and explain the properties and uses of different building materials.
2. **Identify** and explain the functions and types of various components of a building.
3. **Classify** the various hydraulic structures.
4. **Understand** various types of power plants, internal combustion engines, prime movers and its working principles.
5. **Identify** and explain the manufacturing processes such as moulding, melting and casting.
6. **Describe** various welding process in joining metals.

PART A (BASIC CIVIL ENGINEERING)

Module 1 BUILDING MATERIALS, DAMS AND BRIDGES **12**

Building Materials - Stones, Bricks, Aggregates, Cement, Steel, Concrete – Classification, Properties and uses.

Dams – Purpose of Dam, Selection of site for Dam, Classification of Dams, Comparison of different types of dams.

Bridges – Components of a Bridge, Classification of Bridges, Important types of Bridges.

Module 2 BUILDING CONSTRUCTION **12**

Substructure – Types of Foundation, Functions of foundation and Essential requirements of a good Foundation.

Super Structure – Brick Masonry, Stone Masonry.

Floorings – types of flooring for residential, Industrial and office buildings.

PART B (BASIC MECHANICAL ENGINEERING)

Module 3 ENERGY ENGINEERING **12**

Working principle of Impulse and reaction turbine-Working principles of IC engine (CI and SI engine) - Working principle of Two stroke and four stroke in SI and CI engine - Power plant: Steam power Plant and Hydro-electric power Plant.

Module 4 MANUFACTURING PROCESS **12**

Moulding - Basic principles of moulding- melting of metal and casting crucible furnace and cupola.

Metal Joining Process- Basic principle of welding- manual metal arc welding-gas welding and gas cutting- brazing and soldering.

TOTAL: 48 PERIODS

TEXT BOOKS:

1. G. Shanmugam and M.S. Palanichamy, "Basics of Civil and Mechanical Engineering", Tata McGraw Hill Publishers, New Delhi, 2014
2. Shantha Kumar S.R.J., "Basic Mechanical Engineering", Anuradha Publishers, Kumbakonam
3. Venugopal K. and Prahu Raja V., "Basic Mechanical Engineering", 1st Edition, Anuradha Publishers, Kumbakonam, 2000.

REFERENCES:

1. Ramamrutham S., "Basic Civil Engineering", 3rd Edition, Dhanpat Rai Publishing Company, 2013.
2. Bhavikatti. S.S," Basics of civil Engineering", 1st Edition, New Age International Publishers, 2014
3. Kumar M.S., "Basic Civil and Mechanical Engineering",1st Edition, D.D. Publications, Chennai, 2010.

e-RESOURCES:

1. http://nptel.ac.in/courses/112107144/6
2. http://nptel.ac.in/courses/105102088/

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Chairperson - BoS
Dept. of CE - VCET

21EET22	ELECTRIC CIRCUIT THEORY	L T P C 3 1 0 4

Preamble:

The course covers the fundamentals of electrical circuits and the basics of three phase and resonance circuits. Analysis of a circuit consists of solving for the voltages and currents present in the circuit. The study and analysis of AC and DC circuits pays way to the better understanding of the fundamentals of electrical circuits.

COURSE OUTCOMES: Upon completion of the course, students will be able to:

1. Analyze electrical circuits using mesh and nodal analysis.
2. Apply network theorems to analyze electrical circuits.
3. Describe the phenomenon of resonance in RLC circuits.
4. Obtain the transient response of electrical circuits.
5. Analyze three phase electrical circuits.

UNIT 1 BASIC CIRCUIT ANALYSIS 12

Basics of D.C Circuits-Introduction to voltage and current sources - Resistors in series and parallel circuits – voltage and current division- source transformation – star delta conversion – Kirchhoff's laws - Mesh current and node voltage method of analysis for D.C circuits.

UNIT 2 NETWORK REDUCTION 12

A.C fundamentals - Mesh current and node voltage method of analysis for A.C circuits using Kirchhoff's laws- Network reduction - Thevenin, Norton, Superposition, Reciprocity and Maximum power transfer theorem.

UNIT 3 RESONANCE AND COUPLED CIRCUITS 12

Resonant circuits-series, parallel, series-parallel circuits - effect of variation of Q on resonance. Relations between - Q, resonant frequency and bandwidth. Self-inductance and mutual inductance – Dot rule - Coupled circuits –Tuned circuits - single tuned circuits.

UNIT 4 TRANSIENT RESPONSE OF DC AND AC CIRCUITS 12

Transient response of RL, RC and RLC Circuits using Laplace transformation for DC input and A.C. with sinusoidal input –problems related with transient response of RL, RC and RLC Circuits using Laplace transform method.

UNIT 5 THREE PHASE CIRCUITS 12

Three phase balanced / unbalanced circuits - phase sequence – analysis of three phase balanced & unbalanced star and delta connected loads– phasor diagram of voltages and currents – power and power factor measurements in three phase circuits – Two wattmeter method.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Sudhakar A and Shyam Mohan SP, "Circuits and Network Analysis and Synthesis", McGraw Hill Education, 5th Edition, New Delhi, 2015.
2. William H. Hayt, Jr. Jack E. Kemmerly and Steven M. Durbin, "Engineering Circuit Analysis", McGraw Hill Education, 8th Edition, New Delhi, 2013.

REFERENCES:

1. Joseph A. Edminister, Mahmood Nahvi, "Electric circuits", Schaum's series, McGraw-Hill Education, 5th Edition, New Delhi, 2010.
2. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", McGraw Hill Education, 5th Edition, New Delhi ,2013.
3. Robert L. Boylestad "Introductory circuit analysis", Pearson education, 12th Edition, New Delhi, 2010.

e-RESOURCES:

1. http://nptel.ac.in/courses/108102042/ "Review of signals and systems" Prof. S. C. Dutta Roy, IIT Delhi.
2. http://nptel.ac.in/courses/117106101/ "Basics of electrical circuits" Prof Nagendra Krishnapura, IIT Madras.
3. http://nptel.ac.in/courses/108102042/9 "Network theorems" Prof. S. C. Dutta Roy, IIT Delhi.

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21MCL11 **UNIVERSAL HUMAN VALUES** **L T P C**
1 0 1 0

Preamble:
Universal Human Values is a life skill necessary for all to develop physical health and factors for strengthening life force. This course aims to expose the students in the areas of mediation and impart the knowledge on social virtues and morals.

Course Outcomes: Upon completion of the course, students will be able to

1. Demonstrate the knowledge on physical health
2. Discuss the factors for strengthening life force
3. Classify mind waves and explain the benefits of meditation
4. Explain individual and social virtues
5. Identify and explain the importance of morals.

UNIT 1 Physical Health **6**

SKY – Introduction – Education as a means for youth empowerment – Greatness of Education – Yoga for Youth Empowerment – Simplified Physical Exercises: Explanation – Hand, Leg, Breathing and Eye exercises – Kapalabathi, Makarasanam, Massaging, Acupressure and Relaxation practices – Yogasanas-Explanation – Benefits.

UNIT 2 Strengthening Life Forces **6**

Reasons for Diseases: Natural Reasons (Hereditary, Planetary Position, Natural Calamities and Climatic changes) – Artificial Reasons (Food, Thought, Deed). Philosophy of Kayakalpa: Physical Body –Life Force – Biomagnetism – Mind. Maintaining Youthfulness – Postponing Aging – Transformation of Food into seven Body constituents.

UNIT 3 Wellness of Mind **6**

Classification of Mind Waves – Beta, Alpha, Theeta, Delta – Agna Meditation – Benefits. Shanthi Mediation – Benefits. Thuriya Meditation – Benefits. Blessing and its Benefits: Auto Suggestion – Blessing the family and others – Blessings the World – Divine Protection.

UNIT 4 Virtues **6**

Individual Virtues: Self-Control – Self Confidence – Speaking Truth – Contentment – Humility – Mind Control. Tolerance – Adjustment – Sacrifice – Forgiveness. Cleanliness (Body, Dress, Surrounding)-External, Mental, Inner Cleanliness. **Societal Virtues:** Ahimsa – Services, Patriotism – Equality, Respecting the parents and elders – Caring for them – Respecting Teachers. Punctuality – Time Management.

UNIT 5 Morals **6**

Importance of introspection: I and Mine (Ego, Possessiveness), Six Temperaments: Greed – Anger – Miserliness – Immoral Sexual Passion – Inferior Superior complex – Vengeance. Maneuvering the Six Temperaments: Contentment – Tolerance – Charity – Chastity – Parity – Forgiveness. Five important Benefits of Meditation: Perspicacity – Magnanimity – Adaptability – Receptivity – Creativity. (Enhancing memory) (Effective Examination Preparation)

TOTAL: 30 PERIODS

TEXT BOOKS:

1. "Yoga for Youth Empowerment" compiled by Vethathiri Maharishi Institute for Spiritual and Institutional Education, Aliyar, Pollachi, 1st Edition 2016.
2. "Yoga for Human Excellence", compiled by Vethathiri Maharishi Institute for Spiritual and Institutional Education, Aliyar, Pollachi 1st Edition 2009.

e-RESOURCES:

1. www.online.vethathiri.edu.in "online in (Virtual) Programme on Yoga and Human Excellence".

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21PHL21	PHYSICS AND CHEMISTRY LABORATORY II	L T P C 0 0 3 1

Preamble:
The understanding of characteristics of solids and liquids and properties of semiconducting materials has been explored. The practical skills in the instrumental methods for quantitative estimation of metal ions content has been the main focus.

Course Outcomes: Upon completion of the course, students will be able to

1. Experiment and determine the physical characteristics of given solid material.
2. Experiment and determine the Energy band gap of the given semiconducting materials.
3. Experiment and determine the physical characteristics of given liquid.
4. Experiment and estimate dissolved oxygen content using alkali iodide solution by Winkler's method, amount of copper content using EDTA by complexometric titration.
5. Experiment and test chloride content present in the waste water by titrating against silver nitrate using Mohr's method.
6. Experiment and determine the concentration of metals and ions present in the wastewater with the aid of flame photometer and pH meter.

PHYSICS LABORATORY II

(Any Five Experiments)

LIST OF EXPERIMENTS

1. Determination of Young's modulus by uniform bending method.
2. Determination of band gap of a semiconductor.
3. Determination of coefficient of viscosity of a liquid – Poiseuille's method.
4. Determination of thickness of a thin wire – Air wedge method.
5. Determination of rigidity modulus – Torsion pendulum.
6. Determination of Hysteresis of a ferromagnetic material –Deflection magnetometer

CHEMISTRY LABORATORY II

LIST OF EXPERIMENTS

1. Determination of Dissolved Oxygen content of waste water sample by Winkler's method.
2. Determination of chloride content of wastewater sample by Argentometric method.
3. Determination of acid strength in waste water using pH meter.
4. Estimation of dissolved metal ions present in wastewater using flame photometer.
5. Estimation of dissolved metal ions(copper) present in wastewater by EDTA method.

TOTAL: 30 PERIODS

- **Laboratory classes on alternate weeks for Physics and Chemistry.**

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21EEL21	ELECTRIC CIRCUITS LABORATORY	L T P C 0 0 3 1

Preamble:

The course helps the students to develop the experimental skills to analyze the electrical circuits. Here the network theorems are verified and the simulation of three phase circuits is done using simulation software.

COURSE OUTCOMES: Upon completion of the course, students will be able to

1. Experiment and verify the basic circuits using various theorems.
2. Experiment and determine the frequency response of RLC circuits.
3. Experiment and determine the transient response of RC and RL circuits.
4. Design and simulate the RLC circuits.
5. Experiment and determine the power of three phase circuits using two wattmeter method.

LIST OF EXPERIMENTS:

1. Verification of Kirchhoff's voltage law and Kirchhoff's current laws.
2. Verification of Thevenin's theorem.
3. Verification of Nortons's theorem.
4. Verification of Superposition theorem.
5. Verification of Maximum power transfer theorem.
6. Verification of Reciprocity theorem.
7. Experimental determination of transient response of series R-C and R-L electric circuits.
8. Experimental determination of frequency response of RLC circuits.
9. Design and Simulation of series and parallel resonance circuit using suitable simulation software.
10. Design and Simulation of low pass and high pass passive filters using suitable simulation software.
11. Simulation of three phase balanced and unbalanced star, delta networks using suitable simulation Software.
12. Experimental determination of power in three phase circuits by two-watt meter method.

TOTAL: 45 PERIODS

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21MAT31 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C
(Common to B.E/B.Tech BM, EC, EE, IT, CE, ME and MD Programmes in third semester) **3 1 0 4**

Preamble:
The phenomena of heat conduction, wave and signal propagation in media are described by Partial Differential equations (PDE) or Difference equations. For analyzing such phenomena, knowledge of mathematical techniques for solving PDE and Difference equations are needed for engineering students. This course aims to provide sufficient knowledge to engineering students in the specific mathematical techniques such as Fourier series, Fourier transform, Z-transform and PDE.

Course Outcomes: Upon completion of the course, students will be able to

1. Compute the trigonometric form of the Fourier series for periodic waveforms satisfying the Dirichlet's conditions and using them to evaluate infinite series.
2. Compute the solution for the standard forms of linear partial differential equations of first order and solve homogeneous partial differential equations of first and second order with constant coefficients.
3. Compute the analytical solution for the given physical model for the specified initial and boundary conditions in one dimensional and two-dimensional distributions.
4. Compute the Fourier transform of elementary non-periodic waveforms using Fourier Transform properties.
5. Solve the difference equations of first and second order using Z-transform techniques.

UNIT 1 FOURIER SERIES **9+3**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Parseval's identity – Harmonic Analysis.

UNIT 2 PARTIAL DIFFERENTIAL EQUATIONS **9+3**

Formation of partial differential equations – Singular Integrals – Solutions of standard types of first order partial differential equations: $F(p,q) = 0, F(z,p,q) = 0, F(x,p) = G(y,q)$ and $z = px + qy + F(p,q)$ – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients of homogeneous type.

UNIT 3 APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS **9+3**

One dimensional wave equation – Transverse vibrations of a string – One dimensional equation of heat conduction – Steady state temperature distribution in a rod – Two-dimensional steady state temperature distributions in a plate.

UNIT 4 FOURIER TRANSFORMS **9+3**

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Convolution theorem – Parseval's identity.

UNIT 5 Z TRANSFORMS AND DIFFERENCE EQUATIONS **9+3**

Z-transforms - Elementary properties – Inverse Z-transform (using Partial Fraction and Residues) –Convolution theorem - Formation of difference equations – Solution of difference equations using Z-transform.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Bali. N. P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, University Press India (P) Ltd, Hyderabad (2015).
2. Grewal, B.S, "Higher Engineering Mathematics", 43rd Edition, Khanna publishers, Delhi (2016)

REFERENCES:

1. Ramana. B.V., "Higher Engineering Mathematics", First edition, Tata McGraw Hill Publishing Company limited, New Delhi, 2016
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Tenth edition, Wiley Dream Tech India (P) Ltd. 2016
3. Babu Ram, "Engineering Mathematics", Second edition, Vol.2, Dorling Kindersley India (P) Ltd, Licenses of Pearson Education in South Asia, 2012

e-RESOURCES:

1. http://nptel.ac.in/courses/111105035/27, "Advanced Engineering Mathematics", Prof. Jitendra Kumar, Department of Mathematics, Indian Institute of Technology, Kharagpur
2. http://nptel.ac.in/courses/111106046, "Fourier Series", Prof. R. Radha, and Prof S. Thangavelu, Department of Mathematics, Indian Institute of Technology Madras, Chennai

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21EET31 **ELECTROMAGNETIC THEORY** **L T P C**
3 1 0 4

Preamble:

The purpose of this course is to provide students with an introduction to the basics of vector calculus, electrostatics, magneto statics, and electromagnetic waves. The bridge between electric circuits and electromagnetic is done through the study of transmission lines and their lumped-element model, transmission line input impedance, and power flow on lossless transmission line. This course also emphasizes the physical understanding and practical applications of electromagnetic in electronics.

Course Outcomes: Upon completion of the course, students will be able to

1. Solve the problems in vector fields using divergence and stokes' theorem in static electric and magnetic fields.
2. Apply Coulomb's and Gauss law to determine electric field intensity and electric flux density in free space, conductors, dielectrics and capacitance of coaxial cable and transmission lines.
3. Apply Biot savart's and Amperes law to determine magnetic field intensity and magnetic flux density in free space, conductors, circular loop, infinite sheet of current and Inductance of coaxial cable and transmission lines.
4. Determine statically induced emf in transformers and dynamically induced emf in motors, generators and alternators using Faradays law.
5. Analyze the propagation of wave in free space, conductors, lossy and lossless dielectrics using Maxwell Equation.

UNIT 1 VECTOR CALCULUS **12**

Co-ordinate Systems – Gradient, Divergence, and Curl Operations - Divergence theorem - Stokes 'theorem.

UNIT 2 ELECTROSTATIC FIELDS **12**

Coulomb's law – Electric field intensity - Electric flux density - Gauss's law and its Applications- Absolute potential – Potential difference - Potential Gradient -Determination of electric field and potential due to point , line, surface and volume charge distributions – Electric Dipole. Properties of conductors and dielectrics - convection and conduction currents - polarization in dielectrics- dielectric constant and strength - Capacitance: Capacitance of different dielectric media, coaxial cables and transmission lines- Boundary Conditions-Energy density in electrostatic field.

UNIT 3 MAGNETOSTATIC FIELDS **12**

Biot Savart's law - Ampere's circuital law and its applications – Magnetic flux density, Scalar and Vector magnetic potentials - Maxwell's equations for static EM fields-Forces due to magnetic fields - Force and Torque on a closed circuit - Magnetic Materials- Boundary conditions at the interface of two different magnetic materials. Inductance: Inductance of Solenoid, Toroid, Coaxial cable and Transmission line - Energy density in magnetic field.

UNIT 4 TIME VARYING FIELD **12**

Faraday 's Law - Transformer and Motional emfs - Displacement Current- Maxwell 's Equations in final form – relation between field theory and circuit theory.

UNIT 5 WAVE PROPAGATION **12**

Wave propagation in free space – Wave propagation in Dielectrics – Power and the Poynting Vector – Propagation in good conductors – Wave polarization.

TOTAL: (L:45+T:15): 60 PERIODS

TEXT BOOKS:

1. K.A. Gangadhar, P.M. Ramanathan, "Electromagnetic Field Theory", Khanna Publishers, 16th Edition, 2015.
2. Mathew N. O. Sadiku, "Principles of Electromagnetics", Oxford University Press Inc. 4th Edition, 2012.

REFERENCES:

1. Ashutosh Pramanik, "Electromagnetism – Theory and Applications", PHI Learning Private Limited, New Delhi, 2nd Edition, 2009.
2. Joseph. A. Edminister, "Schaum's Outline of Electromagnetics" Tata McGraw Hill, 3rd Edition, 2010.
3. William H. Hayt and John A. Buck, "Engineering Electromagnetics", Tata McGraw Hill 8th Revised edition, 2011.

e. RESOURCES:

1. http://nptel.ac.in/downloads/115101005/, "Electromagnetic Theory", Prof. D. K. Ghosh, IIT, Bombay.
2. http://nptel.ac.in/courses/108104087/, "Electromagnetic Theory", Prof. K. Pradeep Kumar, IIT, Kanpur.

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21EET32	ELECTRON DEVICES AND CIRCUITS	L T P C 3 0 0 3

Preamble:

To equip the students with basic components in electronics and to understand the principles of operation of fundamental electronic devices and circuits Students on completion of this course will have good knowledge about the basic devices, its operation, characteristics in detail

Course Outcomes: Upon completion of the course, students will be able to

1. Describe the behaviour of PN junction diode and Zener diode in forward and reverse characteristics and develop the Half-wave, Full-wave and Bridge rectifier circuit.
2. Enlighten the structure and operation of BJT, JFET, MOSFET and UJT analyze it's input and output characteristics.
3. Analysis the frequency response characteristics of Common emitter amplifier and calculate the voltage gain using BJT small signal model.
4. Discuss about common mode and differential mode operation of Differential amplifier and construct the cascade and cascode model of amplifier and analysis it's performance.
5. Discuss about the positive and negative feedback amplifiers and determine the frequency of oscillation using RC, Wein bridge, Hartley oscillators.

UNIT 1 DIODES 9

The formation of p-n junction diode – P & N type material, Fermi level, open circuited p-n junction, Operation of p-n junction diode – Voltage and current characteristics of p-n junction diode, current equation of p-n diode. Zener Diode- forward characteristics, Revere breakdown region, Zener as voltage regulator. Rectifier circuits, Clipping and clamping circuits. Case Study – Design of voltage regulator.

UNIT 2 TRANSISTORS 9

Device structure, configurations, physical operation, current & voltage characteristics - BJT, JFET, MOSFET and UJT; BJT as a switch. Case Study – Device control using Transistors.

UNIT 3 AMPLIFIERS 9

BJT Amplifier- Biasing, DC Analysis and frequency response of BJT Circuits; Small Signal models, transconductance, input resistances, voltage gain, hybrid-π model. Case Study - Humidity / Light sensing *circuit.*

UNIT 4 DIFFERENTIAL AND MULTISTAGE AMPLIFIER 9

Differential amplifier – CMRR, differential amplifier configurations, Common mode and Difference mode analysis; cascade and cascode amplifier, Power amplifier (Qualitative analysis). Case Study – Design of Audio amplifier.

UNIT 5 FEEDBACK AMPLIFIERS AND OSCILLATORS 9

Negative feedback – voltage / current, Series, Shunt feedback; positive feedback – voltage / current, Series, Shunt feedback – Oscillators: phase shift, Wien Bridge, Hartley. Case Study – Design a LED blinker circuit.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. David A. Bell, "Electronic Devices and Circuits", Prentice Hall of India, 5th Edition, 2008.
2. I. J. Nagrath, "Electronic Devices and Circuits", Prentice Hall of India, 1st Edition, 2007.

REFERENCES:

1. Floyd, "Electron Devices" Pearson Asia 5th Edition, 2001
2. Donald A Neamen, "Electronic Circuit Analysis and Design" Tata McGraw Hill, 3rd Edition, 2003.
3. Rashid, "Micro Electronic Circuits" Thomson publications, 1999

e. RESOURCES:

1. http://www.nptelvideos.in/2012/11/basic-electronics-prof-tsnatarajan.html, "Basic Electronics", Prof T. S. Natarajan, Department of physics, IIT Madras
2. http://www.nptelvideos.in/2012/12/basic-electronics-drchitralekha-mahanta.html,"Basic Electronics", Dr. Chitralekha Mahanta, Department of Electronics and Communication Engineering, IIT Guwahati

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21EET33	ELECTRICAL MACHINES - I	L T P C 3 1 0 4

Preamble:
To introduce the fundamental principles of Electro-mechanical energy conversion and MMF pattern of electrical machines and to impart knowledge on the operation and performance characteristics of DC machines and transformers.

COURSE OUTCOMES: Upon completion of the course, students will be able to

1. Derive the MMF, EMF and Torque equation from the magnetic circuits.
2. Analyze the characteristics of self and separately excited DC generators using load test.
3. Assess the need for parallel operation and analyze the load sharing between transformers.
4. Analyze the performance of transformer using open circuit, short circuit and sumpner's test
5. Analyze the performance of D.C machines using direct load test and Swinburne's test and Hopkinson's test

UNIT 1 MAGNETIC CIRCUITS AND CONCEPTS OF ROTATING MACHINES 12

Magnetic circuits – Laws governing magnetic circuits – Statically and Dynamically induced EMF – Principles of electromechanical energy conversion-Single and multiple excited systems-MMF of distributed A.C windings -Generated EMF-Torque in round rotor machine.

UNIT 2 DC GENERATORS 12

Construction features of DC Machine – Principle of operation – EMF equation – Methods of excitation: Self and separately excited generators - characteristics of DC generators- armature reaction – commutation-Parallel operation of DC shunt and compound generators – applications.

UNIT 3 DC MOTORS 12

Principle and operations – Back EMF and Torque Equation – Characteristics of series, shunt and compound Motors – starting and speed control of DC motors – Losses and efficiency-Brushless D.C Motor concepts-D.C Servo Motors-selection of D.C motors for various industrial application aspects.

UNIT 4 TRANSFORMERS 12

Single Phase Transformer: Principle of Operation – Construction – EMF Equation – Transformer on No Load and Load - Phasor Diagram – Equivalent Circuit – Voltage Regulation – Losses and Efficiency – All Day Efficiency – Auto transformer- Parallel Operation – Three Phase Transformers – Three-Winding Transformers – Phase Conversion – Tap Changing Transformers.

UNIT 5 TESTING OF DC MACHINES AND TRANSFORMERS 12

Testing of DC Machines: Brake Test-Retardation test – Swinburne's test and Hopkinson's test

Testing of Transformers: Polarity and Voltage Ratio Tests – Open Circuit and Short Circuit Test – Sumpner's Test – Separation of Losses

TOTAL (L:45 + T:15): 60 PERIODS

TEXT BOOKS:

1 Nagrath I.J and Kothari D.P., "Electrical Machines", Tata McGraw Hill Education Private Limited Publishing Company Ltd., 4th Edition, 2010.

2 Dr. P.S. Bhimbra, "Electrical Machinery", Khanna Publications, 7th Edition, 2014.

REFERENCES:

1 Murugesh Kumar. K," Electrical Machines Volume-I", Vikas Publishing House Pvt. Ltd, Nodia, First Edition,2010.

2 J.B. Gupta "Theory & Performance of Electrical Machines", S.K. Kataria & Sons, 2013.

3 Ashfaq Husain, "Electric Machines", Dhanpat Rai & Co., New Delhi, 2011

e-RESOURCES:

1 http://nptel.ac.in/courses/108105017/ - Electrical Machines -I by Dr. D. Kastha, IIT Kharagpur

2 http://www.nptelvideos.in/2012/11/electrical-machines-i.html - Electrical Machines-I by Prof. Deba prasad Kastha, Department of Electrical Engineering, IIT Kharagpur

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21EET34	MEASUREMENTS AND INSTRUMENTATION	L T P C 3 0 0 3

Preamble:

This course introduces the basic functional elements and characteristics of an instrument. It also showcases various methods of measurement techniques of an electrical and electronic instrument. It serves as a prerequisite for advanced subjects in the future semesters. This course enables the students to get wider knowledge about sensing and display devices for measurement.

Course Outcomes: Upon completion of the course, students will be able to

1. Identify and explain the characteristics of instruments and statistical evaluation of data for measurement.
2. Classify the electrical instruments based on the principle of operation.
3. Outline the methods of measurements using bridge circuits and also the grounding techniques used.
4. Infer the operation of storage and display devices for the measurement systems.
5. Identify and explain the selection and classification of transducers for the given applications.

UNIT 1 MEASUREMENT SYSTEMS AND ITS CHARACTERISTICS **9**

Elements of Generalized measurement system – Methods of measurement - Classification of instruments. Characteristics of instruments– Static and dynamic Characteristics – Errors in measurement – Statistical evaluation of measurement data: Mean, standard deviation, probability of error. Standards and Calibration of Instruments.

UNIT 2 ELECTRICAL MEASURING INSTRUMENTS **9**

Principle and types of analog voltmeters and ammeters - Permanent Magnet Moving Coil Instruments – Moving Iron Instruments - Electrodynamometer type instruments – Digital voltmeters and Multimeters– Single and three phase watt meters and energy meters –Instrument transformers – Frequency Meters – Phase meters.

UNIT 3 BRIDGE MEASUREMENTS AND GROUNDING TECHNIQUES **9**

Measurement of flux density –measurement of magnetizing force –Determination of B-H curve and Measurements of iron loss using Wattmeter method – Principle and types of DC & AC potentiometers – DC & AC bridges – Electrostatic and electromagnetic interference – shielding and grounding techniques.

UNIT 4 STORAGE AND DISPLAY DEVICES **9**

Magnetic disk –digital plotters and printers– cathode ray oscilloscope– digital CRO– LED– LCD– dot matrix display – Data Loggers.

UNIT 5 TRANSDUCERS **9**

Classification of transducers – Selection of transducers – Resistive, capacitive & inductive transducers– Piezoelectric, Hall effect, Optical and Digital transducers.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. A.K. Sawhney, "A Course in Electrical & Electronic Measurements & Instrumentation", Dhanpat Rai and Co, 2017.
2. J. B. Gupta, "A Course in Electronic and Electrical Measurements", S. K. Kataria & Sons, Delhi, 2013.

REFERENCES:

1. Doebelin E.O. and Manik D.N., Measurement Systems – Applications and Design, Special Indian Edition, Tata McGraw Hill Education Pvt. Ltd., 2007.
3. D.V.S. Murty, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2016.

e. RESOURCES:

1. https://www.nptel.ac.in/courses/108105064/2, "Dynamic characteristics", Prof. Alok Barua, IIT Kharagpur.
2. https://nptel.ac.in/courses/108106070/# "Maxwell bridge, Anderson bridge, Wien bridge and Schering bridge", Prof. V. Jagadeesh Kumar, IIT Madras.

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21EEL31	ELECTRICAL MACHINES LABORATORY - I	L T P C 0 0 3 1

Preamble:
To demonstrate the working operation and performance characteristics of DC machines and transformers.

Course Outcomes: Upon completion of the course, students will be able to

1. Experiment to determine the performance characteristics of DC separately excited and DC self-excited generator using load test.
2. Experiment to determine the performance characteristics of DC motors using direct load test.
3. Experiment to determine the performance characteristics of transformer using direct load test.
4. Experiment to determine the performance characteristics of DC shunt motor using Swinburne's test and Hopkinson's test.
5. Experiment to determine the performance characteristics and the equivalent circuit parameters of single-phase transformer using Sumpner's test, open circuit test and short circuit test.

LIST OF EXPERIMENTS

1. Open circuit and load characteristics of DC separately excited generator
2. Open circuit and load characteristics of DC shunt generator.
3. Load characteristics of DC compound generator with differential and cumulative connections.
4. Load test on DC series generator.
5. Load test on DC shunt and compound motor.
6. Load test on DC series motor.
7. Swinburne's test and speed control of DC shunt motor.
8. Hopkinson's test on DC motor-generator set.
9. Load test on single phase transformer and three phase transformer.
10. Open circuit and short circuit tests on single phase transformer.
11. Polarity Test and Sumpner's test on single phase transformer.

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21EEL32	ELECTRON DEVICES AND CIRCUITS LABORATORY	L T P C 0 0 3 1

Preamble:
The goal is to supplement the theory course Electron Devices and circuits to assist the students in obtaining a better understanding of the operation of electronic circuits.

Course Outcomes: Upon completion of the course, students will be able to

1. Experiment and determine the forward and reverse characteristics of PN, Zener, photo transistor and the input and output characteristics of NPN and FET.
2. Experiment and test the half-wave and full-wave rectifier circuit determine the efficiency.
3. Experiment and test the differential amplifier circuit and determine the voltage gain.
4. Experiment and test the RC phase shift and LC oscillators.
5. Experiment and test mono stable and astable multivibrator circuits.

LIST OF EXPERIMENTS

1 Characteristics of PN Junction diode.

2 Characteristics of Zener diode and Zener diode as a voltage regulator.

3 Half wave and Full wave Rectifier with capacitive filter.

4 Clipper and Clamper circuits.

5 Characteristics of photo transistor.

6 Characteristics of CB and CE configuration.

7 Characteristics of FET.

8 Characteristics of UJT.

9 Frequency response of CE amplifier.

10 Differential amplifiers using BJT.

11 Oscillators: RC phase shift, LC oscillators.

12 Astable and Monostable Multivibrator.

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21MCL03	ESSENTIAL ENGLISH FOR PROFESSIONALS (Common to All Branches in Third Semester)	L T P C 0 0 2 0

Preamble:

Communicative English is a life skill necessary for all students of Engineering and Technology. The course Essential English for Professionals aims at enabling the learners to communicate effectively and appropriately in professional contexts by exposing them to LSRW tasks.

COURSE OUTCOMES: After the completion of this course, students will be able to

1. Analyze the given listening material and answer the questions correctly employing listening techniques.
2. Analyze the given reading material and answer the questions correctly employing reading techniques.
3. Write within the stipulated time syntactically and semantically correct sentences to present ideas in the form of paragraphs and letters.
4. Give well-structured effective time sensitive presentations extemporaneously or after careful preparation.
5. Identify within the stipulated time syntactically and semantically correct sentences for a variety of language exercises.

UNIT 1 LISTENING **6**

Listening to Casual Conversation and TED Talks

UNIT 2 READING **8**

Poem – Robert Frost – Road not Taken
Essays - Bacon's Essays

UNIT 3 WRITING **6**

Letter Writing – Letters Seeking Permission and Letters Seeking Apology and Letters Requesting Certificates and Paragraph Writing

UNIT 4 PRESENTATION **7**

Watching Presentations - Presentation Techniques - JAM and Three Minute Presentation

UNIT 5 VERBAL ABILITY **3**

Verbal Analogy - Cloze Test- Idioms and Phrases- Sentence Completion – Concord – Common Errors

TOTAL: 30 PERIODS

REFERENCES:

1. Rizvi, Ashraf. M, "Effective Technical Communication", 2st Edition, Tata McGraw-Hill, New Delhi,2018.
2. Raman, Meenakshi and Sangeetha Sharma, "Technical Communication: English Skills for Engineers", 1st Edition, Oxford University Press, New Delhi. 2008.

e-RESOURCES:

1. https://agendaweb.org/listening/audio-books-mp3.html
2. https://www.ndtv.com/world-news
3. https://www.naukri.com/blog/self-introduction-for-interview/
4. http://learnenglishteens.britishcouncil.org/skills/reading
5. https://www.bbc.com/bitesize/guides/zphc9j6/revision/1

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Dept. of EEE - VCET

21MAT43	NUMERICAL METHODS (Common to B.E QE & EE Programmes in Fourth Semester)	L T P C
		3 1 0 4

Preamble:

The primary objective of the course is to develop the basic understanding of numerical techniques. Numerical analysis is concerned with finding numerical solutions to solve algebraic, transcendental, and differential equations, and to calculate derivatives and integral problems.

Course Outcomes: Upon completion of the course, students will be able to

1. Compute the real root of the algebraic and transcendental equations and solve the system of linear equations numerically.
2. Construct an Interpolation polynomial that approximates the given data table to determine the intermediate values.
3. Perform differentiation and integration for the functions using numerical techniques.
4. Compute the numerical solutions for the Initial value problems involving ordinary differential equations using single step and multi-step methods.
5. Compute the numerical solution for the Boundary value problems involving partial differential equations using implicit and explicit methods.

UNIT 1 SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS **9+3**

Solution of algebraic and transcendental equations -Newton Raphson method – Solution of linear system of equations- Gauss elimination –Pivoting- Gauss Jordon method - Iterative methods of Gauss Jacobi and Gauss-Seidel methods – Eigen value of a matrix by power method.

UNIT 2 INTERPOLATION AND APPROXIMATION **9+3**

Interpolation with unequal intervals-Lagrangian's interpolation – Newton's divided difference interpolation – Interpolation with equal intervals -Newton's forward and backward difference formulas.

UNIT 3 NUMERICAL DIFFERENTIATION AND INTEGRATION **9+3**

Approximation of derivatives using interpolation polynomials –Numerical integration using Trapezoidal and Simpson's 1/3 rules –Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

UNIT 4 INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS **9+3**

Single step methods: Euler's Methods-Modified Euler's method- Fourth order Runge – Kutta method for solving first order equations – Multistep methods- Milne's predictor and corrector methods for solving first order equations.

UNIT 5 BOUNDARY VALUE PROBLEMS IN PARTIAL DIFFERENTIAL EQUATIONS **9+3**

Finite difference techniques for the solution of One-Dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method-Two dimensional Laplace and Poisson equations on rectangular domain.

TOTAL: 60 PERIODS

TEXT BOOKS:

1. Grewal. B.S., and Grewal. J.S. "Numerical methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2014.
2. Gerald. C.F and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, 7th Edition, New Delhi, 2013.

REFERENCES:

1. Chapra. S.C., and Canale. R.P, "Numerical Methods for Engineers", 7th Edition, McGraw Hill Education India Private Limited,2016.
2. P. Kandasamy, K. Thilagavathy, K. Gunavathi, "Numerical methods", S. Chand and Company Pvt. Ltd, New Delhi,3rd Edition,2013.
3. Sankara Rao. K., "Numerical methods for Scientists and Engineers", Prentice Hall of India Private, 3rd Edition, New Delhi, 2011.

e-RESOURCES:

1. http://nptel.ac.in/courses/111105038/2, "Numerical Solution of Ordinary and Partial differential Equations", Prof. G. P. Raja Shekhar, Department of Mathematics, Indian Institute of Technology, Kharagpur
2. http://nptel.ac.in/courses/122102009/16, "Numerical Methods and Computation", Prof. S.R.K Iyengar, Department of Mathematics, Indian Institute of Technology, New Delhi.

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21EET41	DIGITAL LOGIC CIRCUITS DESIGN	L T P C 3 1 0 4

Preamble:

This course serves as a foreword to the principles of digital electronics engineering, starting from the basic concepts of description of analog signals in digital values using different logic families. Digital logic gates, combinational logic design using basic gates and sequential logic circuits design using flip-flops are introduced. Reduction techniques are considered and digital simulation is taught to realize the digital circuits.

Course Outcomes: Upon completion of the course, students will be able to

1. Determine the minimized expression for the given logic function using Karnaugh map, Quine–McCluskey methods and realize using NAND and NOR gates.
2. Design adders, subtractors, multiplexers, demultiplexers, encoder, decoder, code converters, and realize Boolean expression using multiplexers and demultiplexers.
3. Design the SISO, SIPO, PISO, PIPO shift registers using flipflops.
4. Design the synchronous modulo counter, UP/Down counters using state diagram, state table, state assignment, and state reduction and analyze the asynchronous sequential circuit using implication table, transition table, flow table, hazard free assignment.
5. Implement PLA and PAL using Boolean functions and develop the dataflow, structural and behavioral model of combinational and sequential circuits using VHDL.

UNIT 1 NUMBER SYSTEMS **12**

Number systems- types, conversions, arithmetic's; Binary codes – BCD, Excess three code, Gray Code; error detection and correction - Parity and Hamming code; Logic gates; Logic functions – minterms, maxterms, SOP and POS forms; Minimization techniques - Boolean laws, K-Map, Quine-McCluskey method; Introduction to Combinational and sequential logic circuits.

UNIT 2 COMBINATIONAL CIRCUITS **12**

Combinational logic - definition, examples; simplification and realization – adders, subtractors, multiplexer, demultiplexer, encoder, decoder, code converters. Realization of Boolean functions using multiplexer and demultiplexer.

UNIT 3 SEQUENTIAL LOGIC CIRCUITS **12**

Sequential logic- definition, examples, Types; Flip Flops - SR, JK, D and T, Truth table, Excitation table, conversion, triggering; Shift registers – SISO, SIPO, PISO, PIPO; Types of sequential logic circuits.

UNIT 4 SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS **12**

Synchronous logic - definition, examples; Counters - asynchronous and synchronous type – Modulo, UP/DOWN – State Diagram, State reduction, State assignment, realization. Asynchronous logic - definition, examples; State reduction using implication table, transition table, flow table, hazard free assignment, realization.

UNIT 5 PROGRAMMABLE LOGIC DEVICES AND VHDL: **12**

Programmable Logic Devices: PROM – PLA –PAL, Boolean functions realization, Introduction to CPLD and FPGA. VHDL: Need for HDL, operators, behavioral, data flow and structural description for combinational and sequential circuit functions (Qualitative approach only)

TOTAL (L:45 + T:15) = 60 PERIODS

TEXT BOOK:

1. Raj Kamal 'Digital Systems-Principles and Design' Pearson Education 2nd edition 2007.
2. M. Morris Mano 'Digital Design with an introduction to the VHDL' Pearson Education 2013.

REFERENCES:

1. Floyd and Jain, 'Digital Fundamentals', 8th edition, Pearson Education, 2003
2. S. Salivahanan & S Arivazhagan 'Digital Electronics', Vikas Publishing House Pvt Limited, Jan 1, 2010
3. Jayaram Bhasker 'A VHDL Primer', Prentice Hall PTR, 1999.

e-RESOURCES:

1. NPTEL Lectures @ http://nptel.ac.in/courses/117106086/1
2. IIT Delhi Lectures @ http://web.iitd.ac.in/~shouri/eel201/lectures.php

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21ECT42 LINEAR INTEGRATED CIRCUITS AND APPLICATIONS L T P C

3 0 0 3

Preamble:

Linear Integrated Circuits introduces the basic building blocks of the Integrated circuits along with fundamental concepts of electronic circuits like operational amplifiers, rectifiers & timers and acquire the knowledge in analysis and design IC based circuits. The linear IC is the operational amplifier or *op amp*, which consists of resistors, diodes, and transistors in a conventional analog circuit. Linear ICs are employed in audio amplifiers, A/D (analog-to-digital) converters, averaging amplifiers, differentiators, DC (direct-current) amplifiers, integrators, multivibrators, oscillators, audio filters, and sweep generators. Operational Amplifies performs Algebraic operations, Logarithmic Operations, Trigonometric Operations etc. Operational Amplifiers design goes into System design instead of circuit design. Linear IC applications play vital role in the electronic field starting from home appliances to Super computers.

Course Outcomes: Upon completion of the course, students will be able to:

1. Analyze the performance of operational amplifier with active load and evaluate the performance of op-amp by dominant pole and pole zero compensation techniques.
2. Design inverting, non-inverting, instrumentation amplifiers using operational amplifier and estimate the gain and obtain the output characteristics of clipper, clamper and peak detector using operational amplifier.
3. Design active filters using op-amp IC741 and examine the cutoff frequency and analyze the operation of AM detector, FM Detector, FSK modulator & demodulator using PLL.
4. Analyze the performance of weighted Resistor, R-2R ladder type DAC using operational amplifier and evaluate the performance of Flash type, Successive approximation and dual slope ADC with respect to techniques and conversion time.
5. Design astable multivibrator and monostable multivibrators using 555 Timer IC for the given specifications.

UNIT 1 OPERATIONAL AMPLIFIERS 9

Basic information of Operational Amplifier – Ideal Operational Amplifier – Operational Amplifier internal circuit: Differential Amplifier, Constant Current Source, Active Load – DC characteristics: input bias, offset current, input offset voltage – Compensation for input bias, offset current, input offset voltage – Thermal drift – AC characteristics: Frequency Response, Stability of an Operational Amplifier, Frequency Compensation, Slew rate - Internal diagram of IC 741.

UNIT 2 APPLICATIONS OF OPERATIONAL AMPLIFIERS 9

Inverting Amplifier – Non-inverting Amplifier – Voltage follower – Adder – Subtractor – Difference Amplifier – Instrumentation Amplifier: Three Operational Amplifier Instrumentation, ICAD620-V-to-I and I-to-V converter – Op-Amp Circuits using diodes: Half wave Rectifier, Full wave Rectifier, Peak Detector, Clipper, Clamper-Log and Antilog amplifier – Differentiator – Integrator – Comparator – Schmitt trigger.

UNIT 3 ACTIVE FILTERS AND PLL 9

First order Low Pass Filter – Second Order Low Pass Filter – First order High Pass Active Filter – Block diagrams of first Order Band Pass Filter and Band stop filter – PLL: Basic Principles, Phase Detector, Voltage Controlled Oscillator – PLL Applications – Frequency Multiplication/Division – AM detection – FM detection – FSK modulation and demodulation.

UNIT 4 DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERTERS 9

DAC/ADC Specifications – D/A converter: weighted resistor type, R-2R Ladder type, sample-and-hold circuits – A/D Converters: Flash type, Successive Approximation Converter, Dual Slope ADC – Oversampling A/D Converters.

UNIT 5 555 TIMER AND VOLTAGE REGULATORS 9

Timer IC 555- Functional block diagram and description, Astable and Monostable multivibrator, IC Voltage regulators: Three terminals fixed (LM78XX and LM79XX series) and Adjustable voltage regulators (LM317), Switched capacitor filter – Single supply op-amp – MOS input op-amp.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. D. Roy Choudhry, Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 4th Edition, 2014.
2. Robert F. Coughlin, Frederick F. Driscoll, "Operational Amplifiers and Linear Integrated Circuits", Pearson Education, Sixth Edition, 2015.

REFERENCES:

1. Ramakant A. Gayakwad, "OP-AMP and Linear ICs", Pearson Education, 4th Edition, 2015.
2. S. Salivahanan & V.S. Kanchana Bhaskaran, "Linear Integrated Circuits", McGraw Hill, 2nd Edition, 2014.
3. K.R. Valluvan, P. Senthil Kumar, "Linear Integrated Circuits", Charulatha Publications, 1st Edition, 2019.

e. RESOURCES:

1. http://nptel.ac.in/courses/117107094/5, "Analog Circuits", Prof. Pramod Agarwal, IIT Roorkee.
2. http://nptel.ac.in/courses/117106030/45, "Analog Integrated Circuit Design", Prof. Nagendra Krishnapura, IIT, Madras.

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21EET43	ELECTRICAL MACHINES-II	L T P C 3 1 0 4

Preamble:
To impart knowledge on theory and performance characteristics of Induction machines and Synchronous machines

Course Outcomes: Upon completion of the course, students will be able to

1. Analyze Synchronous Impedance method, Ampere Turn method and Potier's Triangle method to determine the voltage regulation of Synchronous Generator.
2. Derive the power equation of synchronous motor based on torque and analyze the performance using V and Inverted V curves.
3. Compare the Performance characteristics of Squirrel cage and slip ring Induction motor with respect to the speed, slip, frequency, power, torque, losses and efficiency.
4. Evaluate the Voltage control, frequency control, cascade control and slip power recovery Scheme for speed control of Induction motors.
5. Select appropriate of single-phase induction motor and special motor for any application and analyze its significance.

UNIT 1 SYNCHRONOUS GENERATOR **12**

Construction–Principle and types – EMF Equation – Armature Reaction - Voltage Regulation – Predetermination of Regulation by Synchronous Impedance, MMF, and Potier Methods – load characteristics – Parallel Operations – Synchronization torque, reactance and Synchronizing Power –Two reaction theory – Predetermination of voltage regulation for salient pole machines-Alternator grounding in Power Stations.

UNIT 2 SYNCHRONOUS MOTOR **12**

Principle of operation – Starting methods –Torque equation –Phasor diagram– V and Inverted V curves –Power input and power developed equations —Hunting and methods of suppression –synchronous condenser-Applications.

UNIT 3 THREE PHASE INDUCTION MOTOR **12**

Concept of rotating magnetic field. – Principle of operation–construction– types of rotors. –Torque equation–torque-slip characteristics–maximum torque–Slip for maximum power–effect of rotor resistance–Equivalent circuit– Losses and efficiency–Induction generator– Induction generator in windmill power plant–Cogging and crawling. Performance Calculation: Load Test No-load and blocked rotor tests, Circle diagram and separation of no-load losses.

UNIT 4 STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR **12**

Starters: Need for starting – Types of starters – DOL, Rotor resistance, Autotransformer and Star-delta starters; **Speed control Methods**: Voltage control, Frequency control and pole changing, Cascaded connection, V/f control, slip power recovery scheme; **Braking**: Plugging, dynamic braking and regenerative braking.

UNIT 5 SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINES **12**

Single-phase Induction Motor: Constructional details- Double revolving field theory and principle of operation-Types of single -phase induction motors: split-phase, capacitor start, Capacitor run, shaded pole motors–Starting and running characteristics–Applications; **Special electric motors:** Reluctance motors, Hysteresis motors, repulsion motors, AC series motor (universal motors) and stepper motor.

TOTAL (L:45+T:15) = 60 PERIODS

TEXT BOOKS:

1. Nagrath, I.J. and Kothari, D.P., 'Electrical Machines', Tata McGraw Hill Education Private Limited Publishing Company Ltd., 4th Edition, 2010.
2. Dr. P.S. Bhimbra, 'Electrical Machinery', Khanna Publications, 7th Edition, 2014.

REFERENCES:

1. Murugesh Kumar. K, "Induction & Synchronous Machines", Vikas Publishing House Pvt. Ltd, Nodia, First Edition, 2000.
2. J.B. Gupta, 'Theory & Performance of Electrical Machines' S.K. Kataria & Sons, 2013.
3. Theraja B.L., 'A Text Book of Electrical Technology', S. Chand & Co. Ltd, 2007.

e. RESOURCES:

1. http://nptel.ac.in/courses/108106072, "Electrical Machines II"," Prof. Krishna Vasudevan, Prof. G. Sridhara Rao, Prof. P. Sasidhara Rao", Indian Institute of Technology Madras.
2. http://freevideolectures.com/Course/2335, "Basic-Electrical-Technology", Prof. L. Umanand, IISc Bangalore.

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21EET44	TRANSMISSION AND DISTRIBUTION	L T P C 3 0 0 3

Preamble:
To enable the students to gain a fair knowledge on electricity transmission and distribution schemes, power system components. Regulation and efficiency calculations are done for analysing the performance of transmission lines.

Course Outcomes: Upon completion of the course, students will be able to

1. Elucidate the AC and DC power transmission and distribution systems.
2. Compute the transmission line parameters for single phase, three phase symmetrical and unsymmetrical spaced conductors.
3. Analyze the efficiency and voltage regulation of short and medium transmission lines.
4. Discuss the voltage distribution in insulator strings and grading of cables.
5. Design sag and tension of the given transmission line for the effects of wind and ice loading.

UNIT 1 INTRODUCTION **9**

Structure of power system, Typical AC power supply scheme (single line diagram); Transmission: Underground and Overhead systems, EHVAC and HVDC systems; Distribution: Two wire DC, AC single phase and three phase systems (Qualitative treatment); Introduction to FACTS technology.

UNIT 2 TRANSMISSION LINE PARAMETERS **9**

Solid, stranded and bundled conductors; Constants of transmission lines, parameters of single phase two wire, three phase symmetrical, unsymmetrical and transposition of conductors for single and double circuit line; Application of self and mutual GMD; Skin effect; Proximity effect; Corona.

UNIT 3 PERFORMANCE OF TRANSMISSION LINES **9**

Equivalent circuits for short, medium and long lines; Short transmission line: Phasor diagrams, Line regulation and Efficiency; Medium transmission line: Phasor diagrams, Line regulation and Efficiency using Nominal T and Pi methods - ABCD constants; Propagation constant; attenuation constant; Ferranti effect; Surge impedance and Surge impedance loading.

UNIT 4 INSULATORS AND CABLES **9**

Insulators: Types, voltage distribution over a string of suspension insulators, Methods of increasing string efficiency, Testing of insulators; Underground cables: materials, types, capacitance, dielectric stress and grading of cables.

UNIT 5 MECHANICAL DESIGN OF TRANSMISSION AND DISTRIBUTION SYSTEMS **9**

Sag and tension calculations for different weather conditions; Types of towers, Types of substations and substation equipment's, substation bus schemes, methods of grounding, Indian grid scenario.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Mehta V K, Rohit Mehta, "Principles of Power Systems", S. Chand & Co., New Delhi, 2015
2. Uppal S L, "Electrical Power Systems ", Khanna Publishers, New Delhi, 2009.

REFERENCES:

1. Luces M. Fualken berry, Walter Coffer, "Electrical Power Distribution and Transmission", Pearson Education, 2007.
2. Nagarath. I.J. & Kothari. D. P., "Modern Power System Analysis", Tata McGraw Hill Publishing Company, New Delhi 2011.
3. B. R. Gupta, "Power System Analysis and Design", S. Chand, New Delhi, 2011.

e. RESOURCES:

1. http://nptel.ac.in/courses/108102047/ - Power System Generation, Transmission & Distribution - Prof. D.P. Kothari - IIT Delhi.

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21ITT43 DATA STRUCTURES USING OBJECT ORIENTED PROGRAMMING **L T P C**
3 0 0 3

Preamble:
This course provides the data structures and object-oriented programming concepts for the students to develop software in C++ Programming Language. It also demonstrates the C++ techniques and different data structures with associated algorithms by implementing the solutions to real world problems.

Course Outcomes: Upon completion of the course, students will be able to

1. Create array Abstract Data Type for a given list of elements using C++.
2. Develop linked list Abstract Data Type for a given list of elements using C++.
3. Create switch box routing for the given problem statement using stack Abstract Data Type and Create Queue Abstract Data Type for the given problem statement using array.
4. Construct tree and graph Abstract Data Type for the given list of data by ensuring tree properties and analyze the tree and graph traversal for the constructed tree and graph Abstract Data Type.
5. Evaluate the searching and sorting algorithms for a given integer elements using linear search, binary search, bubble sort, Insertion sort and selection sort algorithms.

UNIT 1 INTRODUCTION TO C++ **9**

Introduction to C++ programming – Functions in C++ - Classes and objects - Defining member functions – ADTs and C++ classes - Array ADT – Array implementation in C++.

UNIT 2 LINKED LIST ADT **9**

Linked list ADT - Definition - Singly Linked List - Doubly Linked List – Circular Linked List - Applications of Linked List.

UNIT 3 STACK AND QUEUE ADT **9**

Stack ADT-Array Implementation- Application of Stacks: Infix to postfix conversion – Evaluation of Postfix Expression - Case Study: Switch Box routing using Stack ADT - Queue ADT – Array Implementation.

UNIT 4 TREES AND GRAPHS **9**

Trees: Binary Tree-Binary Tree Traversal-Binary Search Tree, Graphs: Definitions- Graph Traversal - Shortest path algorithm – Dijkstra's Algorithm - Case Study: Wire length optimization in electrical circuit.

UNIT 5 SORTING AND SEARCHING **9**

Sorting Algorithms: Bubble Sort, Selection Sort, Insertion Sort, Searching Algorithms: Linear Search, Binary Search.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. E. Balagurusamy, "Object Oriented Programming with C++", Tata McGraw Hill Company Ltd., 7th Edition, 2017.
2. Yashavant Kanetkar, "Data Structures through C++", 2nd Edition, BPB Publications, 2012.

REFERENCES:

1. Sartaj Sahni, "Data Structures, Algorithms and Applications in C++", 2nd Edition, Universities Press (India) Private Limited, 2011.
2. Bhushan Trivedi, "Programming with ANSI C++, A Step-By-Step approach", Oxford University Press, 2010.
3. Bjarne Stroustrup, "The C++ Programming Language", 4th Edition, Addison Wesley, 2013.

e-RESOURCES:

1. http://nptel.ac.in/courses/106105151, "Programming in C++", Prof. Pratha Pratim Das, Department of computer science, IIT – Kharagpur.
2. https://nptel.ac.in/courses/106102064/, "Introduction to Data Structures and Algorithms", Prof Naveen Garg, IIT – Delhi.

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21EEL41	ELECTRICAL MACHINES LABORATORY - II	L T P C 0 0 3 1

Preamble:
To demonstrate the working principle and performance characteristics of Synchronous machines and Induction machines.

Course Outcomes: Upon completion of the course, students will be able to:

1. Experiment to determine the performance characteristics of alternator using EMF, MMF, ZPF and Slip test methods.
2. Experiment to determine the performance characteristics of synchronous motor
3. Experiment to determine the performance characteristics of induction motor by conducting load test.
4. Experiment to determine the equivalent circuit parameters and losses of induction motor
5. Experiment to determine the performance characteristics and the equivalent circuit parameters of single-phase induction motor.

LIST OF EXPERIMENTS

1	Regulation of three phase alternator by EMF and MMF methods.
2	Regulation of three phase alternator by ZPF method.
3	Regulation of three phase salient pole alternator by slip test.
4	V and Inverted-V curves of Three Phase Synchronous Motor.
5	Load test on three-phase induction motor.
6	No load Test and Blocked Rotor Test on Three Phase Induction Motor.
7	Separation of No-load losses of three phase induction motor.
8	Speed control of 3-phase squirrel cage induction motor by V/F method.
9	Load test on single phase induction motor.
10	No load and blocked rotor test on single phase induction motor.

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21EEL42 LINEAR AND DIGITAL INTEGRATED CIRCUITS LABORATORY L T P C
0 0 3 1

Preamble:
This course encompasses linear and digital integrated circuits from a circuit and monolithic implementation. This includes the design of elements op amp as the basic building block, and transistor circuits for realizing basic digital circuits. This course provides sufficient knowledge to understand the design of op amps and digital circuits through design activities including testing, troubleshooting and documentation.

Course Outcomes: Upon completion of the course, students will be able to

1. Design and experiment the gate-level implementation of a combinational logic function described by a truth table using and/or/inversion gates, multiplexer and analyze its behavior.
2. Analyze the operations of flip-flops, latches, registers and counters with characteristic timing diagrams.
3. Create a state transition diagram from a description of a sequential logic function using flip-flops and convert to finite-state machine with the appropriate combinational and sequential components.
4. Analyze and design basic op-amp linear and non-linear circuits, active filters and signal generators
5. Analyze the characteristics of amplifiers and oscillators in different modes.

LIST OF EXPERIMENTS:

1 Implementation of Boolean Functions, Adder/ Subtractor, Multiplexer/Demultiplexer.

2 Code converters: Excess-3 to BCD and Binary to Gray code converter and vice-versa.

3 Parity generator and parity checking.

4 Encoders and Decoders.

5 Realization of Flipflops.

6 Synchronous and Asynchronous Counters.

7 Shift Registers: SISO, SIPO, PISO, PIPO.

8 Timer IC application: Astable, Monostable operation.

9 Op-Amp: Inverting and non-inverting amplifier, Adder, comparator.

10 Op–Amp: Instrumentation Amplifier

11 Op-Amp: Integrator and Differentiator.

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21ITL42 DATA STRUCTURES USING OBJECT ORIENTED PROGRAMMING LABORATORY **L T P C 0 0 3 1**

Preamble:
This Laboratory course will enable students to identify, formulate and solve real world engineering problems that require usage of data structure algorithms in C++. The course serves as a foundation laboratory for improving the problem-solving skills of students

Course Outcomes: Upon completion of the course, students will be able to:

1. Develop and test C++ program to implement a list, stack and queue ADT for a given set of elements.
2. Develop a C++ program to implement inorder, preorder and postorder traversal techniques for a given binary tree using recursive functions.
3. Construct a binary search tree to perform insertion, deletion, and search operations for the given list of data.
4. Develop a C++ program to find shortest wire length between two components using Dijkstra's algorithm for a given circuit.
5. Implement and test C++ program to perform bubble sort and binary search for a given set of elements.

LIST OF EXPERIMENTS

1. Develop and test C++ program to implement an array ADT using classes, objects and member functions.
2. Develop a C++ program to implement insert, search and display operations in a singly linked list for a given list of integer data.
3. Design a C++ program to implement the stack operations (PUSH, POP, DISPLAY) using array concept for a given list of integer data.
4. Code a C++ program to implement Queue ADT using array for the following operations
   i) Enqueue ii) Dequeue iii) Display
5. Construct a C++ program to evaluate the postfix expression using stack.
6. Develop a C++ program for traversing a binary tree in preorder, inorder and postorder using recursive function.
7. Create a Binary Search Tree to implement the insert, search and delete operations using recursive function.
8. Develop a C++ program to find shortest wire length between two components using Dijkstra's algorithm for a given circuit.
9. Implement and test a C++ program to sort the given list of numbers using bubble sort.
10. Develop and test a C++ Program to check whether the given number is in the list using binary search.

TOTAL: 45 PERIODS

SOFTWARE

Code Blocks - GCC Compiler

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21MCL04	PROFESSIONAL COMMUNICATION (Common to All Branches in Fourth Semester)	L T P C 0 0 2 0

Preamble:

Communicative English is a life skill necessary for all students of Engineering and Technology. The course Professional Communication aims at enabling the learners to communicate effectively and appropriately in professional contexts by exposing them to LSRW tasks.

COURSE OUTCOMES: After the completion of this course, students will be able to

1. Analyze the given listening material and answer the questions correctly, employing listening techniques.
2. Take part effectively in group discussions, conforming to professional norms
3. Analyze the given reading material and answer the questions correctly, employing reading techniques
4. Write within the stipulated time, syntactically and semantically correct sentences to present ideas in the form of an essay.
5. Identify within the stipulated time syntactically and semantically correct sentences for a variety of language exercises

UNIT 1 LISTENING **6**

Listening to News Bulletins and Documentaries

UNIT 2 GROUP DISCUSSION **8**

Watching Group Discussion videos – Do's and Don'ts of GD – Mock GD

UNIT 3 READING **6**

Letters to Editor Column - Reading News Articles - Biographies of Famous Personalities

UNIT 4 WRITING **6**

IELTS Essay Writing

UNIT 5 VERBAL ABILITY **4**

Verbal analogy - Cloze Test- Idioms and Phrases- Sentence Completion -Error Spotting

TOTAL: 30 PERIODS

REFERENCES:

1. Raman, Meenakshi and Sangeetha Sharma, "Technical Communication: English Skills for Engineers", 1st Edition, Oxford University Press, New Delhi. 2008.
2. Rizvi, Ashraf. M, "Effective Technical Communication", 2nd Edition, Tata McGraw-Hill, New Delhi,2018

e-RESOURCES:

1. http://www.slideshare.net/rohitjsh/presentation-on-group-discussion
2. https://www.bbc.com/bitesize/guides/zphc9j6/revision/1
3. https://www.fresherslive.com/online-test/verbal-ability-test/questions-and-answers

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21EET51 **POWER ELECTRONICS** **L T P C**
3 0 0 3

Preamble:
Familiarizes the power semi-conductor switching devices and their characteristics and imparts knowledge on the operation, characteristics and performance parameters of phase-controlled converters, inverters and choppers. The switching techniques, control strategies for phase-controlled converters and choppers are introduced. The modulation techniques of PWM inverters and harmonic reduction methods are acquainted.

Course Outcomes: Upon completion of the course, students will be able to:

1. Describe the basic structure, static and dynamic characteristics of power semiconductor switching devices
2. Illustrate the operation, characteristics and performance parameters of Phase Controlled Converters.
3. Analyze the operation, switching techniques of available topologies of DC-DC Converters
4. Explain the different modulation techniques of PWM inverters and discuss various harmonic reduction
5. Describe the operation of various configurations of AC-AC Converters

UNIT 1 POWER SEMICONDUCTOR DEVICES **9**

Study of switching devices: Basic structure, operation, static and dynamic characteristics of Power DIODE, SCR, TRIAC, GTO, BJT, MOSFET, and IGBT. Triggering circuits and Commutation circuits for SCR – Design of Driver circuits and Snubber circuits.

UNIT 2 PHASE-CONTROLLED CONVERTERS **9**

Single-pulse, Two-pulse converter circuits-operation with R, RL and RLE Load Waveforms–Estimation of average load voltage and average load current for Continuous Current Operation–Input power factor estimation for ripple free load Current–Effect of source inductance;3-pulse, 6-pulse Converter circuit–operation, waveforms, Estimation of average load voltage, Performance parameters–Gate drive circuit schemes for Phase Control– Dual converters.

UNIT 3 DC TO DC CONVERTER **9**

Step-down and step-up chopper – Control strategy, forced Commutated Chopper –Voltage commutated, Current commutated and Load commutated Chopper–Switched mode regulators– Buck, Boost, Buck-boost converter–Concept of Resonant Switching Converters.

UNIT 4 INVERTERS **9**

Single phase and three phase voltage source inverters (120° and 180° conduction mode) – Voltage and harmonic control– PWM techniques: Sinusoidal PWM, modified sinusoidal PWM, and multiple PWM – Current source inverter-single phase ASC Inverter–Concept of space vector modulation, UPS – types of UPS.

UNIT 5 AC TO AC CONVERTERS **9**

Single phase AC Voltage Controllers–Control strategy: Integral cycle control, Phase angle Control–Estimation of RMS load voltage, RMS load current and input power factor–Sequence control of AC Voltage controllers: Two-stage sequence control and single-phase sinusoidal Voltage controller–Single phase to single phase Cyclo-converters–Three phase AC Voltage controllers –Introduction to Matrix Converters.

TOTAL:45 PERIODS

TEXT BOOK:

1. M.H. Rashid, "Power Electronics: Circuits, Devices and Applications ", Pearson Education, 3rdEdition, 2014.
2. P.S. Bimbra "Power Electronics", Khanna Publishers, 5th Edition, 2012, Reprint2014.

REFERENCES:

1. Ned Mohan, Tore. M. Undeland, William. P. Robbins, "Power Electronics: Converters, Applications and Design", John Wiley and sons, Third Edition, 2003, 2013 Reprint.
2. M.D. Singh and K.B. Khanchandani, "Power Electronics", Mc Graw Hill India, 2013, 17th Reprint.
3. Joseph Vithayathil, "Power Electronics, Principles and Applications", McGraw Hill Series, 8th Reprint, 2015.

e-RESOURCES:

1. http://nptel.ac.in/courses/108108077/, Industrial Drives - Power Electronics, Prof. K Gopakumar, Centre for Electronics Design and Technology, IISC, Bangalore.
2. http://www.nptelvideos.in/2012/11/industrial-drives-power-electronics.html, Industrial Drives - Power Electronics, Prof. K Gopakumar, Centre for Electronics Design and Technology, IISC, Bangalore.

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21EET52 **MICROPROCESSOR AND MICROCONTROLLER** **L T P C**
3 0 0 3

Preamble:
Provides the fundamental concepts of 8085 Microprocessor and 8051 Microcontroller and illustrates the interfacing of peripheral devices with 8085 Microprocessor. Applications development using 8051 Microcontroller is acquainted.

COURSE OUTCOMES: Upon completion of the course, students will be able to:

1. Illustrate the architecture and timing diagram of memory read, write and I/O read, write and interrupt acknowledge machine cycles of 8085 Microprocessor.
2. Develop the 8085 assembly language programs for the simple applications using available addressing modes.
3. Explain the architecture of 8051 Microcontroller and illustrates the memory organization, I/O port features and interrupts.
4. Draw and explain the interfacing diagram of 8255, 8254, 8251, 8279 and data converters with 8085 microprocessor.
5. Develop assembly language programs for given applications using 8051 Microcontroller.

UNIT 1 8085 PROCESSOR ARCHITECTURE **9**

Architecture of 8085 Microprocessor – Functional Building Blocks of 8085 Processor – Memory organization – I/O ports and data transfer concepts: Memory mapped I/O and I/O mapped I/O – Timing Diagram – Interrupts.

UNIT 2 PROGRAMMING OF 8085 PROCESSOR **9**

Instruction format –Addressing modes – Assembly language format – Instruction set classification: Data transfer, data manipulation and control instructions – Programming: Loop structure with counting and Indexing – Look up table – Subroutine instructions – Stack – Simple programming exercises.

UNIT 3 8051 MICROCONTROLLER ARCHITECTURE AND PROGRAMMING **9**

Architecture – Functional Building Blocks of 8051 Microcontroller – Memory organization – I/O ports and data transfer concepts – Timing Diagram – Interrupts – Data Transfer, data manipulation, Control transfer and I/O instructions – Simple programming exercises.

UNIT 4 PERIPHERALS AND INTERFACING **9**

Architecture, configuration of peripheral ICs: 8255 PPI, 8254 PIT, 8251 PSI, 8257 DMA, 8259 PIC, 8279 Key board and Display Controller – A/D and D/A converters – Peripheral ICs interfacing with 8085.

UNIT 5 8051 MICROCONTROLLER APPLICATIONS AND INTRODUCTION TO ARDUINO **9**

Key board and display interface – DC motor control – Stepper motor control – Traffic light control – Introduction to Arduino platform.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Krishna Kant, 'Microprocessor and Microcontrollers', Eastern Company Edition, Prentice Hall of India, 2012.
2. Muhammad Ali Mazidi. Janice Gillispie Mazidi. Rolin D. McKinlay, 'The 8051 Microcontroller and Embedded Systems Using Assembly and C', PHI Pearson Education, 2014.
3. Brain Evans, 'Beginning Arduino programming', Technology in Action,2011

REFERENCES:

1. R.S. Gaonkar, 'Microprocessor Architecture Programming and Application with 8085', Wiley Eastern Ltd., New Delhi, 2013.
2. N.Senthil Kumar, M.Saravanan, S.Jeevananthan, 'Microprocessors and Microcontrollers', Oxford, 2013.
3. Soumitra Kumar Mandal, 'Microprocessors and Microcontrollers: Architecture, Programming and Interfacing Using 8085, 8086 and 8051', McGraw Hill Edu,2013

E-Resources:

1. http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/microcontrollers/micro/ui/TOC.htm, "Microprocessor and applications", Prof. S.P. Das, IIT Kharagpur.
2. http://freevideolectures.com/ Course/ 3018/ Microprocessors-and-Microcontrollers, "Microprocessors and Microcontrollers", Prof. Ajit Pal, IIT Kharagpur.

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21EET53	CONTROL SYSTEMS	L T P C 3 1 0 4

Preamble:
Provides adequate knowledge in control systems with analysis of time response, frequency response and stability of the systems. State variable analysis with the concepts of controllability and observability are acquainted.

Course Outcomes: Upon completion of the course, students will be able to:

1. Determine the transfer function of RLC network, AC servomotor, DC servomotor, mass, spring and damper systems with block diagram reduction techniques and signal flow graphs.
2. Analyze the time response of first order and second order system with step, ramp and parabolic inputs.
3. Analyze the frequency response of open loop systems by using Bode plot and Polar plot, closed loop by using M and N circles and Nichol's chart.
4. Determine the stability of open loop and closed loop system with RH criterion, Nyquist stability criterion, Root locus technique and compensation techniques.
5. Illustrate the state space model of RLC network, AC servomotor, DC servomotor, mass, spring and damper systems and test its controllability and observability.

UNIT 1 SYSTEMS AND THEIR REPRESENTATION **12**

Introduction – Basic elements in control systems – Open and closed loop systems – Electrical analogy of mechanical and thermal systems – Transfer function of field and armature-controlled DC Motor – AC and DC servomotors – Block diagram reduction techniques – Signal flow graphs

UNIT 2 TIME RESPONSE **12**

Time response – Time domain specifications – Types of test input – Time response of first and second order system – Error coefficients – Generalized error series – Steady state error – P, PI and PID modes of feedback control.

UNIT 3 FREQUENCY RESPONSE **12**

Frequency response – Bode plot – Polar plot – Determination of closed loop response from open loop response: M and N Circles and Nichols Chart; Correlation between frequency domain and time domain specifications

UNIT 4 STABILITY ANALYSIS AND COMPENSATOR DESIGN **12**

Characteristics equation – Routh-Hurwitz criterion – Nyquist stability criterion – Root locus construction – Performance criteria – Effect of Lag, lead and lag-lead compensation on frequency response – Lag/Lead compensator design using bode plots.

UNIT 5 STATE VARIABLE ANALYSIS **12**

Introduction – State variables – State model – State space representation of electrical and mechanical systems – state transition matrix – Solution of state and output equation – Concepts of controllability and observability.

TOTAL (L:45 + T:15): 60 PERIODS

TEXT BOOKS:

1. Nagarath, I.J. and Gopal, M., "Control Systems Engineering", New Age International Publishers, 2017
2. Benjamin C. Kuo, "Automatic Control Systems", Wiley, 2014

REFERENCES:

1. Katsuhiko Ogata, "Modern Control Engineering", Pearson, 2015.
2. S.K. Bhattacharya, "Control System Engineering", 3rd Edition, Pearson, 2013.
3. John J.D., Azzo Constantine, H. and Houpis Sttuart, N Sheldon, "Linear Control System Analysis and Design with MATLAB", CRC Taylor and Francis Reprint 2009

e-RESOURCES:

1. https://nptel.ac.in/courses/107/106/107106081/
2. http://www.nptelvideos.in/2012/11/control-engineering.html

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21MCT05	APTITUDE AND LOGICAL REASONING (Common to All Branches in Fifth Semester)	L T P C 2 0 0 0

Preamble:

Aptitude tests are used to determine an individual's ability/potential to succeed in a certain task, with no prior knowledge or training and are frequently used as part of a pre-employment assessment. Aptitude tests are a proven tool used to identify those who are best equipped to carry out any given role.

A **logical reasoning test** is a form of testing that is widely used by corporate employers to help assess candidates during their recruitment process.

Course Outcomes: Upon completion of the course, students will be able to

1. Solve the given equation using appropriate simplification methods.
2. Apply aptitude method of ratio and proportion to solve the given scenario.
3. Calculate time, speed, distance by applying suitable aptitude method for the given problem statement.
4. Calculate percentage and profit & loss for the given problem statement.
5. Compute simple interest, compound interest and predict relationship for the given problem/scenario.

UNIT 1 **6**

Number System, Simple Equation, Sequence and Series

UNIT 2 **6**

Ratio and Proportion, Problems on Ages, Partnership

UNIT 3 **6**

Time and Distance, Problems on Trains, Boats and Streams

UNIT 4 **6**

Percentage, Profit and Loss, Directions Sense

UNIT 5 **6**

Simple Interest and Compound Interest, Blood Relations

TOTAL: 30 PERIODS

REFERENCES:

1 Dr. R.S. Aggarwal, "Quantitative Aptitude for Competitive Examination", S. Chand Publications, 2017

2 Dr. R.S. Aggarwal, "A Modern Approach to Verbal & Non-Verbal Reasoning", S. Chand Publications, 2018

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21EEL51 MICROPROCESSOR AND MICROCONTROLLER LABORATORY L T P C
0 0 3 1

Preamble:
This course provides fundamental knowledge on assembly language programming of 8085 Microprocessor and 8051 Microcontroller. The student develops their skills in simple application development using 8085 Microprocessor and 8051 Microcontroller. It also provides an introduction to Arduino platform.

COURSE OUTCOMES: Upon completion of the course, students will be able to:

1. Write the assembly language programs for 8085 Microprocessor and test using trainer kits with assembler.
2. Write the assembly language programs for 8051 Microcontroller and test using trainer kits with assembler.
3. Experiment the Stepper motor, DC motor, ADC and DAC interfacing with 8051Microcontroller and 8085 Microprocessor.
4. Experiment the keyboard and display interface, and develop a traffic light controller, time delay circuit and event counter using 8085Microprocessor.
5. Simulate a DC motor and stepper motor interface with Arduino platform using open-source software.

LIST OF EXPERIMENTS

1. Simple Arithmetic operations using 8085 Microprocessor: Addition, Subtraction, Multiplication and Division
2. 8085 Programming with control instructions: Ascending and Descending, Maximum and Minimum of N numbers, Code conversions, Program using rotate instructions.
3. 8085 Interfacing experiments: ADC and DAC Interface, Keyboard and seven segment display interface, Time delay and event counter, Traffic light controller.
4. Simple Arithmetic operations using 8051Microcontroller: Addition, Subtraction, Multiplication and Division
5. 8051 Programming: Program using Conditional jumps, looping and subroutine call instructions.
6. 8051 Interfacing experiments: ADC and DAC Interface, Stepper motor and DC motor interface.
7. Simulation of DC motor and stepper motor interface with Arduino platform using open-source software.

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21EEL52 CONTROL SYSTEMS AND INSTRUMENTATION LABORATORY **L T P C**
0 0 3 1

Preamble:
Analysis and design of control systems **for** determining transfer functions are introduced and operational characteristics of bridges, transducer instruments are acquainted.

Course Outcomes: Upon completion of the course, students will be able to:

1. Experiment and govern the transfer function of DC and AC servo motors.
2. Determine the time and frequency response of first order and second order systems with step, ramp and impulse inputs by simulation and verify experimentally.
3. Simulate the Proportional, Proportional Integral, Proportional, Integral and derivative controllers and lag, lead and lag-lead compensators and verify experimentally.
4. Experiment and test Wheatstone bridge, Kelvin's double bridge and Maxwell's bridge and determine the value of unknown resistance, inductance and capacitance.
5. Experiment and test the temperature, pressure, flow, strain, displacement, light transducers and calibrate the Energy meters.

LIST OF EXPERIMENTS

1 Transfer function of DC Motor. a) Armature Control Mode. b) Field Control Mode.

2 Study the characteristics of Synchro's and transfer function of AC Servomotor.

3 Analyze the response of first and second order system using step, ramp and impulse inputs.

4 Design and experimental verification of P, PI and PID Controllers.

5 Design of Lag, Lead and Lag-Lead Compensators.

6 Measurement of Impedance using AC Bridge.

7 Measurement of Resistance using DC Bridges.

8 Measurement of Strain using Strain gauge.

9 Study the characteristics of inductive transducer and light transducers.

10 Measurement of Temperature using (RTD / Thermocouple / Thermistor).

11 Calibration of single-phase energy meter.

12 Measurement of pressure using Pressure transducer.

13 Measurement of flow using flow meters.

14 Simulate the response of first and second order system using step, ramp and impulse inputs by using suitable software.

15 Simulation of P, PI and PID controllers by using suitable simulation software.

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21MCL09	COMMUNICATION SKILLS LABORATORY (Fifth /Sixth Semester)	L T P C 0 0 2 0

Preamble:

Communication Skill is a life skill necessary for all students of Engineering and Technology. The course Communicative Skills Laboratory aims at developing effective oral and written communication to facilitate their success in competitive examinations, and recruitment screening thereby ensuring professional success and progress.

Course Outcomes: Upon completion of the course, students will be able to:

1. Respond quickly and correctly to questions from different types of scripts, exhibiting good comprehension and analyzing skills
2. Participate effectively in formal group discussions and prepare professional emails, persuasive and expository paragraphs to establish and meet organizational needs and goals.
3. Fare well in IELTS and other English language assessment segments of competitive examinations within the stipulated time.
4. Write effective résumés and face interviews with communicative competence and confidence, with a good knowledge of career skills.
5. Select appropriate vocabulary and idiomatic expressions, identify errors in syntax, arrange sentences to make meaningful paragraphs, without any aid.

UNIT 1 RECEPTIVE SKILLS **6**

LISTENING & READING – Developing Listening & Reading Skills - Comprehension and Analysis – Listening & Reading for Main Idea - Specific Information - Sequence-Vocabulary - Cultural Interest-Attitude and Opinion- Functional language.

UNIT 2 PRODUCTIVE SKILLS **8**

SPEAKING - Group Discussion skills – Structure- Types- Techniques - Keywords -Vital qualities -Tips to improve performance. WRITING - Emails and Paragraph Writing - Expository and Persuasive

UNIT 3 ENGLISH FOR NATIONAL AND INTERNATIONAL EXAMINATIONS **4**

Orientation to International English Language Testing System (IELTS), Public Service Commission Exams (TNPSC, UPSC)

UNIT 4 CAREER SKILLS **6**

Different types of Interview formats - Answering Questions – FAQ's - Mock Interviews - Body Language - Preparation of Résumé and Job Application Letter - Team Work - Managing Time - Managing Stress - Negotiation Skills - Networking Professionally - Social Protocols – Upskilling

UNIT 5 VERBAL ABILITY **6**

Synonyms and Antonyms - Verbal Analogy - Cloze Test- Idioms and Phrases - Sentence Completion - Jumbled Sentences - Error Spotting - Theme Detection - Sentence Arrangement

TOTAL: 30 PERIODS

RECOMMENDED SOFTWARE: Globerena

TEXT BOOKS:

1. Rizvi M. Ashraf, 'Effective Technical Communication' McGraw Hill Education, New Delhi,
2. Koneru Aruna 'Professional Communication' McGraw Hill Education, Chennai, 2008.
3. Upadhyay Meenakshi & Arun Sharma 'Comprehension Interpersonal & Communication Skills for General Studies Civil Services Preliminary Examination' McGraw Hill Education, New Delhi,

REFERENCES:

1. http://www.slideshare.net/rohitjsh/presentation-on-group-discussion
2. https://www.teachingenglish.org.uk/article/email-writing
3. https://www.naukri.com/blog/frequently-asked-hr-interview-questions-and-answers/
4. http://www.oxforddictionaries.com/words/writing-job-applications
5. https://www.fresherslive.com/online-test/verbal-ability-test/questions-and-answers

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21EET61	SOLID STATE DRIVES	L T P C 3 0 0 3

Preamble:
Provides an introduction to the operation of electric drives controlled by power electronic converters and the design concepts of controllers are introduced.

Course Outcomes: Upon completion of the course, students will be able to:

1. Analyze the steady state and transient operation of motor load system.
2. Analyze the steady state operation of converter/chopper fed DC drive.
3. Describe the principle of operation of speed control of induction motor drives
4. Describe the principle of operation of speed control of Synchronous motor drives
5. Differentiate the drive systems required for special machines

UNIT 1 DRIVE CHARACTERISTICS 9

Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, starting and stopping – typical load torque characteristics – Selection of motor.

UNIT 2 CONVERTER AND CHOPPER FED DC MOTOR DRIVE 9

Steady state analysis of the single and three phase converter fed separately excited DC motor drive–continuous conduction – Time-ratio and current-limit control– 4-quadrant operation of converter/chopper fed drive– Applications.

UNIT 3 INDUCTION MOTOR DRIVES 9

Stator voltage control–V/f control– Rotor-resistance control–qualitative treatment of slip power recovery drives– closed-loop control– vector control– Applications.

UNIT 4 SYNCHRONOUS MOTOR DRIVES 9

V/f control and self-control of synchronous motor: Marginal angle control and power factor control– Three phase voltage source inverter (VSI)/current source inverter (CSI) fed synchronous motor drives– Applications.

UNIT 5 BLDC, STEPPER AND SWITCHED RELUCTANCE MOTOR DRIVES 9

Brushless DC motor drives and its applications – Variable reluctance and permanent magnet stepper motor Drives – Operation and control of switched reluctance motor – Applications, modern trends in industrial drives.

TOTAL: 45 PERIODS

TEXT BOOK:

1. Dubey G K, "Fundamentals of Electrical Drives", Narosa Publishing House, New Delhi, 2012.
2. Bose B K, "Modern Power Electronics and AC Drives", Pearson Education, New Delhi, 2009.

REFERENCES:

1. Ion Boldea and Nasar S A, "Electric Drives", CRC Press LLC, New York, 2005
2. Krishnan R, "Electric Motor Drives: Modeling, Analysis and Control", Prentice Hall of India, New Delhi, 2010
3. Vedam Subramanyam, "Electric Drives: Concepts and Applications", Tata McGraw-Hill, New Delhi, 2011.

e-RESOURCES:

1. https://nptel.ac.in/courses/108104140/, "Introduction to Electric Drives", Prof. Shyama Prasad Das, IIT Kanpur
2. https://nptel.ac.in/courses/108104011/, "Advanced Electric Drives", Prof. Shyama Prasad Das, IIT Kanpur

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21EET62	POWER SYSTEM ANALYSIS	L T P C 3 1 0 4

Preamble:

The course is designed to give students the required knowledge for the design and analysis of electrical power system networks. Calculation of power flow in a power system network using various techniques, formation of Z-bus and its importance are covered in this course. It also deals with short circuit analysis and analysis of power system for steady state and transient stability.

COURSE OUTCOMES: Upon completion of the course, students will be able to:

1. Formulate bus admittance matrices and bus impedance matrices using single line representation in power system network.
2. Compare and contrast the load flow solution using Gauss-Seidel method, Newton-Raphson method and Fast decoupled method in power flow problem
3. Calculate the post fault voltage and current using Thevenin's theorem in short circuit power system
4. Classify the single Line-to-Ground fault, Line-to-Line fault, Double Line-to-Ground fault using Symmetrical components in power system network
5. Infer the voltage stability and transient stability analysis of power system using swing equation by Euler's method and Runge-Kutta method.

UNIT 1 PER UNIT REPRESENTATION AND TOPOLOGY PER UNIT QUANTITIES 12

Need for system planning and operational studies – Power scenario in India – Power system components – Representation – Single line diagram – Per Unit quantities – p.u. impedance diagram – p.u. reactance diagram – Network graph, Bus incidence matrix, Primitive parameters, Bus admittance matrix from primitive parameters – Formation of bus admittance matrix of large power network.

UNIT 2 POWER FLOW STUDIES 12

Importance of power flow analysis in planning and operation of power systems – Statement of power flow problem – Bus Classifications – power flow solution methods –Gauss-Seidel method – Newton-Raphson method (polar form) – Fast decoupled method (qualitative study only) – Flow charts and Comparison of the three methods.

UNIT 3 SYMMETRICAL FAULT ANALYSIS 12

Need of short circuit analysis – Assumptions in short circuit analysis – Symmetrical short circuit analysis using Thevenin's theorem – Bus Impedance matrix building algorithm (without mutual coupling) – Symmetrical fault analysis through bus impedance matrix.

UNIT 4 UNSYMMETRICAL FAULT ANALYSIS 12

Symmetrical components – Sequence impedances – Sequence networks – Analysis of unsymmetrical faults at generator terminals: LG, LL and LLG – unsymmetrical fault occurring at any point in a power system – computation of post fault currents in symmetrical component and phasor domains.

UNIT 5 STABILITY ANALYSIS 12

Importance of stability analysis in power system planning and operation –Basic concepts and definitions – Swing equation – Rotor angle stability – An elementary view of transient stability – Equal area criterion – critical clearing angle and time – Numerical integration methods (Algorithm and flow chart) – Euler method – modified Euler method.

TOTAL (L:45 + T:15): 60 PERIODS

TEXT BOOKS:

1. Nagrath I.J. and Kothari D.P., "Modern Power System Analysis", Tata McGraw-Hill, Fourth Edition, 2011.
2. Mehta V K, Rohit Mehta, "Principles of Power Systems", S. Chand & Co., New Delhi, 2015

REFERENCES:

1. Uppal S L, "Electrical Power Systems", Khanna Publishers, New Delhi, 2009
2. B. R. Gupta, "Power System Analysis and Design", S. Chand, New Delhi, 2011.
3. Luces M. Fualken berry, Walter Coffer, "Electrical Power Distribution and Transmission", Pearson Education, 2007.

E-Resources:

1. http://nptel.ac.in/courses/108105067, "Power System Analysis, Prof A.K. Sinha, IIT-Kharagpur
2. https://pdhonline.com/courses/e194/e194_new.htm

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21EET63	DISCRETE TIME SIGNAL PROCESSING	L T P C 3 1 0 4

Preamble:

Discrete Time Signal Processing introduces the basic principles, methods, and applications of digital signal processing by exploring its algorithmic, computational, and programming aspects, and to learn programming of DSP hardware for signal processing applications.

Course Outcomes: Upon completion of the course, students will be able to:

1. Understand the discrete-time signal, system types, analyze the response concepts for linear, time-invariant (LTI), stable systems and the relation between Fourier transforms of the sampled analog signal and the resulting discrete-time signal.
2. Describe z and inverse-z transform, region of convergence concepts with their properties, perform a transform calculation and analyze the system function to impulse and frequency responses.
3. Discuss the periodicity and symmetry properties of forward and inverse Discrete Fourier Transformation (DFT) and their computation by using Fast Fourier Transformation (FFT) algorithms.
4. Describe the digital filter design methods for transformation of analog Butter-worth and Chebyshev filters to yield digital IIR filters, impulse-invariance and bilinear transformation methods, IIR and FIR filter design based on windowing techniques.
5. Illustrate the architectural features, addressing formats and functional modes of fixed-point and a floating-point digital signal processor with their commercial applications.

UNIT 1 SIGNALS AND SYSTEMS 12

Signals: Classification of signals – Continuous and Discrete, Single and Multi-dimensional, Deterministic and Non-deterministic, Periodic and Aperiodic, Even and Odd, Energy and Power; **Systems**: Classification - Analog and Digital, Static and Dynamic, Linear, Time variant and invariant, Causal, Stable, revertible;

Signal processing: Functional diagram; Analog to Digital conversion - Sampling, Quantization, Coding, Nyquist rate, Aliasing; Advantages and Applications of Digital Signal Processing.

UNIT 2 FREQUENCY DOMAIN TRANSFORMATION 12

z transform: Region of Convergence; Conversions from time to frequency domain; Inverse transform – Long division, Partial fraction, Residue method; Properties; Solution to difference equations.

Discrete Time Fourier Transform: Conversions from time to frequency domain; Inverse DTFT; Properties; Solution to difference equations; Limitations.

UNIT 3 DISCRETE FOURIER TRANSFORMATION 12

Need for **Discrete Fourier Transformation,** Conversion from time to frequency domain; Inverse DFT; Properties; Convolution Methods – Graphical method, Tabulation method, DFT and IDFT method, Matrix method. **Fast Fourier Transformation**: Need for FFT, Twiddle factor – Properties, Classification of FFT algorithms; Radix-2 FFT – Computation Decimation-in-Time (DIT-FFT) and Decimation-in-Frequency (DIF-FFT) algorithm.

UNIT 4 DIGITAL FILTER DESIGN 12

FIR Filter: Linear phase characteristic; Fourier Series method; Windowing Techniques – Rectangular, Hanning and Hamming window. **IIR Filter**: Analog – Butter-worth, Chebyshev approximation (qualitative analysis); Impulse invariant method; Bilinear transformation.

UNIT 5 DIGITAL SIGNAL PROCESSORS 12

Introduction – Architecture – Features – Addressing Formats – Functional modes – Introduction to Commercial Processors.

TOTAL (L:45+T:15): 60 PERIODS

TEXT BOOK:

1. *S.* Salivahanan, "Digital Signal Processing", Fourth Edition, McGraw Hill, 2015.
2. Sanjay Sharma, "Digital Signal Processing", Fourth Edition, S. K. Kataria & Sons, 2010.

REFERENCES:

1. B. P. Lathi, "Principles of Linear Systems and Signals", Second Edition, Oxford, 2009.
2. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing – Principles, Algorithms and Applications", Fourth edition, Pearson education / Prentice Hall, 2007.

e-RESOURCES:

1. http://www.nptelvideos.in/2012/12/digital-signal-processing.html, "Digital Signal Processing", S.C Dutta Roy, IIT Delhi.
2. http://www.nptelvideos.in/2012/11/digital-signal-processing.html, "Digital Signal Processing", T.K. Basu, IIT Kharagpur.

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21MCT06	ARITHMETIC AND ANALYTICAL ABILITY (Common to All Branches in Sixth Semester)	L T P C 2 0 0 0

Preamble:

Arithmetic And Analytical Ability evaluates the talent and potential to perform a certain task, with no prior knowledge and/or training. This course deals with sort of problems on dynamic thinking, numeric capacity and spatial question. This course is further used for prediction of future success both in educational and vocational careers and aptitude skills help the students in the proper choice of courses and careers.

Course Outcomes: Upon completion of the course, students will be able to

1. Compute time, work, capacity and identify the pattern by analyzing the given problem/scenario
2. Analyze the given problem involving mixture, averages, seating arrangement and apply the suitable method to get the appropriate result.
3. Interpret the given chart and determine the solution.
4. Identify and apply the appropriate permutation, Combination, probability technique to determine the solution.
5. Infer the solution for the given scenario involving syllogisms, clocks, calendar using suitable techniques.

UNIT 1 **6**

Time and Work, Pipes and Cisterns, Symbol Series

UNIT 2 **6**

Alligation or Mixture, Averages, Seating Arrangements

UNIT 3 **6**

Data Interpretation-Table Charts, Bar Charts, Pie Charts, Line Charts

UNIT 4 **6**

Permutation and Combination, Probability

UNIT 5 **6**

Syllogisms, Clocks, Calendar

TOTAL: 30 PERIODS

REFERENCES:

1 Dr. R.S. Aggarwal, "Quantitative Aptitude for Competitive Examination", S. Chand Publications, 2017

2 Dr. R.S. Aggarwal, "A Modern Approach to Verbal & Non-Verbal Reasoning", S. Chand Publications, 2018

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21EEL61	POWER ELECTRONICS AND DRIVES LABORATORY	L T P C 0 0 3 1

Preamble:
Familiarizes with the characteristics of power semiconductor devices and their drive circuits and demonstrates the performance and characteristics of converters, inverters and choppers, open loop / closed loop control of converter and chopper fed DC Drives. Provides hands on experience with BLDC motor drives, PLC based drives and FPGA based drives. Simulation model for various power converters and AC/DC motor drive circuits using suitable simulation tool are acquainted.

Course Outcomes: Upon completion of the course, students will be able to:

1. Experiment and test the characteristics of power semiconductor switching devices and triggering circuit for AC-DC converters.
2. Experiment and test the Static and dynamic characteristics of power semiconductor switching devices.
3. Experiment and test the operation of Power converters such as AC-DC converter, Inverter, DC-DC converter, AC Voltage controller and Cyclo-converter.
4. Experiment the Pulse width modulation techniques and apply PWM control in single phase and three phase inverter circuits
5. Simulate and analyze the response of power converters and performance of closed loop speed control of AC and DC motor drives using a simulation tool.

LIST OF EXPERIMENTS

1 R, RC and UJT firing circuit for SCR.

2 Static Characteristics of SCR and TRIAC.

3 Static Characteristics of MOSFET and IGBT.

4 Dynamic Characteristics of SCR and MOSFET.

5 Single phase half and fully controlled AC to DC converter.

6 MOSFET based Step-down and step-up choppers.

7 IGBT based single phase and three phase PWM inverters.

8 Single phase AC-AC converters.

9 DSP based chopper fed DC motor drive.

10 DSP based speed control of three phase induction motor using PWM inverter.

11 Speed control of Brush Less DC motor.

12 PLC based three phase Induction motor drives.

13 Simulation of Power Converter circuits (1Φ and 3Φ half and fully controlled converter, DC-DC converters, AC Voltage controllers) and closed loop speed control of AC and DC motor drives.

TOTAL: 45 PERIODS

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21EEL62	DISCRETE TIME SIGNAL PROCESSING LABORATORY	L T P C 0 0 3 1

Preamble:

Discrete Time Signal Processing laboratory experiments illustrating the basic principles and techniques of signal processing involving discrete sequences and programming of signal processing algorithms using a Digital Signal Processor.

COURSE OUTCOMES: Upon completion of the course, students will be able to:

1 Simulate discrete time test signals – Impulse, Step, Ramp, Parabolic, Exponential, Sine signals for the specified signal parameters of causal and non-causal nature.

2 Compute the linear convolution and circular convolution between the two specified discrete time sequences.

3 Analyze the magnitude and phase characteristics - Frequency response characteristics of a digital FIR filters using window techniques.

4 Analyze the magnitude and phase characteristics - Frequency response characteristics of a digital IIR-Butterworth, Chebyshev filters.

5 Realize DSP algorithms using general purpose programming language C in digital signal processors for computing convolution and filter design.

LIST OF EXPERIMENTS:

PROGRAM USING MATLAB CODES

1 Generation of Discrete Time Waveforms

2 Sampling

3 FFT Computations

4 IFFT Computation

5 Frequency Response of LTI Systems

6 Linear Convolution

7 Circular Convolution

8 Design of IIR and FIR Filter

PROGRAM USING DIGITAL SIGNAL PROCESSOR KIT

1 Linear and Circular Convolution

2 Design of FIR Filters

TOTAL: 45 PERIODS

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21EET71	PROTECTION AND SWITCHGEAR	L T P C 3 0 0 3

Preamble:

This course covers a refreshed pedagogy of Power System Protection and Switchgear technology covering the contemporary protection system, relays and breaker principles, Types operations and applications with measuring, control and regulating arrangements for modern power system network.

Course Outcomes: Upon completion of the course, students will be able to:

1. Discuss the causes of abnormal operating conditions (faults, lightning and switching surges) of the apparatus and system.
2. Illustrate the protection schemes for different power system components.
3. Describe and demonstrate the basic principles of digital protection.
4. Analyze the modeling and simulation of protection schemes.
5. Describe the system protection schemes, and the use of wide-area measurements.

UNIT 1 INTRODUCTION 9

Principles of Power System Protection–Relays–Instrument transformers–Circuit Breakers–Review of Fault Analysis–Sequence Networks–Introduction to Over current Protection and over current relay co-ordination.

UNIT 2 EQUIPMENT PROTECTION SCHEMES 9

Directional, Distance, Differential protection–Transformer and Generator protection–Bus-bar Protection, Bus-bar arrangement schemes.

UNIT 3 DIGITAL PROTECTION 9

Computer-aided protection – Block diagram of Numerical relays–Distant protection of transmission lines–Demonstration of time based over-current Relays–Over-load Relays.

UNIT 4 MODELING AND SIMULATION OF PROTECTION SCHEMES 9

CT/PT modeling and standards–Simulation of transients using Electro-Magnetic Transients (EMT) programs–Relay Testing.

UNIT 5 SYSTEM PROTECTION 9

System Protection Schemes–Under-frequency, under-voltage and df/dt relays–Synchro - phasors, Phasor Measurement Units and Wide-Area Measurement Systems (WAMS)–Application of WAMS for improving protection systems.

TOTAL:45 PERIODS

TEXT BOOK:

1. J. L. Blackburn, "Protective Relaying: Principles and Applications", Marcel Dekker, New York, 2015
2. Sunil S. Rao, "Switchgear and Protection and Power System", 13th Edition, Khanna publishers, New Delhi, 2008
3. Y. G. Paithankar and S. R. Bhide, "Fundamentals of power system protection", Prentice Hall, India, 2010

REFERENCES:

1. A. G. Phadke and J. S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer, 2008.
2. Badri Ram, Vishwakarma, "Power System Protection and Switchgear", 2nd Edition, Tata McGraw Hill, New Delhi, 2012
3. D. Reimert, "Protective Relaying for Power Generation Systems", Taylor and Francis,2006.

e-RESOURCES:

1. https://nptel.ac.in/courses/108/101/108101039/ - Power System Protection, NPTEL, IIT Bombay.
2. https://nptel.ac.in/courses/108/107/108107167/ - Power System Protection and Switchgear, NPTEL, IIT Roorkee.

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21ITT71	ECONOMICS AND MANAGEMENT FOR ENGINEERS	L T P C
	(Common to BE / B.Tech. BM, CS, EC, EE, IT & MDE Programmes)	3 0 0 3

Preamble:

The main aim of this course is to understand the concepts of Economics with respect to the demand and supply analysis. This course makes the students to analyze the theory of production and the analysis of the cost parameter by using the Elasticity. This course will enable the students to manage and plan the situation with the help of the available strategies to support the decision-making process.

Course Outcomes: Upon completion of the course, students will be able to:

1. Summarize how to solve economics principles to solve economic problems in engineering discipline by satisfying the economic laws.
2. Discuss the demand and supply process for a market analysis using Price elasticity, Cross elasticity and Income elasticity.
3. Interpret short run and long run costs in the process of production for carrying out a business.
4. Apply managerial skills to make decisions and solve problems for achieving organizational objectives.
5. Express the principles of effective planning for survival and success of all organizations using standing and single use planning methods.

UNIT 1 INTRODUCTION TO ECONOMICS 9

Introduction to Economics – Scope of Economics – Positive and Normative Science – Methodology of Economics – Economic Laws - Economy and its basic problems: Economy and its working – Kinds of economy systems – Basic problems of economy.

UNIT 2 DEMAND AND SUPPLY ANALYSIS 9

The Law of Demand – The Law of Supply – Elasticities of Demand and Supply: Price Elasticity of Demand - Price Elasticity and Consumption Expenditure- Cross Elasticity of Demand – Income Elasticity of Demand – The Elasticity of Price Expectations – The uses of Elasticity– Price Elasticity of Supply.

UNIT 3 THEORY OF PRODUCTION AND ANALYSIS OF COST 9

Meaning of Production – Production concepts – Production Function – Laws of Production – Cost Concepts - Short-Run Cost Output Relations – Long Run Cost output relations – Economics of Scale.

UNIT 4 INTRODUCTION TO MANAGEMENT 9

Management: An Overview – Management Defined – Managerial skill – Managerial roles – Management responsibilities – Management functions. Evolution of Management: Classical approaches to Management – Contemporary Management Perspectives.

UNIT 5 PLANNING 9

Planning and Forecasting: Importance of Planning – Principles of effective Planning – Planning process – Types of Plans. Strategic Planning: Strategic Planning process – Rational decision making.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. D. N. Dwivedi, "Principles of Economics", Second Edition, Vikas Publishing House (P) Limited, New Delhi, 2012.
2. J. S. Chandan, "Management Concepts and Strategies", Vikas Publishing House (P) Limited, New Delhi, 2003.

REFERENCES:

1. Ranbir Singh, "Principles of Engineering Economics and Management", S.K. Kataria & Sons, New Delhi, 2013.
2. Manish Varshney and Vidhan Banerjee, "Engineering and Managerial Economics", First Edition, CBS Publishers and Distributors Pvt. Ltd., 2015.

e-RESOURCES:

1. http://nptel.ac.in/courses/110101005/, Prof. Trupti Mishra, S.J.M. School of Management, IIT Mumbai, Managerial Economics.
2. https://nptel.ac.in/courses/122106031/slides/3_1s.pdf, Dr. M. Thenmozhi, Professor, IIT Madras.

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21HST71	HUMAN VALUES AND PROFESSIONAL ETHICS (Common to All Programmes)	L T P C 3 0 0 3

Preamble:

Universal Human Values is a life skill necessary for all students of Engineering and Technology. The course aims to identify the values and skills, and to realize the need, basic guidelines, content and process of value education. Professional Ethics For Engineers deals with the human values, integrity and work ethics in the common world. This course is mainly concerned about the theories of ethics, which form the basis for the understanding and responsibility of the various groups encountered in Engineering.

Course Outcomes: Upon completion of the course, students will be able to:

1. Relate the significance of value inputs in a classroom and start applying them in their life and profession.
2. Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual.
3. Interpret the value of harmonious relationships based on the trust and respect in their life and profession.
4. Discuss the ethical issues related to Engineering.
5. Discuss Engineer's work in the context of its impact on society.

UNIT 1 INTRODUCTION TO UNIVERSAL HUMAN VALUES 9

Understanding the need, basic guidelines, content and process for Value Education. Self Exploration–Mechanism for self exploration. Continuous Happiness and Prosperity- Basic Human Aspirations and its requirements for fulfillment of Human Aspirations understanding and living in harmony at various levels.

UNIT 2 HARMONY IN ONESELF, FAMILY AND SOCIETY 9

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding harmony in the Family- the basic unit of human interaction. Understanding values in human-human relationships. Trust and Respect- values of relationship. Difference between intention and competence. Difference between respect and differentiation

UNIT 3 HOLISTIC UNDERSTANDING OF HARMONY ON PROFESSIONAL ETHICS 9

Natural acceptance of human values. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in Professional Ethics. Ability to utilize the professional competence for augmenting universal human order, Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems, technologies and management models.

UNIT 4 ENGINEERING ETHICS 9

Senses of Engineering Ethics– Variety of moral issues – Types of inquiry – Moral dilemmas – Moral autonomy – Kohlberg's theory – Gilligan's theory – Consensus and controversy – Models of professional roles – Professional responsibility - Moral reasoning - Theories about right action – Self interest – Self respect – Duty ethics – Customs and religion.

UNIT 5 ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as experimentation – Engineers as responsible experimenters – Role of codes- Codes of Ethics – Sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of Electronics and Telecommunication Engineers (IETE) – A balanced outlook on law - Safe exits -The Bhopal gas tragedy and Challenger case study.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Gaur R R, Sangal R, Bagaria G P, "A Foundation Course in Human Values and Professional Ethics". 2009
2. Govindarajan M, Natarajan S and Senthil Kumar V. S, "Engineering Ethics", PHI Learning Pvt. Ltd, New Delhi, 2017.

REFERENCES:

1. Banerjee B P, "Foundations of Ethics and Management", Excel Books. 2005.
2. Bajpai B L, "Indian Ethos and Modern Management", New Royal Book Co., Lucknow. Reprinted 2008.
3. Subramanian R, "Professional Ethics", Oxford university press, 2017.

e-RESOURCES:

1. https://www.uhv.org.in/
2. https://nptel.ac.in/courses/109/106/109106117/

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Dept. of ME - VCET

21MCT07 INDIAN CONSTITUTION AND TRADITIONAL KNOWLEDGE L T P C
2 0 0 0

Preamble:
The course provides basic information on Indian Constitution and Indian Traditional knowledge. This is essential for all citizens and especially for engineers so that they become aware of Indian polity and governance. This also reminds the citizen about their obligation, adherence and up keeping of Constitutional rights.

Course Outcomes: Upon completion of the course, students will be able to:

1. Outline the evolution of Indian constitution and Federal structure
2. List and explain the functions of Centre, States and District Administrations
3. Elaborate the roles of Panchayat raj
4. Explain the powers and roles of Election Commission
5. Illustrate the Indian traditional knowledge and elucidate their recovery

UNIT 1 **6**

'Constitution' meaning of the term, Indian Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy - Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha

UNIT 2 **6**

Governor: Role and Position, CM and Council of ministers, State Secretariat: organisation, Structure and Functions District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation.

UNIT 3 **6**

Panchayatraj: Introduction, PRI: Zila Panchayat, Elected officials and their roles, CEO Zila Panchayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT 4 **6**

Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women.

UNIT 5 **6**

Basic structure of Indian Knowledge System-Modern Science and Indian Knowledge –Philosophical Tradition - Indian Linguistic Tradition (Phonology, morphology, syntax and semantics) – Indian Artistic Tradition.

TOTAL: 30 PERIODS

TEXT BOOKS:

1. M. Rajaram, Indian Constitution, New Age International, 2009
2. V. Sivaramakrishnan (Ed.) Cultural Heritage of India (Course Material), Bharatiya Vidya Bhavan, Mumbai. 5th Edition,2014

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21EEL71	POWER SYSTEM SIMULATION AND RENEWABLE ENERGY SYSTEMS LABORATORY	L T P C 0 0 3 1

Preamble:

This course deals with the performance of power system networks by conducting various experiments and develop computer programs for analysis of power systems.

Course Outcomes: Upon completion of the course, students will be able to:

1. Model the Transmission Lines and Simulate the solution of a power system network by forming bus impedance and bus admittance matrix.
2. Simulate and analyze the solution of a load flow problems on power system networks using Gauss–Seidel and Newton– Raphson method.
3. Simulate and analyze the various types of power system faults and protection, Small Signal and Transient Stability of Single-Machine Infinite Bus System using simulation tools.
4. Simulate the electromagnetic Transients, Economic load dispatch and the Load-Frequency dynamics of Single-area and Two-area Power Systems.
5. Experiment to determine the performance of a Solar PV System and Induction generators under different operating conditions.

LIST OF EXPERIMENTS

1	Computation of Parameters and Modeling of Transmission Lines.
2	Formation of Bus Admittance and Bus Impedance Matrices and Solution of power system Networks.
3	Load Flow study on power system networks by Gauss-Seidel method and Newton-Raphson method.
4	Short circuit studies for symmetrical and unsymmetrical (LL, LG, LLG) faults in a power system.
5	Transient and Small Signal Stability Analysis of Single-Machine Infinite Bus System.
6	Load – Frequency Dynamics of Single- Area and Two-Area Power Systems
7	Economic load Dispatch in Power Systems.
8	Experiment on 1 kW Solar PV System for V-I Characteristics and Efficiency calculation.
9	Experiment on Performance Assessment of Micro Wind Energy Generator.
10	Experiment on Performance Assessment of Hybrid (Solar-Wind) energy conversion System.

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21EEL72	MINI PROJECT	L T P C 0 0 6 3

Preamble:

This course is designed to develop the ability to solve a specific problem right from its identification and literature review till the successful solution for the same. These courses also train the students in preparing project reports and in facing reviews and viva voce examination.

Course Outcomes: Upon completion of the course, students will be able to:

1. Discover potential research areas in the field of Electrical and Electronics Engineering.
2. Compare and contrast the several existing solutions for the problems identified.
3. Formulate and propose a plan for creating a solution for the research plan identified.
4. Conduct the experiments as a team and interpret the results.
5. Report and present the findings of the work done.

The student in a group of 5 to 6 works on a topic approved by the head of the department and prepares a comprehensive mini project report after completing the work to the satisfaction. The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A mini project report is required at the end of the semester. The mini project work is evaluated based on oral presentation and the mini project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 60 PERIODS

OUTCOMES:

- On completion of the mini project work students will be in a position to take up their final year project work and find solution by formulating proper methodology.

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21EEL81	PROJECT WORK	L T P C 0 0 20 10

Preamble:

This course is designed to develop the ability to solve a specific problem right from its identification and literature review till the successful solution for the same. These courses also train the students in preparing project reports and in facing reviews and viva voce examination.

Course Outcomes: Upon completion of the course, students will be able to:

1. Discover potential research areas in the field of Electrical and Electronics Engineering.
2. Compare and contrast the several existing solutions for the problems identified.
3. Formulate and propose a plan for creating a solution for the research plan identified.
4. Conduct the experiments as a team and interpret the results.
5. Report and present the findings of the work done.

The student in a group of 3 to 4 works on a topic approved by the head of the department under the guidance of a faculty member and prepares a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.

TOTAL: 180 PERIODS

OUTCOMES:

- On Completion of the project work students will be in a position to take up any challenging practical problems and find solution by formulating proper methodology.

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21EEE01	UNDER GROUND CABLE ENGINEERING	L	T	P	C
		3	0	0	3

Preamble

To provide adequate knowledge understanding Power Cable Characteristics and Application, Cable Manufacturing, Installation of underground power cables, Underground cable System Fault Locating, Testing and maintenance of Underground cable system, Cable Performance and Field Assessment of Power Cable

Course Outcomes: Upon completion of the course, students will be able to:

1. Ability to understand the fundamental of underground cable system.
2. Ability to gain knowledge on the architecture of UG cable and physical and electrical characteristics of the UG cable.
3. Ability to understand different types of cable used in distribution system.
4. Ability to acquire knowledge on Underground cables used in transmission system.
5. Ability to understand the cable installations procedures and practices, the theory / methodology of cable fault detection and rectification, testing and maintenance.

UNIT 1 INTRODUCTION TO ELECTRICAL POWER CABLES 9

Development of Underground Cables - Electric Lighting- Distribution of Energy for Lighting- Paper Insulated Cables - Underground Residential Distribution Systems-Underground Residential Distribution Systems- Medium Voltage Cable Development.

UNIT 2 CABLE ARCHITECTURE, DIELECTRIC THEORY AND CABLE CHARACTERISTICS 9

Architecture of Underground Cabling System - Basic Dielectric Theory of Cable -Conductors -Armour and Protective Finishes - Cable Characteristics: Electrical-Fundamentals of Electrical Insulation Materials - Electrical Properties of Cable Insulating Materials - Cable Standards and Quality Assurance - Cable design parameters- Current Carrying Capacity - Short-circuit Ratings.

UNIT 3 SUPPLY DISTRIBUTION SYSTEMS AND CABLES 9

Supply Distribution Systems - Distribution Cable Types, Design and Applications-Paper Insulated Distribution Cables - PVC Insulated Cables - Polymeric Insulated Distribution Cables for 6-30 kV - Manufacture of Distribution Cables - Joints and Terminations for Distribution Cables - Testing of Distribution Cables.

UNIT 4 TRANSMISSION SYSTEMS AND CABLES 9

Basic Cable Types for A.C. Transmission - Self-contained Fluid-filled Cables – Gas Pressure Cables - High Pressure Fluid-filled Pipe Cables - Polymeric Insulated Cables for Transmission Voltages - Techniques for Increasing Current Carrying Capacity -Transmission Cable Accessories and Jointing for Pressure-assisted and Polymeric Cables.

UNIT 5 CABLE INSTALLATION, TESTING, MAINTENANCE 9

Installation of Transmission Cables -Splicing, Terminating, and Accessories-Sheath Bonding and Grounding-Testing of Transmission Cable Systems - Underground System Fault Locating - Field Assessment of Power Cable Systems- Condition monitoring tests - PD measurements.

TOTAL:45 PERIODS

TEXT BOOKS:

1. William Thue, 'Electrical Power Cable Engineering', CRC Press Taylor & Francis Group., 6000 Broken Sound Parkway NW, Suite 300Boca Raton, FL 33487-2742,3rd Edition 2017.
2. G. F. Moore, 'Electric Cables Handbook' -Third edition, Blackwell Science Ltd,9600 Garsington Road, Oxford OX4 2DQ, UK., January 2017.

REFERENCES:

1. Leonard L. Grigsby, 'Electrical Power Cable Engineering' - CRC Press, Marcel Dekker, 3 Edition 2012.
2. Christian Flytkjaer Jensen, Online Location of Faults on AC Cables in Underground Transmission Systems (Springer Theses), 2014, March.
3. https://kafactor.com/content/technical-resources/kerite-underground-cableengineeringhandbook.pdf.

e-Resources:

1. https://iccexplore.ieee.org/stamp/stamp.jsp?arnumber=9807279
2. https://www.osti.gov/servlets/purl/7233049

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21EEE02 **POWER SYSTEM TRANSIENTS** L T P C
3 0 0 3

Preamble:
Fundamentals of transients with their causes, classifications, impact of switching and lightening transients are introduced and computations of transients are illustrated for transmission lines and integrated power systems.

Course Outcomes: Upon completion of the course, students will be able to:

1. Analyze power system operation, stability, control, protection and identify the causes for transients, effect of transients on power system.
2. Demonstrate the transients over voltages due to switching and explain the effect of source regulation
3. Describe the mechanism of lightning discharges, characteristics of lightning strokes and interaction between lightning and power system
4. Explain the concept of Travelling waves, wave propagation and analyze the transient response of a power system.
5. Investigate transients in integrated power system and Compute transients using EMTP.

UNIT 1 INTRODUCTION AND SURVEY 9

Review and importance of the study of transients; causes for transients; RL circuit transient with sine wave excitation; double frequency transients; basic transforms of the series and parallel RLC circuit transients; Different types of power system transient; effect of transients on power systems.

UNIT 2 SWITCHING TRANSIENTS 9

Over voltages due to switching transients; resistance switching and the equivalent circuit for interrupting the resistor current; load switching and equivalent circuit; waveforms for transient voltage across the load and the switch; Current suppression; current chopping; effective equivalent circuit; Capacitance switching; effect of source regulation; capacitance switching with a restrike, with multiple restrikes; ferro resonance.

UNIT 3 LIGHTNING TRANSIENTS 9

Review of the theories in the formation of clouds and charge formation; rate of charging of thunder clouds; mechanism of lightning discharges and characteristics of lightning strokes; model for lightning stroke; factors contributing to good line design; protection using ground wires; tower footing resistance; Interaction between lightning and power system.

UNIT 4 TRAVELING WAVES ON TRANSMISSION LINE COMPUTATION OF TRANSIENTS 9

Computation of transients – transient response of systems with series and shunt lumped parameters and distributed lines; Traveling wave concept – step response – Bewley's lattice diagram - standing waves and natural frequencies – reflection and refraction of traveling waves.

UNIT 5 TRANSIENTS IN INTEGRATED POWER SYSTEM 9

The short line and kilometric fault; distribution of voltages in a power system; Line dropping and load rejection; voltage transients on closing and reclosing lines; switching surges on integrated system; Qualitative application of EMTP for transient computation.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Allan Greenwood, "Electrical Transients in Power Systems", Wiley Inter Science, 2nd Edition, 1991.
2. C.S. Indulkar, D.P. Kothari, K. Ramalingam, "Power System Transients – A statistical approach", PHI Learning Private Limited, Second Edition, 2010.
3. Pritindra Chowdhari, "Electromagnetic transients in Power System", John Wiley and Sons, 2nd Edition, 2009.

REFERENCES:

1. M.S. Naidu and V. Kamaraju, "High Voltage Engineering", Tata McGraw Hill, Fifth Edition, 2013.
2. R.D. Begamudre, "Extra High Voltage AC Transmission Engineering", Wiley Eastern Limited, 1986.
3. Y. Hase, "Handbook of Power System Engineering," Wiley India, 2012.

e. RESOURCES:

1. http://nptel.ac.in/courses/108102047/ , Power System Dynamics and Control, Dr. A.M. Kulkarni, IIT Bombay.
2. https://www.youtube.com/watch?v=xB8HWNB26ec/, Transient and Dynamic Stability, Prof. Ned Mohan, Professor of ECE, University of Minnesota.

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21EEE03	FLEXIBLE AC TRANSMISSION SYSTEMS	L T P C
		3 0 0 3

Preamble:

Alternating current transmission systems incorporating power electronics - based converters and other static controllers for enhancing control ability and power transfer capability are introduced. Types of FACTS devices and controllers are acquainted.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the concepts of FACTS and describe the necessity, importance, types and benefits of FACTS controllers.
2. Summarize the objectives of static shunt compensators and describe the characteristics of shunt compensation devices used in power system network.
3. Illustrate the control schemes for Grid Side Converter (GSC), Thyristor Switched Series Capacitor (TSSC), Thyristor Controlled Series Capacitor (TCSC) and compare their operating characteristics.
4. Explain the principle and modes of operation of Static Compensator (STATCOM) and Unified Power Flow Controller (UPFC) controllers, and model the UPFC for Power Flow Studies.
5. Illustrate the interaction and co-ordination of multiple FACTS controllers using linear control techniques and genetic algorithms.

UNIT 1 FACTS CONCEPTS 9

Transmission inter-connections power flow in an AC system, loading capability limits, Dynamic stability considerations, importance of controllable parameters, basic types of FACTS controllers, benefits from FACTS controllers.

UNIT 2 STATIC SHUNT COMPENSATOR 9

Need for compensation - introduction to shunt compensation - objectives of shunt compensation - configuration and operating characteristics - Thyristor Controlled Reactor (TCR) - Thyristor Switched Capacitor (TSC) - Comparison of TCR and TSC.

UNIT 3 STATIC SERIES COMPENSATOR 9

Introduction to series compensation – Variable impedance type of Series compensation: Thyristor Switched Series Capacitor (TSSC) – Thyristor Controlled Series Capacitor (TCSC) - Control schemes for Grid Side Converter (GSC), TSSC and TCSC – Comparison of TSSC and TCSC.

UNIT 4 EMERGING FACTS CONTROLLERS 9

Static Synchronous Compensator (STATCOM) – Principle of operation – V-I Characteristics – Unified Power Flow Controller (UPFC) – Principle of operation – Modes of Operation – Applications – Modeling of UPFC for Power Flow Studies.

UNIT 5 CO-ORDINATION OF FACTS CONTROLLERS 9

Controller interactions – SVC – SVC interaction – Co-ordination of multiple controllers using linear control techniques – Control coordination using genetic algorithms.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. K.R. Padiyar," FACTS Controllers in Power Transmission and Distribution", New Age International (P) Limited, Publishers, New Delhi, January 2016.
2. R. Mohan Mathur, Rajiv K. Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, January 2011.

REFERENCES:

1. Narain G. Hingorani, "Understanding FACTS –Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers Distributors, New Delhi, March 2011.
2. A. T. John, "Flexible A.C. Transmission Systems", Institution of Electrical and Electronic Engineers (IEEE), 2008.

e. RESOURCES:

1. https://nptel.ac.in/courses/108/107/108107114/, "Flexible AC Transmission System" Prof. Avik Bhattacharya, Indian Institute of Technology, Roorkee

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21EEE04	POWER QUALITY	L T P C 3 0 0 3

Preamble:
Provides the impact of voltage and current imperfections, harmonics, voltage regulation, power factor improvement and importance of distributed generation, power quality monitoring using measurement equipment's.

Course Outcomes: Upon completion of the course, students will be able to:

1. Recognize and explain various power quality issues, sources and effects of power qualityproblems.
2. Identify the origin of voltage sag and interruptions and analyzethe influence on the performance of electric machines in transmission system distribution system.
3. Discuss the sources of transient overvoltage's, identifies the device for over voltage protection and apply the principles of over voltage protection.
4. Describe the sources of harmonics, effects of harmonics on utility and facility equipment's, and apply the principles to control the power system harmonics.
5. Illustrate the needs and various methods of power quality monitoring using PQ measurement equipment's.

UNIT 1 INTRODUCTION 9

Definitions – Power quality, Voltage quality; Power quality issues – Short duration voltage variations, Long duration voltage variations, Transients, Waveform distortion, Voltage imbalance, Voltage fluctuation and Power frequency variations; Sources and Effects of power quality problems; Power quality terms – Power quality and Electro Magnetic Compatibility (EMC) , IEEE and IEC Standards CBEMA and ITI curves.

UNIT 2 VOLTAGE SAGS AND INTERRUPTIONS 9

Sources of sags and interruptions – Causes of Voltage Sag – Estimating voltage sag performance – Transmission system sag performance evaluation, Utility distribution system sag performance evaluation; Solution to the end user side; Estimating the costs for voltage sag events; Motor starting sags–Overview of mitigation methods.

UNIT 3 TRANSIENT OVER VOLTAGES 9

Sources of transient over voltages; Principles of over voltage protection – Types and causes of transients– Devices for overvoltage protection; Utility capacitor switching transients–Lightning transients – Transients from load switching – Utility system lightning protection.

UNIT 4 HARMONICS 9

Harmonic distortion; Voltage versus current distortion; Harmonics versus Transients; Harmonic indices; Harmonic sources from commercial and industrial loads; Effects of harmonics on various equipment's; Harmonic distortion evaluation; Principle of controlling harmonics; Devices for controlling harmonic distortion–Standards and limitation.

UNIT 5 POWER QUALITY MONITORING 9

Introduction – Power quality monitoring; Need for power quality monitoring; Introduction to Power quality measurement equipment's and power conditioning equipment's; Planning, Conducting and Analyzing power quality survey – Mitigation and control techniques – Active Filters for Harmonic Reduction–Power quality monitoring and the Internet.

TOTAL:45 PERIODS

TEXT BOOK:

1. Roger. C. Dugan, Mark. F. McGranagham, Surya Santoso, H. Wayne Beaty, "Electrical Power Systems Quality", McGraw Hill, 2012.
2. Barry W. Kennedy, "Power Quality Primer", McGraw-Hill, New York, 2000.

REFERENCES:

1. Math H.J. Bollen, "Understanding Power Quality Problems: Voltage sags and Interruptions", IEEE Press, 2000.
2. C. Sankaran, "Power Quality", CRC press, Taylor & Francis group, 2002.
3. J. Arrillaga, N.R. Watson, S. Chen, "Power System Quality Assessment", Wiley, 2011.

e-RESOURCES:

1. http://nptel.ac.in/courses/108106025/, Power Quality in Power Distribution Systems, Dr. Mahesh Kumar Professor, Department of Electrical Engineering, Indian Institute of Technology Madras Chennai.
2. https://www.youtube.com/watch?v=ILJdJCAOHdA/, Improving Power Quality (PQ) Through Low-cost Solutions, Mark Stephens & Mark Josef, Principal Project Managers, Electric Power Research institute (EPRI).

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21EEE05	UTILIZATION AND CONSERVATION OF ELECTRICAL ENERGY	L	T	P	C
		3	0	0	3

Preamble : Generation of electrical power by conventional and non-conventional methods with their energy conversion systems is introduced. Types, characteristics and applications of electric drives and traction, illumination, heating and welding applications are acquainted.

Course outcomes: Upon completion of the course, students will be able to

1. Ability to choose suitable electric drives for different applications.
2. Ability to design the illumination systems for energy saving.
3. Ability to demonstrate the utilization of electrical energy for heating and welding purposes.
4. To illustrate the need for energy conservation and to simulate three phase power control.
5. Ability to do electric connection for any domestic appliance like refrigerator, battery, charging circuit for a specific household application.

UNIT 1 ELECTRIC DRIVES AND TRACTION 9

Fundamentals of Electric Drive - Choice of an Electric Motor - Application of Motors for Particular Services Traction Generator Set, Traction Motors, Power Transformers - Characteristic Features of Traction Motor - Systems of Railway Electrification - Electric Braking - Train Movement and Energy Consumption -Traction Motor Control - Track Equipment and Collection Gear.

UNIT 2 ILLUMINATION 9

Introduction - Definition and Meaning of Terms used in Illumination Engineering - Classification of Light Sources - Incandescent Lamps, Sodium Vapour Lamps, Mercury Vapour Lamps, Fluorescent Lamps – Design of Illumination Systems - Indoor Lighting Schemes - Factory Lighting Halls - Outdoor Lighting Schemes - Flood Lighting - Street Lighting - Energy Saving Lamps, LED.

UNIT 3 HEATING AND WELDING 9

Introduction - Advantages of Electric heating – Modes of heat transfer - Methods of Electric heating - Resistance heating - Arc furnaces - Induction heating - Dielectric heating - Electric welding – types -Resistance welding - arc welding - Power supply for arc welding - Radiation welding.

UNIT 4 ENERGY CONSERVATION AND ITS IMPORTANCE 9

Energy conservation act 2001 and its Features-Review of Industrial Energy Conservation-Energy conservation in Electrical Industries-Simulation study of energy conservation using power factor controller. (Three phase circuit simulation with and without capacitor).

UNIT 5 DOMESTIC UTILIZATION OF ELECTRICAL ENERGY 9

House wiring - working principle of air conditioning system, Induction based appliances, Online and OFF line UPS, Batteries - Power quality aspects – nonlinear and domestic loads – Earthing system for Domestic, Industrial and Substation.

TOTAL:45 PERIODS

TEXT BOOKS:

1. N.V. Suryanarayana, "Utilisation of Electric Power", Wiley Eastern Limited, New Age International Limited, 1994 & Second Edition 2017 Feb.
2. J.B.Gupta, "Utilisation Electric power and Electric Traction", S.K.Kataria and sons, 2000 2012th Edition, 2013, January.
3. G.D.Rai, "Non-Conventional Energy sources", Khanna publications Ltd., New Delhi 1998
4. D.P.Kothari, K.C.Singal, Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Learing Private Limited, 3rd Edition 2022.

REFERENCES:

1. R.K.Rajput, "Utilisation of Electric Power", Laxmi publications 2nd Edition 2016.
2. H.Partab, "Art and Science of Utilisation of Electrical Energy", Edition, Dhanpat Rai and Co., New Delhi-2004.
3. C.L.Wadhwa, "Generation, Distribution and Utilisation of Electrical Energy", New Age International Pvt.Ltd., 3rd Edition, 2015 January.

e-Resources:

1. http://nptel.ac.in/courses/108105058/1, Energy Resources & Technology, Prof. S. Banerjee, NPTEL, IIT Kharagpur.
2. http://nptel.ac.in/courses/108108078/, Non-Conventional Energy Systems, Dr.L. Umanand, NPTEL Videos, IISC Bangalore.

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21EEE06 **HIGH VOLTAGE ENGINEERING** **L T P C**
3 0 0 3

Preamble:
Planning, operation and testing of high voltage electrical devices and insulation materials in the form of liquid, gas and solid mediums are acquainted and illustrates the impact of extra high voltage on an environment.
Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the causes of over voltages and its effects on power system and protection of power system networks against over voltages.
2. Analyze the concept of corona discharge and describe the electrical breakdown mechanisms in various mediums.
3. Summarize the systems/circuits used to generate the high voltages and high currents for testing the power system components and equipment's.
4. Identify and explain the different measuring instruments and equipment's used to measure high voltage and high currents in power system.
5. Describe the methods of high voltage testing of electrical power apparatus and discuss insulation coordination.

UNIT 1 OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS **9**

Introduction to over voltages – Natural Causes of over voltages – Charge formation in the clouds – Lightning phenomenon – Mechanism of lightning stroke, Mathematical modeling of lightning - Switching surges – Causes – its effect on power system – Control of switching surges in power system - Protection of transmission lines against over voltages.

UNIT 2 ELECTRICAL BREAKDOWN IN GAS, LIQUID AND SOLID DIELECTRICS **9**

Gaseous breakdown – Uniform field – Townsend criterion, Streamer theory- Pachen's law - non-uniform fields – Corona discharges – Vacuum break-down – Conduction and break-down in pure and commercial liquids – Break-down mechanisms in solid dielectrics.

UNIT 3 GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS **9**

Generation of High DC Voltages: Voltage doubler, Cockcroft Walton Voltage multiplier and V and e-Graff generator **–Generation of high AC voltages:** Cascaded transformer, Resonant transformer, and Tesla coil - **Generation of Impulse voltage:** multi-stage impulse generator – Marx circuit generation of switching surges – impulse current generation – Tripping and control of impulse generators.

UNIT 4 MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS **9**

Measurement of High DC voltages **–AC voltages**: Power frequency, High frequency and impulse – High DC currents **–AC currents**: Power frequency, High frequency and impulse – PD Measurements – Cathode Ray Oscillograph for Impulse Voltage and Current measurements.

UNIT 5 HIGH VOLTAGE TESTING OF ELECTRICAL POWER APPARATUS **9**

Terminologies and Definitions – High voltage testing of electrical power apparatus as per standards: Insulators, Bushings, Isolators and Circuit Breakers, Cables, Transformers, and Surge Arrester – Insulation Coordination.

TOTAL: 45 PERIODS

TEXT BOOK:

1. S. Naidu and V. Kamaraju, "High Voltage Engineering", McGraw Hill, Fifth Edition, 2016.
2. Subir Ray, "An Introduction to High Voltage Engineering" PHI Learning Private Limited, New Delhi, Second Edition, 2013.

REFERENCES:

1. C.L. Wadhwa, "High voltage Engineering", New Age International Publishers, Third Edition, 2010.
2. Chakrabarti A, Soni M.L, Gupta P.V, "Text book on Power System Engineering", Dhanpat Rai & Co Ltd., 2011.
3. Kuffel, Zaengel W.S, "High Voltage Engineering Fundamentals", Pergamon Press, 2nd edition, 2000.

e-RESOURCES:

1. http://nptel.ac.in/courses/108104048/, High voltage Engineering, Prof. Ravindra Arora, IIT Kanpur.
2. https://www.btechguru.com/courses--nptel-electrical-engineering-video-lecture--ee.html, High voltage Engineering, Prof. Ravindra Arora, IIT Kanpur.

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21EEE07	SMART GRID	L T P C 3 0 0 3

Preamble:

Provides overview of smart grid and its potential in power generation, transmission and distribution system and emphasizes on the key aspects of smart grid development and deployment. Explores the issues in operation, management, monitoring, control and protection. The information and communication technologies and Standards for information exchange are acquainted.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the Smart Grid interoperability Standards, architecture and describe the functions of Smart Grid Components, Challenges and Benefits of planning the smart grid.
2. Illustrate the distribution system equipment's and intelligent devices used in smart grid distribution for power flow monitoring, management and control.
3. Explain the advanced metering infrastructure for smart grid monitoring and measurement, and illustrate the Multi-Agent System Technologies for smart grid implementation.
4. Describe the types of power electronic converters employed in smart grid for power quality improvement and bulk power flow.
5. Explain the appropriate information and communication technologies and Standards for information exchange in smart grid.

UNIT 1 INTRODUCTION TO SMART GRID 9

Conventional grid Vs Smart Grid; Need for Smart Grid; Smart Grid Standards; Smart Grid Architecture; Functions of Smart Grid Components; Challenges and Benefits; Smart grid initiative

UNIT 2 SMART DISTRIBUTION SYSTEMS 9

Wide area monitoring; Volt/VAR control; Power Quality; Demand Side Management; Fault Detection, Isolation and service restoration, Outage management; Substation Equipment; Intelligent Electronics Devices

UNIT 3 SMART METERS 9

Introduction to Smart Meters; Phasor Measurement Unit (PMU); Advanced Metering infrastructure (AMI); Multi-Agent System Technologies.

UNIT 4 POWER ELECTRONIC CONVERTERS IN SMART GRID 9

Introduction; Fault Current Limiting; Shunt Compensation: D-STATCOM and Active Filtering, Series Compensation; FACTS and HVDC.

UNIT 5 SMART GRID COMMUNICATION 9

Switching Techniques; Communication Channels; Layered Architecture; Communication Technologies and Standards for Information Exchange.

TOTAL: 45 PERIODS

TEXT BOOK:

1. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, Nick Jenkis, "Smart Grid: Technology and Applications", John Wiley and Sons Publications, First Edition, 2012.
2. James Momoh, "Smart Grid: Fundamentals of Design and Analysis", IEEE Press and John Wiley and Sons Publications, 2012.

REFERENCES:

1. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", The Fairmont Press Inc., and CRC Press, 2009.
2. Fereidoon P. Siosanshi, "Smart Grid: Integration Renewable, Distributed and Efficient Energy", Academic Press, Elsevier Inc., 2012.
3. Stuart Borlase, "Smart Grids: Infrastructure, Technology and Solutions", CRC Press, 2013.
4. Smart Grid Handbook for Regulators and Policy Makers, India Smart Grid Forum, Nov' 2017

e-RESOURCES:

1. https://energy.gov/oe/services/technology-development/smart-grid, Grid Modernization and the Smart Grid, Michel Pesin, Office of Electricity Delivery and Energy, U.S. Department of Energy.
2. https://www.smartgrid.gov/the_smart_grid, What is Smart Grid? Michel Pesin, Office of Electricity Delivery and Energy, U.S. Department of Energy.

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21EEE08	DESIGN OF ELECTRICAL APPARATUS	L T P C
		3 0 0 3

Preamble:

This course provides an introduction to the design of various DC and AC Machines and gives a general idea about the computer-aided design of Electrical machines.

Course Outcomes: Upon completion of the course, students will be able to:

1. Recognize the various factors such as electrical, magnetic and thermal loading of electrical machines etc., which influence the design of electrical machines.
2. Explain the principal design procedure for transformer and carry out a basic design of transformer and cooling tank.
3. Describe the principal design procedure of induction motor and carry out a basic design of induction motors.
4. Illustrate the principal design procedure of synchronous machine and carry out a basic design of synchronous machines.
5. Identify the traditional design limitations and explain the need for computer aided design of electrical machines and carry out design calculations using software tools.

UNIT 1 INTRODUCTION 9

Major considerations in electrical machine design–electrical engineering materials –space factor–choice of specific electrical and magnetic loadings– thermal considerations– temperature rise– rating of machines.

UNIT 2 TRANSFORMERS 9

Sizing of a transformer, main dimensions– KVA output for single-phase and three-phase transformers – window space factor – overall dimensions – regulation – no-load current – temperature rise in transformers –design of the cooling tank – methods for cooling of transformers.

UNIT 3 INDUCTION MOTORS 9

Sizing of induction motor – main dimensions, length of the air gap– rules for selecting rotor slots of squirrel cage machines– design of rotor bars and slots– design of end rings and wound rotor– magnetic leakage calculations– magnetizing current– short circuit current.

UNIT 4 SYNCHRONOUS MACHINES 9

Sizing of a synchronous machine– main dimensions– design of salient pole machines–short circuit ratio– armature design– estimation of air-gap length– design of rotor – design of damper winding, field winding– design of turbo – alternators.

UNIT 5 COMPUTER-AIDED DESIGN 9

Limitations (assumptions) of traditional designs– need for CAD analysis, synthesis and hybrid methods – design optimization methods, variables, constraints and objective function, problem formulation – Introduction to FEM based machine design.

TOTAL: 45 PERIODS

TEXT BOOK:

1. A. K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 2013.
2. S. K. Sen, "Principles of Electrical Machine Design with computer programmes", Oxford and IBH Publishing, 2006.

REFERENCES:

1. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London, Third Edition, 2008.
2. K.M.V. Murthy, 'Computer Aided design of Electrical Machines', B S Publications, 2008.

e-RESOURCES:

1. https://nptel.ac.in/courses/108/106/108106023/ - Modelling and Analysis of Electrical Machines IIT Madras

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21EEE09	SPECIAL ELECTRICAL MACHINES	L T P C
		3 0 0 3

Preamble:
An advanced course on electrical machines that familiarizes various special electrical machines which are gaining importance in industry. This course highlights the operating principle, performance and applications of special electrical machines including synchronous reluctance motors switched reluctance motors, stepper motors, permanent magnet motors and electric motors for traction drives.

Course Outcomes: Upon completion of the course, students will be able to:

1. Describe the Construction, Principle of operation, Performance characteristics of Synchronous Reluctance Motors.
2. Describe the Constructional features, Principle of operation, control and characteristics of stepper motor.
3. Explain the Construction, Principle of operation, control and characteristics of Switched Reluctance Motor and discuss their applications in speed/position control.
4. Illustrates the Principle of operation, Control, Commutation schemes and Characteristics of Permanent Magnet Brushless DC Motor.
5. Explain the Principle of operation, Control and Torque / Speed characteristics of Permanent Magnet Synchronous Motors.

UNIT 1 SYNCHRONOUS RELUCTANCE MOTORS 9

Constructional features – Axial and radial flux motors – Operating principle – Reluctance Torque – Voltage and Torque Equations – Phasor diagram - performance characteristics – Applications – Vernier motor.

UNIT 2 STEPPER MOTORS 9

Constructional features – Principle of operation – Modes of excitation - Torque production in Variable reluctance stepper motor – PM stepper- Hybrid motor – Single and multi-stack configurations – Linear and non-linear analysis – Characteristics – Drive circuits- open loop and closed loop control-Concept of lead angle – Applications.

UNIT 3 SWITCHED RELUCTANCE MOTORS 9

Constructional features – Rotary and Linear SRM – Principle of operation – Torque production and Torque equation – Power Converters and their controllers – Characteristics and Closed loop control – Computer control – Applications.

UNIT 4 PERMANENT MAGNET BRUSHLESS DC MOTORS 9

Principle of operation – Types – Magnetic circuit analysis – EMF and torque equations – Commutation in brushed and brushless DC motors – Hall sensors- Optical sensors- square wave PMBLDC drives – Sensor-less techniques – Speed/Torque characteristics - Power Converter Circuits and their controllers - Microprocessor based control – Applications.

UNIT 5 PERMANENT MAGNET SYNCHRONOUS MOTORS 9

Principle of operation – Ideal PMSM – EMF, power input and torque equations - Armature MMF – Synchronous Reactance – Phasor diagram – Torque/speed characteristics – Power controllers – Converter Volt-ampere requirements–Applications

TOTAL: 45 PERIODS

TEXT BOOK:

1. K. Venkataratnam, 'Special Electrical Machines', Universities Press (India) Private Limited, 2008
2. T. Kenjo and S. Nagamori, "Permanent Magnet and Brushless DC Motors", Clarendon Press, Oxford University, London, 1990.
3. T.J.E. Miller, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, Oxford, 1989.

REFERENCES:

1. V. V. Athani, "Stepper Motors – Fundamentals, Applications and Design", New Age International, 2013.
2. R. Krishnan "Switched Reluctance Motor and Drives" CRC Press, Washington, 2001.
3. Xia, Chang-liang. "Permanent magnet brushless DC motor drives and controls" John Wiley & Sons, 2012.
4. E.G. Janardanan, 'Special electrical machines', PHI learning Private Limited, Delhi, 2014

e-RESOURCES:

1. https://nptel.ac.in/courses/108/102/108102156/ Special Electro-mechanical Systems / IIT Delhi
2. https://nptel.ac.in/courses/108/104/108104011/ Advanced Electric Drives / IIT Kanpur

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21EEE10	MODERN POWER CONVERTERS	L T P C 3 0 0 3

Preamble:

In this course student will get exposure to basic principle of operation, structure, characteristics of modern power converters

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the working principle of single-phase thyristor-controlled converter with different types loads
2. Describe the operation, characteristics and performance parameters of three phase thyristor-controlled converter
3. Analyze the different types of dc-dc converters
4. Describe the operation of single-phase bi-directional controllers with R, L and R-L loads & 3-phase controllers
5. Explain the Principle of operation of single phase and three phase Cycloconverters

UNIT 1 SWITCHED MODE POWER SUPPLIES (SMPS) 9

DC Power supplies-Classification; Switched mode dc power supplies - with and without isolation, single and multiple outputs; Closed loop control-regulation; Design exampleson converter-closed loop performance.

UNIT 2 AC-DC CONVERTERS 9

Switched mode AC-DC converters. synchronous rectification - single and three phase topologies - switching techniques - high input power factor-reduced input current harmonic distortion-improved efficiency-with and without input-output isolation-performance indices design examples

UNIT 3 DC-AC CONVERTERS 9

Multi-level Inverters –Basic concept, classification of multilevel inverters, Principle of operation, main features and analysis of Diode clamped, Flying capacitor and cascaded multilevel inverters; Modulation schemes

UNIT 4 AC-AC CONVERTERS WITH AND WITHOUT DC LINK 9

Matrix converters-Basic topology of Commutation – current path; Modulation techniques - scalar modulation,indirect modulation; Matrix converter as only AC-DC converter; AC-AC converter with DC link - topologies and operation - with and without resonance link - converter with dc link converter; Performance comparison with matrix converter of DC link converters

UNIT 5 SOFT-SWITCHING POWER CONVERTERS 9

Soft switching techniques. ZVS, ZCS, quasi resonance operation; Performance comparison hard switched and soft switched converters, AC-DC converter, DC-DC converter, DC-AC converter.; Resonant DC power supplies.

TOTAL: 45 PERIODS

TEXT BOOK:

1. Power Electronics Handbook, M. H. Rashid, Academic press, New York, 2000.
2. Advanced DC/DC Converters, Fang Lin Luo and Fang Lin Luo, CRC Press, New York, 2004.

REFERENCES:

1. Control in Power Electronics- Selected Problem, Marian P. Kazmier kowski, R. Krishnan and Frede Blaabjerg, Academic Press (Elsevier Science), 2002
2. Power Electronics for Modern Wind Turbines, Frede Blaabjerg and Zhe Chen, Morgan & Claypool Publishers series, United States of America, 2006.
3. Krein Philip T, Elements of Power Electronics, Oxford University press, 2008

e-RESOURCES:

1. http://www.nptelvideos.in/2012/11/industrial-drives-power-electronics.html, Industrial Drives - Power Electronics, Prof. K Gopakumar, Centre for Electronics Design and Technology, IISC, Bangalore.
2. https://nptel.ac.in/courses/108104011/, —Advanced Electric Drives‖, Prof. Shyama Prasad Das, IIT Kanpur

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21EEE11		L	T	P	C
	Artificial Intelligence in Electrical Drives	3	0	0	3

Preamble

This course is designed to impart knowledge about various Artificial Intelligence -based control strategies for electrical drives.

Course Outcomes: Upon completion of the course, students will be able to:

1. Understand feed forward neural networks, feedback neural networks and learning techniques.
2. Analyze fuzziness involved in various systems and fuzzy set theory.
3. Develop fuzzy logic control for applications in electrical engineering
4. Develop genetic algorithm for applications in electrical engineering.
5. Understand the various real time applications of AI Techniques.

UNIT 1 Artificial Neural Networks **9**

Introduction-Models of Neural Network – Architectures – Knowledge representation – Artificial Intelligence and Neural networks – Learning process – Error correction learning – Hebbian learning – Competitive learning – Boltzman learning – Supervised learning – Unsupervised learning – Reinforcement learning – learning tasks.

UNIT 2 ANN Paradigms **9**

Multi – layer perceptron using Back propagation Algorithm-Self – organizing Map – Radial Basis Function Network – Functional link, network – Hopfield Network.

UNIT 3 Fuzzy Logic **9**

Introduction – Fuzzy versus crisp – Fuzzy sets – Membership function – Basic Fuzzy set operations – Properties of Fuzzy sets – Fuzzy cartesian Product – Operations on Fuzzy relations – Fuzzy logic – Fuzzy Quantifiers – Fuzzy Inference – Fuzzy Rule based system – Defuzzification methods.

UNIT 4 Genetic Algorithms **9**

Introduction-Encoding – Fitness Function-Reproduction operators – Genetic Modeling – Genetic operators – Crossover – Single–site crossover – Two-point crossover – Multi point crossover-Uniform crossover – Matrix crossover – Crossover Rate – Inversion & Deletion – Mutation operator –Mutation – Mutation Rate-Bit-wise operators – Generational cycle-convergence of Genetic Algorithm.

UNIT 5 Applications of AI Techniques **9**

AI based four quadrant operation of converter / chopper fed drive – closed loop control with current and speed feedback – V/f control and self-control of electric motor drives – speed control of DC and AC Motors.

TOTAL:45 PERIODS

TEXT BOOKS:

1. S. Russell and P. Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall, Fourth Edition, 2021
2. S.N.Sivanandam and S.N.Deepa, Principles of soft computing-Wiley India.3 rd edition, 2018

REFERENCES:

1. I. Bratko, "Prolog: Programming for Artificial Intelligencell, Fourth edition, Addison-Wesley Educational Publishers Inc., 2011.
2. R.Krishnan, Electric Motor & Drives: Modeling, Analysis and Control, Prentice hall of India, 2001, 1st Edition
3. Bimal K.Bose. Modern Power Electronics and AC Drives, Pearson Education, 2002 1st Edition

e-Resources:

1. https://www.digimat.in/nptel/courses/video/108104140/L01.html
2. https://www.digimat.in/nptel/courses/video/108104011/L01.html

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21EEE12 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

L	T	P	C
3	0	0	3

Preamble:
Provides an overview of different types of renewable energy sources and energy conversion systems and the concepts of stand-alone and grid-connected Wind, Solar and Hybrid renewable energy conversion systems are acquainted.

Course Outcomes: Upon completion of the course, students will be able to:

1. Illustrate the renewable energy resources, describe the environmental aspects of energy conversion and explain the impact of renewable energy systems on environment.
2. Explain the basic concepts of solar energy conversion systems, and explore maximum power point tracking algorithm.
3. Explain the basic concepts of wind energy conversion systems, operation of synchronous, induction generators and select the suitable generator for wind energy conversion system.
4. Analyze and comprehend the various operating modes of grid connected wind and solar energy conversion systems and describe the issues in grid integration.
5. Describe the need for hybrid renewable energy systems and expose in to Wind-PV, Wind-Diesel and Wind-Mini-hydro Systems.

UNIT 1 RENEWABLE ENERGY RESOURCES AND SYSTEMS **9**

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

UNIT 2 PHOTOVOLTAIC ENERGY CONVERSION SYSTEMS **9**

Solar radiation and measurements - Solar cells – Panels and their characteristics – Influence of insulation and temperature – PV arrays –Maximum Power Point Tracking– line commutated converters (inversion-mode) - Boost and buck-boost converters - Selection of inverter, battery sizing, array sizing– Applications – Water pumping – Street lighting. Stand-alone operation of solar energy conversion systems.

UNIT 3 WIND ENERGY CONVERSION SYSTEMS **9**

Basic principle of Wind Energy Conversion System (WECS) – Nature of Wind –Components of Wind Energy Conversion System –Generators for WECS- Classifications of WECS – Self excited induction generator - synchronous generator - Power conditioning schemes-Stand-alone operation of fixed and variable speed wind energy conversion systems.

UNIT 4 GRID-CONNECTED WIND ENERGY CONVERSION AND SOLAR ENERGY CONVERSION SYSTEMS **9**

Grid connectors –Grid connection Issues–Wind farm and its accessories -- Generator control – Performance improvements - Different schemes – Power converters for Grid connected WECS –Three phase AC voltage controllers- AC-DC-AC converters: Uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters – Line commutated inverters – multi-level inverters – Matrix converters – Grid integrated PMSG, SCIG Based WECS– Grid connected solar energy converter systems.

UNIT 5 HYBRID RENEWABLE ENERGY SYSTEMS **9**

Need for Hybrid Systems – Range and types of Hybrid systems – Case studies of Wind-PV, Wind-Diesel and Wind-Mini-hydro Systems.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. G.D. Rai, "Non - Conventional Energy Sources", 5th Edition, Khanna publishers, 2010.
2. S. N. Bhadra, D. Kastha, S. Banerjee, "Wind Electrical Systems", Oxford University Press, 2005.
3. B.H. Khan Non-conventional Energy sources Tata McGraw-Hill Publishing Company, New Delhi, 2009.
4. Mukund R. Patel, "Wind and Solar Power Systems: Design, Analysis, and Operation", CRC Press, London, 2006.

REFERENCES:

1. Ned Mohan Tore. M. Undeland, William. P. Robbins, "Power Electronics converters, Applications and design", 3rd Edition, John Wiley and Sons, 2006.
2. M. H Rashid. "Power Electronics Hand book", Academic press, 2001.
3. D. P. Kothari, K.C. Singal and Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", 2nd Edition, Prentice Hall of India, New Delhi, 2011.
4. Haitham Abu-Rub, Mariusz Malinowski, Kamal Al-Haddad, "Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications", IEEE, Wiley,2014.

e-RESOURCES:

1. https://nptel.ac.in/courses/108/105/108105058/, "Renewable Energy Resources and Technology", Prof. S. Banerjee, Dept. of Electrical Engineering, IIT Kharagpur.
2. https://nptel.ac.in/courses/108/101/108101038/, "Power Electronics", Prof. B. G. Fernandes, Dept. of Electrical Engineering, IIT Bombay.

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21EET13	POWER SYSTEM OPERATION AND CONTROL	L T P C
		3 0 0 3

Preamble:

Load Forecasting, modeling of turbines, generators and automatic controllers, Economic operation of Power Systems and Hydrothermal scheduling are illustrated and emphasizes the load frequency control and reactive power control in single area and two area power system.

Course Outcomes: Upon completion of the course, students will be able to:

1. Describe the fundamental concepts of power system operation and control
2. Analyze Power-frequency dynamics and to design power-frequency controller
3. Analyze reactive power-voltage interaction and the control actions to be implemented for maintaining the voltage profile against varying system load.
4. Analyze the optimum unit commitment problem and economic load dispatch for a power system.
5. Discuss the monitoring and control operation of power system components using digital computer.

UNIT 1 INTRODUCTION 9

Types of loads –components of system loads–load curves –load factor, demand factor, diversity factor, capacity factor, utilization factor, base load and peak load stations–Reserve Capacity and requirements–Load Forecasting–Electrical Tariff–types of tariffs–Objectives of power system control and evaluation of control strategy in power system –Need for voltage and Frequency regulation and system load characteristics

UNIT 2 REAL POWER AND FREQUENCY CONTROL 9

Basics of speed governing mechanism and modeling – speed-load characteristics – load sharing between two synchronous machines in parallel – control area concept – LFC control of a single-area power system – static and dynamic analysis of uncontrolled and controlled cases – two-area power system – modeling – static analysis of uncontrolled case – tie-line with frequency bias control – state variable model – integration of economic dispatch control with LFC.

UNIT 3 REACTIVE POWER AND VOLTAGE CONTROL 9

Generation and absorption of reactive power – basics of reactive power control – excitation systems – modeling – static and dynamic analysis – stability compensation – methods of voltage control: tap changing transformer, Shunt reactors –Shunt Capacitors –Series Capacitors –Synchronous condensers –Static VAR systems -SVC (TCR + TSC) and STATCOM.

UNIT 4 ECONOMIC DISPATCH AND UNIT COMMITMENT 9

Introduction-economic dispatch problem –cost of generation –incremental cost curve -co-ordination equations without loss and with loss, solution by direct method and λ-iteration method. (No derivation of loss coefficients). Base Point and participation factors. Statement of Unit Commitment problem –constraints; spinning reserve, thermal unit constraints, hydro constraints, fuel constraints and other constraints. UC Solution methods -Priority-list methods. Numerical problems only in priority-list method using full-load average production cost.

UNIT 5 CONTROL OF POWER SYSTEMS 9

System operating states by security control functions –Monitoring, evaluation of system state by contingency analysis –Corrective controls (Preventive, emergency and restorative) –Energy control center –SCADA system –Functions – Monitoring, Data acquisition and controls –EMS system.

TOTAL: 45 PERIODS

TEXT BOOK:

1. Olle. I. Elgerd, 'Electric Energy Systems theory – An introduction', Tata McGraw Hill Education Pvt. Ltd., New
2. S. Sivanagaraju, G. Sreenivasan., "Power System Operation and Control", Pearson Education India, 2009.

REFERENCES:

1. Abhijit Chakrabarti, Sunita Halder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.
2. Kundur P., 'Power System Stability and Control, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint, 2010.
3. Nagrath I.J. and Kothari D.P., 'Modern Power System Analysis', Tata McGraw-Hill, Fourth Edition, 2011.

e-RESOURCES:

1. http://nptel.ac.in/courses/108104052, "Power system operation and control", Prof S.N. Singh, IIT-Kanpur
2. https://www.btechguru.com/engineeringvideos/video-lesson/power-systems-operation-and-control/electrical-engineering/bc3c42e6c23f23ed~c6c45d988f670c72.html

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21EEE14	MULTILEVEL POWER CONVERTERS	L	T	P	C
		3	0	0	3

Preamble

Analysis of power converters teaches students, how to analyze and model the behavior of converters and so to improve their design and control. Moreover this with a set of confirmed algorithms specifically developed for use with power converters.

Course Outcomes: Upon completion of this course, students will be able to:

1 Examine the different topologies of multilevel inverters (MLIs) with and without DC link capacitor.
2 Examine the performance of MLIs with Bipolar Pulse Width Modulation (PWM) Unipolar PWM Carrier-Based PWM Schemes Phase Level Shifted Multicarrier Modulation
3 Demonstrate the working principles of diode clamped MLI and analyze the voltage balancing performance in Diode clamped MLI.
4 Describe the working principles of flying capacitor MLI .
5 Explain the working principles of flying capacitor MLI with reduced switch count.

UNIT 1 MULTILEVEL TOPOLOGIES 9

Introduction – Generalized Topology with a Common DC bus – Converters derived from the generalized topology – symmetric topology without a common DC link – Asymmetric topology.

UNIT 2 CASCADED H-BRIDGE MULTILEVEL INVERTERS 9

Introduction -H-Bridge Inverter, Bipolar Pulse Width Modulation, Unipolar Pulse Width Modulation. Multilevel Inverter Topologies, CHB Inverter with Equal DC Voltage, H-Bridges with Unequal DC Voltages – PWM, Carrier-Based PWM Schemes, Phase-Shifted Multicarrier Modulation, Level-Shifted Multicarrier Modulation, Comparison Between Phase- and Level-Shifted PWM Schemes-Staircase Modulation

UNIT 3 DIODE CLAMPED MULTILEVEL CONVERTER 9

Introduction – Converter structure and Functional Description – Modulation of Multilevel converters – Voltage balance Control – Effectiveness Boundary of voltage balancing in DCMC converters – Performance results.

UNIT 4 FLYING CAPACITOR MULTILEVEL CONVERTER 9

Introduction – Flying Capacitor topology – Modulation scheme for the FCMC – Dynamic voltage balance of FCMC.

UNIT 5 MULTILEVEL CONVERTER WITH REDUCED SWITCH COUNT 9

Multilevel inverter with reduced switch count-structures, working principles and pulse generation methods.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Rashid M.H,"Power Electronics Circuits, Devices and Applications", Prentice Hall India,Third Edition, New Delhi, 2014 Pearson 4th edition.
2. Sergio Alberto Gonzalez, Santiago Andres Verne, Maria Ines Valla,"Multilevel Converters for Industrial Applications", CRC Press, 22-Jul-2013, 20171st Edition.

REFERENCES:

1. Thomas A. Lipo, Pulse Width Modulation for Power Converters: Principles and Practice,D.Grahame Holmes, John Wiley & Sons, Oct-2003, 1st Edition.
2. Fang Lin Luo, Hong Ye,Advanced DC/AC Inverters: Applications in Renewable Energy,CRC Press, 22-Jan-2013, 2017, 1st Edition.
3. Hani Vahedi, Mohamed Trabelsi, Single-DC-Source Multilevel Inverters, Springer, 2019, 1stEdition.

e-Resources:

1. https://archive.nptel.ac.in/courses/108/102/108102157/- High Power Multilevel Converters-Analysis, design and operational Issues by Dr.Anandarup Das ,IIT Delhi

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21EEE15	EMBEDDED SYSTEMS	L T P C 3 0 0 3

Preamble:

This course introduces the basic functional elements and characteristics of embedded products. It also showcases various methods to be used to develop an Embedded product and how the testing has been carried out before launching a product.

Course Outcomes: Upon completion of the course, students will be able to:

1. Select the Microprocessor or Microcontroller for designing the small, medium and sophisticated embedded system.
2. Identify and select appropriate protocol from RS232,422,485, I2C, CAN based on the distance, speed, size of data to be transferred for Data transmission and reception in embedded system.
3. Apply the knowledge of different phases in Embedded Design Life Cycle and use the methods in development of embedded product development life cycle.
4. Test and identify the faults in Hardware using automatic pattern generation methods, and for software using software testing.
5. Design Digital clock, Audio player, Drone Camera, Smart cards and IoT based home security system using Arduino board or PIC 16F877A controller.

UNIT 1 INTRODUCTION TO EMBEDDED SYSTEMS 9

Definition and classification – Overview of processors – Hardware units in an Embedded system –Software embedded into system – Design technologies: Embedded Systems on Chip (SoC), Design process and challenges.

UNIT 2 EMBEDDED NETWORKING PROTOCOLS 9

Communication Protocols: RS232, RS422, RS485 – Standard, Signalling/communication Techniques, advantages, applications;**I^2C**- Master-Slave Communication, Multi-Master Communication, SDA, SCL Buses, Data Transmission speeds, Bus Interface, Frame Formats, Errors; SPI Bus – SPI Configuration with Master and a slave, Data Transmission, Multi-slave SPI Daisy-Chain Configuration; **CAN** bus Protocols: Overview, Frame formats of Standard and Extended CAN, Arbitration Field, Message Types, Error Checking and Fault Confinement, CAN Bus Traffic, CMRR.

UNIT 3 EMBEDDED PRODUCT DEVELOPMENT LIFE CYCLE AND MODELING 9

Embedded Product Development Life Cycle – Objectives, Different phases of EDLC, Modeling of EDLC, Issues in Hardware-Software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent Model, object-oriented Model.

UNIT 4 TESTING OF EMBEDDED SYSTEMS 9

Introduction: Testing, Verification, Testing Vs Verification, Embedded System Testing; **Faults in Embedded Systems-** Hardware Fault Models (Gate Level Fault Models), Software/Hardware Co-validation Fault Model, Textual Fault Models, Control-Dataflow Fault Models, State Machine Fault Models, Application-Specific Fault Models, Interface Faults, Testing of Embedded Core-Based System-on-Chips (SOCs), Test Access Mechanism, Core Test Wrapper, Non-concurrent testing, Concurrent testing; **Test Pattern Generation-** Test Plan, Test Programming, Test Pattern Generation, automatic test generation for Software/Hardware Co-validation; **Embedded Software Testing** - Software Unit Testing, Software Integration Testing, Software Validation Testing, System Unit Testing, System Integration Testing, System Validation Testing, Interaction Testing Technique between Hardware and Software in Embedded Systems.

UNIT 5 CASE STUDY - EMBEDDED SYSTEM APPLICATION DEVELOPMENT 9

Digital Clock, Audio Player, Drone with camera, Smart Card System, IoT based Home Security System

TOTAL: 45 PERIODS

TEXT BOOK:

1. Rajkamal, "Embedded System-Architecture, Programming and Design", McGraw Hill, 2011.
2. Shibu. K.V, "Introduction to Embedded Systems", McGraw Hill, 2017.

REFERENCES:

1. Lyla B Das, "Embedded Systems-An Integrated Approach", Pearson, 2013
2. James K. Peckol, "Embedded systems: A contemporary Design Tool", Wiley India Pvt. Limited, 2009
3. Edward Ashford Lee, Sanjit Arunkumar Seshia, "Introduction to Embedded Systems – A Cyber Physical System Approach", Second Edition, MIT Press, 2017

e-RESOURCES:

1. https://nptel.ac.in/courses/108/105/108105057/, "Embedded Systems", Dr. Santanu Chaudhury, Department of Electrical Engineering, IIT, Delhi.
2. http://www.nptelvideos.in/2012/11/real-time-systems.html , "Real-Time Systems", Dr. Rajib Mall, Department of Computer Science & Engineering, IIT Kharagpur

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21EEE16	EMBEDDED C PROGRAMMING	L	T	P	C
		3	0	0	3

Preamble

Introducing the basics of Embedded system programming by exposing GNC C programming tool chain with the basics of 8051 programming.

Course Outcomes: Upon completion of this course, students will be able to:

1 Deliver insight into embedded C programming and its salient features for embedded systems.
2 Illustrate the software and hardware architecture for distributed computing in embedded systems.
3 Develop a solution for problems by using the concept learned in programming using the embedded controllers.
4 Develop simple applications with 8051 by using its various features and interfacing with various external hardware.
5 Improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded programming skills.

UNIT 1 BASIC C PROGRAMMING 9

Typical C Program Development Environment - Introduction to C Programming - Structured Program Development in C - Data Types and Operators - C Program Control - C Functions - Introduction to Arrays.

UNIT 2 EMBEDDED C 9

Adding Structure to 'C' Code: Object-oriented programming with C, Header files for Project and Port, Examples. Meeting Real-time constraints: Creating hardware delays - Need for timeout mechanism - Creating loop time outs - Creating hardware timeouts.

UNIT 3 8051 PROGRAMMING IN C 9

Data types and time delay in 8051, I/O programming in 8051, Logic operations in 8051, Data conversion program in 8051, Accessing code ROM space n 8051, Data serialization using 8051.

UNIT 4 8051 SERIAL PORT AND INTERRUPT PROGRAMMING IN C 9

Basics of serial communication, 8051 interface to RS232- serial port programming in 8051. 8051 interrupts and programming, Programming for timer configuration.

UNIT 5 8051 INTERFACING 9

8051: ADC interfacing, DAC interfacing, Sensor interfacing, LCD interfacing, Stepper motor Interfacing.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Paul Deitel and Harvey Deitel, "C How to Program", 9th Edition, Pearson Education Limited, 2022, 1st edition.
2. Michael J Pont, "Embedded C", Addison-Wesley, An imprint of Pearson Education, 2002.

REFERENCES:

1. Noel Kalicharan, "Learn to Program with C". Apress Inc., 2015, 1st edition.
2. Steve Oualline, "Practical C programming", O'Reilly Media, 1997, 3rd edition.
3. Muhammad Ali Mazidi, Janice G. Mazidi and Rolin D. McKinlay, 'The 8051 Microcontroller and Embedded Systems' Prentice Hall, 2nd Edition 2007.

e-Resources:

1. https://nptel.ac.in/courses/108/105/108105057/, "Embedded Systems", Dr.Santanu Chaudhury, Department of Electrical Engineering, IIT, Delhi.
2. http://www.nptelvideos.in/2012/11/real-time-systems.html , "Real-Time Systems", Dr. Rajib Mall, Department of Computer Science & Engineering, IIT Kharagpur.

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21EEE17	EMBEDDED PROCESSORS	L	T	P	C
		3	0	0	3

Preamble

The course aims to understand the building blocks of embedded system and to have adequate understanding of various embedded development strategies with arm Communication processors. It also makes students to understanding real time operating System.

Course Outcomes: Upon completion of this course, students will be able to:

1. Interpret the basics and functionality of processor functional blocks.
2. Observe the specialty of RISC processor Architecture.
3. Incorporate the I/O hardware interface of processor with peripherals.
4. Emphasis the communication features of the processor.
5. Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in commercial embedded processors.

UNIT 1 ARM ARCHITECTURE **9**

Architecture – Memory Organization – addressing modes -Registers – Pipeline - Interrupts – Coprocessors – Interrupt Structure.

UNIT 2 ARM MICROCONTROLLER PROGRAMMING **9**

ARM general Instruction set – Thumb instruction set –Introduction to DSP on ARM- basic programming.

UNIT 3 PERIPHERALS OF ARM **9**

ARM: I/O Memory – EEPROM – I/O Ports – SRAM –Timer –UART - Serial Communication with PC – ADC/DAC Interfacing-stepper motor interfacing.

UNIT 4 ARM COMMUNICATION **9**

ARM With CAN, I2C, and SPI protocols.

UNIT 5 INTRODUCTION TO SINGLE BOARD EMBEDDED PROCESSOR **9**

Raspberry Pi Architecture - Booting Up RPi- Operating System and Linux Commands -Working with RPi using Python and Sensing Data using Python-programming - GPIO and interfacing peripherals With Raspberry Pi.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Steve Furber, 'ARM system on chip architecture',Addisonn Wesley,2nd Edition,2015.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield's ARM System Developer's Guide Designing and Optimizing System Software', Elsevier 2004, 1st Edition.

REFERENCES:

1. William Hohl, ' ARMAssebly Language' Fundamentals and Techniques, CRC Press, 2nd Edition 2014.
2. Rajkamal," Microcontrollers Architecture, Programming, Interfacing, & System Design, Pearson,2012, 2nd Edition.
3. ARM Architecture Reference Manual, LPC214x User Manual www.Nuvoton .com/websites on Advanced ARM Cortex Processors.

e-Resources:

1. https://nptel.ac.in/courses/117106111
2. https://onlinecourses.nptel.ac.in/noc20_cs15/preview
3. https://www.csie.ntu.edu.tw/~cyy/courses/assembly/12fall/lectures/handouts/lec08_ARMarc

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21EEE18	EMBEDDED CONTROL FOR ELECTRIC DRIVES	L	T	P	C
		3	0	0	3

Preamble

This course is designed to impart knowledge about various embedded system-based control strategies for electrical drives.

Course Outcomes: Upon completion of this course, students will be able to:

1 Interpret the significance of embedded control of electrical drives.
2 Deliver insight into various control strategies for electrical drives
3 Developing knowledge of Machine learning and optimization techniques for motor control.
4 Develop embedded system solutions for real-time application such as Electric vehicles and UAVs.
5 Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded system skills required for motor control strategy.

UNIT 1 INTRODUCTION TO ELECTRIC DRIVES 9

Electric drives and its classification-Four-quadrant drive-Solid State Controlled Drives-Machine learning and optimization techniques for electrical drives.

UNIT 2 EMBEDDED SYSTEM FOR MOTOR CONTROL 9

Embedded Processors choice for motor control- Sensors and interface modules for Electric drives IoT for Electrical drives applications

UNIT 3 INDUCTION MOTOR CONTROL 9

Speed control methods-PWM techniques- VSI fed three-phase induction motor- Fuzzy logic Based speed control for three-phase induction motor- Embedded processor based three phase induction motor speed control.

UNIT 4 BLDC MOTOR CONTROL 9

Overview of BLDC Motor -Speed control methods -PWM techniques- Embedded processor based BDLC motor speed control.

UNIT 5 SRM MOTOR CONTROL 9

Overview of SRM Motor -Speed control methods -PWM techniques- Embedded processor based SRM motor speed control.

TOTAL:45 PERIODS

TEXT BOOKS:

1. R.Krishnan, "Electric Motor Drives – Modeling, Analysis and Control",Prentice-Hall of India Pvt. Ltd., New Delhi,2010, 1st Edition.
2. Steve Kilts, "Advanced FPGA Design: Architecture, Implementation, and Optimization" Willey, 2007, 1st Edition.

REFERENCES:

1. VedamSubramanyam, "Electric Drives – Concepts and Applications", Tata McGraw- Hill publishing company Ltd., New Delhi, 2002, 2nd Edition.
2. K. Venkataratnam ,Special Electrical Machines, Universities Press, 2014, 1st Edition.
3. Steve Furber, 'ARM system on chip architecture', Addision Wesley, 2nd Edition 2015.

e-Resources:

1. https://archive.nptel.ac.in/courses/108/104/108104140/
2. https://www.embedded.com/mcus-or-dsps-which-is-in-motor-control/ https://www.e3s-conferences.org/articles/e3sconf/pdf/2019/13/e3sconf_SeFct2019_01004.pdf

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21EEE19	SMART SYSTEM AUTOMATION	L	T	P	C
		3	0	0	3

Preamble

This course helps the student to basic idea of role of Automation. Students are introduced to the basic design consideration of robots.

Course Outcomes: Upon completion of this course, students will be able to:

1 Understand the concepts of smart system design and its present developments.
2 Illustrate different embedded open-source and cost-effective techniques for developing solution for real time applications.
3 Acquire knowledge on different platforms and Infrastructure for Smart system design.
4 Infer about smart appliances and energy management concepts.
5 Improve Employability and entrepreneurship capacity due to knowledge upgradation on embedded system technologies.

UNIT 1 INTRODUCTION **9**

Overview of a smart system - Hardware and software selection - Smart sensors and Actuators – Communication protocols used for smart systems.

UNIT 2 HOME AUTOMATION **9**

Home Automation – System Architecture - Essential Components- Design Considerations: Control Unit, Sensing Requirements, Communication, Data Security.

UNIT 3 SMART APPLIANCES AND ENERGY MANAGEMENT **9**

Significance of smart appliances for energy management -Smart Meters: Significance, Architecture & Energy Measurement Technique – Security Considerations.

UNIT 4 SMART WEARABLE DEVICES **9**

Body Area Networks - Sensors– communication protocol for Wearable devices- Application of Smart Wearable in Healthcare & Activity Monitoring.

UNIT 5 EMBEDDED SYSTEMS AND ROBOTICS **9**

Fundamental concepts in Robotics- Robots and Controllers components - Embedded processor based: pick and place robot- Mobile Robot Design- UAV.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Grimm, Christoph, Neumann, Peter, Mahlknech and Stefan, Embedded Systems for Smart Appliances and Energy Management, Springer 2013, 1st Edition.
2. KazemSohraby, Daniel Minoli and TaiebZnati, Wireless Sensor Networks Technology, Protocols, and Applications, John Wiley & Sons, 2007, 1st Edition.

REFERENCES:

1. Thomas Bräunl, Embedded Robotics, Springer, 2003.
2. Raj Kamal, Embedded Systems - Architecture, Programming and Design, McGraw- Hill, 2008.
3. Karim Yaghmour, Embedded Android, O'Reilly, 2013.

e-Resources:

1. https://microcontrollerslab.com/home-automation-projects-ideas/
2. https://www.learnrobotics.org/blog/simple-robot/
3. https://robolabor.ee/homelab/en/iot

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21EEE20	EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS	L	T	P	C
		3	0	0	3

Preamble

To provides adequate knowledge to expose the students to the fundamentals and building of Electronic Engine Control systems, sensor functional components for vehicles, programmable controllers for vehicles management systems, teach logics of automation & communication techniques for vehicle communication.

Course Outcomes: Upon completion of this course, students will be able to:

1 Insight into the significance of the role of embedded system for automotive applications.
2 Illustrate the need, selection of sensors and actuators and interfacing with ECU.
3 Develop the Embedded concepts for vehicle management and control systems.
4 Demonstrate the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs
5 Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design and its application in automotive systems.

UNIT 1 INTRODUCTION TO AUTOMOTIVE SYSTEMS **9**

Overview of Automotive systems, fuel economy, air-fuel ratio, emission limits and vehicle performance; Electronic control Unit– open-source ECU.

UNIT 2 SENSORS AND ACTUATORS FOR AUTOMOTIVES **9**

Review of automotive sensors- sensors interface to the ECU, Smart sensor and actuators for automotive applications.

UNIT 3 VEHICLE MANAGEMENT SYSTEMS **9**

Energy Management system -Adaptive cruise control - anti-locking braking system - Safety and Collision Avoidance.

UNIT 4 ONBOARD DIAGONSTICS AND COMMUNICATION **9**

OBD, Vehicle communication protocols- Bluetooth, CAN, LIN, FLEXRAY and MOST.

UNIT 5 RECENT TRENDS **9**

Navigation- Autonomous car- Role of IoT in Automotive systems.

TOTAL:45 PERIODS

TEXT BOOKS:

1. William B. Ribbens ,"Understanding Automotive Electronics", Elseiver,8 th Edition, 2017.
2. Jurgen, R., Automotive Electronics Hand Book, McGraw Hill, 2 nd Edition, 1999.
3. L.Vlacic,M.Parent,F.Harahima,"Intelligent Vehicle Technologies",SAE International, 2001, 1st Edition, 2017.

REFERENCES:

1. Ali Emedi, Mehrdedehsani, John M Miller , "Vehicular Electric power system- land, Sea, Air and Space Vehicles" Marcel Decker, 2004, 1st Edition.
2. Jack Erjavec,JeffArias,"Alternate Fuel Technology-Electric ,Hybrid& Fuel Cell Vehicles", engage ,2012, 2nd Edition.
3. Electronic Engine Control technology – Ronald K Jurgen Chilton's guide to Fuel Injection –Ford 2 nd Edition, 2004.
4. Automotive Electricals / Electronics System and Components, Tom Denton, 5 th Edition, 2017.
5. Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 5 th Edition, 2014.
6. Automotive Hand Book, Robert Bosch, Bently Publishers, 10 th Edition, 2018.

e-Resources:

1. https://www.autosar.org/fileadmin/ABOUT/AUTOSAR_EXP_Introduction.pdf
2 https://microcontrollerslab.com/can-communication-protocol/

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21EEE21 **SOFT COMPUTING TECHNIQUES** **L T P C**
3 0 0 3

Preamble:
Concepts of neural networks, fuzzy logic and genetic algorithm are introduced and expediency of estimated calculations to provide usable solutions for complex computational problems are illustrated.

Course Outcomes: Upon completion of the course, students will be able to:

1. Summarize the soft computing constituents and conventional AI and Illustrate the soft computing techniques using neural networks, fuzzy logic and evolutionary algorithms and its characteristics.
2. Describe the neural network architectures adopted in real time applications and discuss their advancements.
3. Demonstrate the fuzzy sets, fuzzy relations, fuzzy rules, fuzzy reasoning, fuzzy systems and fuzzy decision-making approach in real life problem solving.
4. Explain the Adaptive Neuro-Fuzzy Inference Systems, classification of Neuro-Fuzzy modeling and Implement the Neuro-Fuzzy modeling and control in real time applications.
5. Discuss the basic concepts and working principle of genetic algorithm (GA), summarize the differences and similarities between GA and other traditional methods and apply the genetic algorithms in optimization problems.

UNIT 1 NEURO – FUZZY AND SOFT COMPUTING **9**

Introduction – Soft Computing Constituents and Conventional Artificial Intelligence – From Conventional AI to Computational Intelligence – Neural Networks – Fuzzy Set Theory – Evolutionary Computation – Neuro-Fuzzy and Soft Computing Characteristics.

UNIT 2 NEURAL NETWORKS **9**

Adaptive Networks – Feed Forward Networks – Supervised Learning Neural Networks – Radial Basis Function Networks – Reinforcement Learning – Unsupervised Learning Neural Networks – Adaptive Resonance Architectures – Advances in Neural Networks.

UNIT 3 FUZZY LOGIC **9**

Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations – Membership Functions – Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems – Fuzzy Expert Systems – Fuzzy Decision Making.

UNIT 4 NEURO – FUZZY MODELING **9**

Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Classification and Regression Trees – Data Clustering Algorithms – Rule base Structure Identification – Neuro-Fuzzy Control – Case Studies.

UNIT 5 GENETIC ALGORITHMS **9**

Basic Concepts – working principle – Basic operators and Terminologies like individuals – Genes – encoding – fitness function and reproduction – Genetic modeling – Significance of Genetic operators – Inheritance operator – Breeding (crossover) – inversion and deletion – mutation operator – Bitwise operator – GA optimization problem –Travelling Salesman Problem (TSP) – Differences and similarities between GA and other traditional methods – Applications of GA.

TOTAL: 45 PERIODS

TEXT BOOK:

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, "Neuro-Fuzzy and Soft Computing", Prentice Hall of India, 2003.
2. S. Rajasekaran, G.A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm", PHI Learning., 2003.

REFERENCES:

1. S. N. Sivanandam, S.N. Deepa, "Principles of Soft Computing", John Wiley & Sons, 2011.
2. George J. Klir and Bo Yuan, "Fuzzy sets and fuzzy logic – theory and applications", Prentice Hall, 1995.

e-RESOURCES:

1. https://nptel.ac.in/courses/127/105/127105006/, "Fuzzy logic and Neural Networks", Prof. Dhilip Kumar Pratihar, IIT - Kharagpur.
2. https://nptel.ac.in/courses/108/108/108108148/, "Neural Networks for signal processing", Prof. Shayan Srinivasa Garani, IISc - Bengaluru.

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21EEE22 **BIOMEDICAL INSTRUMENTATION** L T P C
3 0 0 3

Preamble: Describe the theory of operation, functioning and clinical application of medical devices such as Medical Monitoring and recording equipment's, Physiotherapy and Electrotherapy Equipment, Medical Imaging Equipment, Critical care Equipment, Therapeutic Equipment's and carry out operational checks on such devices.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the functioning of Human anatomy systems like Cardio-vascular, Respiratory, Nervous Systems and Identify the Bio Electric signals, Potential Electrodes and Bio Amplifiers.
2. Describe the recording and analysis of Electro-Physiological signals and its characteristics. Articulate the Electrical safety in Medical Environment.
3. Describe the recording and analysis of Non-Electrical Parameters and Bio Chemical Measurements.
4. Explain the basic principles in medical imaging techniques such as X Ray, CT, MRI and Ultrasonography.
5. Depict the importance of Assist Devices and role of Bio Telemetry in Patient Monitoring.

UNIT 1 FUNDAMENTALS OF MEDICAL INSTRUMENTATION 9

Physiological systems of the body – Cardio-vascular system, respiratory system, nervous system, Sources of biomedical signals, Basic medical instrumentation system, Bio-electric signals and electrodes – The origin of Bio-potentials– bio-potential electrodes– biological amplifiers.

UNIT 2 ELECTRO-PHYSIOLOGICAL RECORDING AND ITS SAFETY 9

Electro-cardiograph (ECG), Electro-encephalograph (EEG), Electro-myograph (EMG), Phono-cardiograph (PCG), lead systems and recording methods, typical waveforms and signal characteristics. Electrical safety in medical environment, shock hazards – leakage current-Instruments for checking safety parameters of biomedical equipment.

UNIT 3 BIO-CHEMICAL AND NON-ELECTRICAL PARAMETER MEASUREMENT 9

Measurement of Heart rate, Pulse rate, Measurement of blood pressure – Direct and Indirect methods, Pulmonary function measurements – spirometer, Blood Gas analysers – pH of blood, measurement of blood pCO_2, pO_2.

UNIT 4 IMAGING MODALITIES AND ANALYSIS 9

Nature of X rays, X ray machine – Tube, grid, power supply, Visualization of X-rays, Computer tomography – System components, MRI – Basic NMR components, Ultrasonography – Physics of Ultrasonic waves – Basic pulse-echo apparatus – A, B and M mode.

UNIT 5 ASSIST DEVICES AND BIOTELEMETRY 9

Cardiac pacemakers, DC Defibrillator, Hemodialysis machine, Heart lung machine, Ventilators, Bio-telemetry – Single channel and multi-channel wireless telemetry systems

TOTAL:45 PERIODS

TEXT BOOKS:

1. Khandpur R S, "Handbook of Biomedical Instrumentation", Tata McGraw Hill, New Delhi, 2014.
2. Leslie Cromwell, "Biomedical Instrumentation and Measurement", Prentice Hall of India, New Delhi, 2007.

REFERENCES:

1. John G. Webster, "Medical Instrumentation Application and Design", 3rd Edition, Wiley India Edition, 2007.
2. Joseph J. Carr and John M. Brown, "Introduction to Biomedical Equipment Technology", John Wiley and Sons, New York, 2004.
3. Scott K N, Mathur A K, "Textbook of Biomedical Instrumentation", CBS publishers, New Delhi, 2007.

e-RESOURCES:

1. http://oyc.yale.edu/biomedical-engineering/beng-100#overview, "Frontiers of Biomedical Engineering", W. Mark Saltzman, Chemical and Biomedical Engineering at Yale University.
2. https://www.youtube.com/watch?v=JC_TDo0xSb4, "Bio medical Instrumentation", Prof. Suryakant Bhosale, Hansa Embedded Systems Academy, Mumbai.

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21EEE23 **PRINCIPLES OF ROBOTICS** **L T P C**
3 0 0 3

Preamble:
This course introduces the functions of basic components and various types of end effectors andsensors used in robots. It illustrates the spatial transformation techniques to obtain forward and inverse kinematics equations of robot manipulators used in trajectory planning with their safety considerations and economic impact.

Course Outcomes: Upon completion of the course, students will be able to:

1. Demonstrate the relationships between mechanical structures of industrial robots and their operational workspace characteristics with their applications.
2. Understand the use of various drive systems and end effectors with their design considerations.
3. Analyze the requirements of different sensors needed in robotics for performing machine visionapplications.
4. Illustrate an ability to apply spatial transformation techniques to obtain forward and inverse kinematics equations of robot manipulators required for trajectory planning.
5. Describe the safety considerations and economic impact of robotic operations in different environments.

UNIT 1 BASIC CONCEPTS **9**

Robot – Definition – Robot Anatomy – Coordinate Systems, Work Envelope Types and Classification - Specifications - Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions -Need for Robots - Applications.

UNIT 2 ROBOT DRIVE SYSTEMS AND END EFFECTORS **9**

Pneumatic Drives - Hydraulic Drives - Mechanical Drives - Electrical Drives - D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of Drives, End Effectors -Grippers - Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT 3 SENSORS AND MACHINE VISION **9**

Requirements of a sensor, principles and applications - Position sensors – Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, Pneumatic Position Sensors, Range Sensors, Laser Range Meters, Touch Sensors, Binary Sensors, Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data - Signal Conversion, Image Storage, Lighting Techniques. Image Processing and Analysis - Data Reduction, Segmentation, Feature Extraction, Object Recognition, Applications - Inspection, Identification, Visual Serving and Navigation.

UNIT 4 ROBOT KINEMATICS AND ROBOT PROGRAMMING **9**

Forward Kinematics, Inverse Kinematics; Degrees of Freedom, Velocity and Forces - Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design. Introduction to Robot Programming Languages.

UNIT 5 IMPLEMENTATION AND ROBOT ECONOMICS **9**

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for Robot Operations – Economic Analysis of Robots.

TOTAL: 45 PERIODS

TEXT BOOK:

1. Klafter R.D., Chmielewski T.A and Negin M., -Robotic Engineering - An Integrated Approach, Prentice Hall
2. Groover M.P., -Industrial Robotics -Technology Programming and Applications‖, McGraw Hill, 2001.

REFERENCES:

1. John J. Craig, -Introduction to Robotics Mechanics and Control‖, Third edition, Pearson Education, 2009.
2. Janakiraman P.A., -Robotics and Image Processing‖, Tata McGraw Hill, 1995.
3. R.K. Mittal and I.J. Magrath, -Robotics and Control‖, Tata McGraw Hill, New Delhi,4thReprint, 2005.
4. Rajput R.K., -Robotics and Industrial Automation‖, S. Chand and Company, 2008.

e-RESOURCES:

1. https://nptel.ac.in/courses/107/106/107106090/, -Introduction to Robotics‖, Prof. Asokan Thondiyath, IIT, Madras.
2. https://nptel.ac.in/courses/112/105/112105249/ , -Introduction to Robots and Robotics‖, Prof. Dilip Kumar Pratihar, IIT – Kharagpur.

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21EEE24	SENSORS AND TRANSDUCERS	L	T	P	C
		3	0	0	3

Preamble

Provides adequate knowledge about the various sensors used to measure various physical parameters and the fundamentals of signal conditioning, data acquisition and communication systems.

Course Outcomes: Upon completion of this course, students will be able to:

1 Understand the various calibration techniques and signal types for sensors.
2 Explain about the various sensors in the Automotive and Mechatronics applications
3 Study the basic principles of various smart sensors.
4 Understand the operation of various optical, pressure and temperature sensors.
5 Implement the DAQ systems with different sensors for real time applications.

UNIT 1 INTRODUCTION 9

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types.

UNIT 2 MOTION, PROXIMITY AND RANGING SENSORS 9

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT 3 FORCE, MAGNETIC AND HEADING SENSORS 9

Strain Gauge, Load Cell, Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall Effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers.

UNIT 4 OPTICAL, PRESSURE AND TEMPERATURE SENSORS 9

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric – Tactile sensors, Temperature – IC, Thermistor, RTD, Thermocouple. Acoustic Sensors – flow and level measurement, Radiation Sensors - Smart Sensors - Film sensor, MEMS & Nano Sensors, LASER sensors.

UNIT 5 SIGNAL CONDITIONING AND DAQ SYSTEMS 9

Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Ernest O Doebelin, "Measurement Systems – Applications and Design", Tata McGraw-Hill, 2009
2. Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", 12th edition, Dhanpat Rai & Co, New Delhi, 2013.

REFERENCES:

1. Patranabis D, "Sensors and Transducers", 2 nd Edition, PHI, New Delhi, 2010.
2. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999.
3. Richard Zurawski, "Industrial Communication Technology Handbook" 2nd edition, CRC Press, 2015.

e-Resources:

1. https://archive.nptel.ac.in/courses/108/108/108108147/
2. https://www.studocu.com/in/document/sardar-patel-university/mechanical-engineering/sensor-and-signal-conditioning-nptel/26618066

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21EEE25	PLC AND AUTOMATION	L T P C 3 0 0 3

Preamble:

Provides the knowledge of factory and process automation components, PLC tools, PLC Programming and Networking, Human Interface Systems involved in industrial automation

Course Outcomes: Upon completion of the course, students will be able to:

1. Discuss the evolution and need for PLC, and summarize the importance of control elements in Industrial automation and their selection criteria.
2. Describe the architecture, types, capabilities of PLC, and discuss the concept of PLC communication with PC, PLC wiring and summarize the selection criteria for PLC's.
3. Illustrate the types of PLC programming, arithmetic functions, data transfer concepts using bit manipulation instructions and develop a simple process control programs using Relay Ladder Logic.
4. Discuss the need of Human-Machine Interface (HMI) in Industrial Automation and explain the configuration of HMI, HMI objects and Interfacing with PLC.
5. Describe the PLC networking, IEEE Standards and Protocols, and Design a PLC configurations for Manufacturing automation and Process automation applications.

UNIT 1 INTRODUCTION TO FACTORY & PROCESS AUTOMATION 9

Industrial Versions–Control elements of Industrial Automation–IEC/ ISA Standards for Control Elements–Selection criteria for control elements– Construction of Relay Ladder logic with different control elements –Need for PLC – PLC evolution.

UNIT 2 PROGRAMMABLE LOGIC CONTROLLERS 9

Architecture of PLC – Types of PLC – PLC modules, PLC Configuration -Scan cycle – Capabilities of PLC– Selection criteria for PLC – PLC Communication with PC – PLC Wiring– Installation of PLC and its Modules.

UNIT 3 PROGRAMMING OF PLC 9

Types of Programming –PLC arithmetic functions – Timers and counters – data transfer – comparison and manipulation instructions, Proportional, Integral, Derivative control instructions, Pulse Train Output / Pulse Width modulation generation - simple process control programs using Relay Ladder Logic.

UNIT 4 HUMAN-MACHINE INTERFACE(HMI) SYSTEMS 9

Need for Human-Machine Interface (HMI) in Industrial Automation, Types of HMI – Configuration of HMI, Screen development and navigation, Configuration of HMI objects and Interfacing with PLC.

UNIT 5 PLC NETWORKING AND APPLICATIONS 9

PLC Networking– Networking standards and IEEE Standard – Protocols – Field bus – Process bus and Ethernet – CAN. Case studies of Manufacturing automation and Process automation.

TOTAL:45 PERIODS

TEXT BOOK:

1. W. Bolton, "Programmable logic controllers", Elsevier Ltd, 2015.
2. Frank D Petruzella, "Programmable Logic Controllers ", McGraw Hill Inc, 2005

REFERENCES:

1. John R Hackworth and Fredrick D Hackworth Jr." Programmable Logic Controllers: Programming Methods and Applications", Pearson Education, 2006.
2. Kelvin T Erikson, "Programmable Logic Controllers ", Dogwood Valley Press, 2005.
3. John W Webb & Ronald A Reis, "Programmable logic controllers: Principles and Applications", Prentice Hall India, 2003.

e-RESOURCES:

1. http://nptel.ac.in/courses/108105062/, "Introduction to Industrial Automation and Control" Department of Electrical Engineering, IIT Kharagpur.
2. http://nptel.ac.in/courses/108105088/, "Architecture of Industrial Automation Systems" Department of Electrical Engineering, IIT Kharagpur.

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21EEE26	VIRTUAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

Preamble

The course deals with the study of basic concepts, Software, Programming Structures, Instrument Connectivity and applications of Virtual Instrumentation.

UNIT 1 VIRTUAL INSTRUMENTATION **9**

Concept & Architecture – Role of Hardware and Software in Virtual Instrumentation - Advantages of Virtual instruments over Conventional Instruments.

UNIT 2 SOFTWARE OVERVIEW **9**

Graphical Programming-Advantages- LabVIEW environment: Front panel - Controls palette - Controls and Indicators- Block diagram- Functions palette-Functions and Libraries - Data flow programming – Creating simple Virtual Instruments- Editing -Debugging and Running a Virtual Instrument - Creating SUBVIs.

UNIT 3 PROGRAMMING STRUCTURES **9**

Control Structures: FOR loops - WHILE loops - Creation of Local and Global variables. Selection structures: CASE structure - Sequence structures - Flat and Stacked structures - Arrays: Creation and array operations. Clusters - Assembling and disassembling of elements using cluster operations. Waveform graphs and charts - String functions and File I/O functions.

UNIT 4 INSTRUMENT CONNECTIVITY **9**

GPIB Hardware & Software specifications - Serial Communication - RS232 - RS 485 standards- PXI / PCI: Controller and Chassis Configuration – configuration using VISA.

UNIT 5 APPLICATIONS OF VIRTUAL INSTRUMENTATION **9**

Image Acquisition - Machine vision system - Machine Vision Hardware and Software - Introduction to IMAQ and IMAQ Vision. Motion Control: Components of a motion control system – Software for configuration - Prototyping and Development - General Applications.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Sanjay Gupta, Joseph John, "Virtual Instrumentation using LabVIEW", Tata McGraw-Hill, New Delhi, 2010.
2. Jovitha Jerome, "Virtual Instrumentation using LabVIEW", Prentice Hall of India, New Delhi, 2011.

REFERENCES:

1. National Instruments, "LabVIEW: Basics I & II Manual", National Instruments, Bengaluru, 2005.
2. Garry W Johnson, Richard Jennings, "LabVIEW Graphical Programming", Tata McGraw Hill, New Delhi, 2011.
3. Jeffrey Travis, Jim Kring, "LabVIEW for Everyone: Graphical Programming Made Easy and Fun", 3rd Edition, Prentice Hall of India Learning Private Limited, New Delhi, 2006.
4. Rick Bitter, Taqi Mohiuddin, Matt Nawrocki, "LabView: Advanced Programming Techniques", 2nd Edition, CRC Press, USA, 2006.

e-Resources:

1. https://www.ni.com/en-in/shop/labview/virtual-instrumentation.html

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21EEE27	ADVANCED CONTROL SYSTEMS	L T P C 3 0 0 3

Preamble:

Provides modeling of linear continuous time systems using state space techniques and solution of state equations for homogeneous and non-homogeneous systems. Stability analysis methods of linear and nonlinear systems are acquainted.

Course Outcomes: Upon completion of the course, students will be able to:

1. Develop the state space model for linear continuous time systems.
2. Develop the solution of state equation for homogeneous and non-homogeneous systems.
3. Construct the phase portraits for linear and nonlinear systems.
4. Identify the stability of given system using Lyapunov and Krasovskii's method of stability.
5. Design the state feedback controller and observer.

UNIT 1 STATE VARIABLE ANALYSIS 9

Concept of state – State Variable and State Model – State models for linear and continuous time systems: Electrical and Mechanical Systems – State Diagrams – Realization of state models: State space to transfer function model and Transfer function to state space model.

UNIT 2 SOLUTION OF STATE EQUATION 9

Solution of Homogeneous and Non-homogeneous systems – State transition matrix and its properties – Solution of state and output equation – Role of Eigen values and vectors – Controllability and Observability – Output Controllability.

UNIT 3 NON-LINEAR SYSTEMS 9

Features of linear and non-linear systems – Common physical non-linearities – Typical examples – Concept of phase portraits – Singular points – Isocline method – Describing functions of various non-linearities – Limit cycles – Jump resonance – Asynchronous Quenching – Conditions for stability.

UNIT 4 STABILITY ANALYSIS 9

Introduction – Equilibrium Points – Stability in the sense of Lyapunov – BIBO and asymptotic stability – Lyapunov stability analysis for linear and non-linear systems – Krasovskii's method for non-linear systems.

UNIT 5 CONTROLLER SYNTHESIS FOR NON-LINEAR SYSTEMS 9

Non-linear internal model control – Model predictive controller – Pole Placement by State Feedback for both SISO and MIMO Systems – Full order observer and Reduced order observer.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. M. Gopal, "Modern Control System Theory", New Age International Publishers, 2002.
2. K. Ogata, "Modern Control Engineering", 5th edition, PHI, 2012.

REFERENCES:

1. Norman. S. Nise, "Control Systems Engineering", 7th Edition, Wiley Publishers, 2014.
2. Bay. J.S., "Linear State Space Systems", McGraw-Hill, 1999.
3. K. P. Mohandas, "Modern Control Engineering", Sanguine Technical Publishers, 2006.

e-RESOURCES:

1. http://nptel.ac.in/courses/108103007/, "Advanced Control Systems", Dr. Somanath Majhi, IIT, Guwahati.
2. http://nptel.ac.in/courses/101108047/, "Advanced Control System Design", Dr. Radhakanth Padhi, IISC Bangalore.

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21EEE28	DIGITAL IMAGE PROCESSING	L T P C 3 0 0 3

Preamble:
Provides the knowledge of Image processing fundamentals, mathematical transforms, image enhancement techniques, image compression and segmentation techniques for processing digital images through an algorithm are acquainted and the concepts of image restoration procedures are introduced.

Course Outcomes: Upon completion of the course, students will be able to:

1. Discuss digital image processing fundamentals, components and elements of images and summarize the types of color models.
2. Apply the image enhancement techniques for processing images in spatial and frequency domain.
3. Illustrate the methodologies for image segmentation and object recognition.
4. Apply wavelet transform and image compression techniques for practical image processing applications.
5. Implement noise filtering, image restoration and reconstruction techniques in real time applications and describe the principles of Computed Tomography (CT)

UNIT 1 DIGITAL IMAGE FUNDAMENTALS 9

Introduction – Origin – Fundamental Steps in Digital Image Processing – Components – Elements of Visual Perception, Image Sensing and Acquisition, Sampling and Quantization, Relationships between pixels, Color models – RGB color model – CMY and CMYK color models – HIS color model.

UNIT 2 IMAGE ENHANCEMENT 9

Spatial Domain: Basic intensity transformation, Histogram processing, fundamentals of Spatial Filtering, Smoothing and Sharpening Spatial Filtering. **Frequency Domain:** Sampling –Fourier Transform – Sampling theorem and aliasing, DFT, Smoothing and Sharpening in the frequency domain filters.

UNIT 3 IMAGE SEGMENTATION AND OBJECT RECOGNITION 9

Fundamentals, Point, line and Edge detection, Thresholding, Region Based segmentation, Watershed segmentation algorithm. Patterns and Pattern classes, Recognition based on decision theoretic methods– matching –Optimum statistical classifiers.

UNIT 4 WAVELETS AND IMAGE COMPRESSION 9

Wavelets – Sub-band coding – Haar Transform, Multi-resolution expansions. **Compression:** Fundamentals – Image compression standards– **Coding**: Run length – Huffman – Arithmetic - Bit plane – predictive and wavelet.

UNIT 5 IMAGE RESTORATION AND RECONSTRUCTION 9

Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering, Image reconstruction from projections – Principles of Computed Tomography (CT)– Projections and the Radon Transform – The Fourier–Slice Theorem – Reconstruction Using Parallel–Beam Filtered Back projections – Reconstruction using Fan-Beam Filtered Back projections

TOTAL:45 PERIODS

TEXT BOOKS:

1. Rafael C, Gonzalez and Richard E Woods, "Digital Image Processing", Pearson Education Asia, Third Edition, 2007.
2. Anil K Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India, 2nd edition 1997.

REFERENCES:

1. William K Pratt, "Digital Image Processing", John Wiley NJ, 4th Edition, 2007.
2. S Jayaraman, S Esakkirajan, T Veerakumar, "Digital Image Processing", Tata Mc Graw Hill Education Private Limited, First Edition,2009.

e-RESOURCES:

1. http://nptel.ac.in/courses/117105079/, "Digital Image Processing", Prof. P. K. Biswas, Indian Institute of Technology, Kharagpur.
2. http://nptel.ac.in/courses/106105032/, "Digital Image Processing", Prof. G. Harit, Indian Institute of Technology, Kharagpur.

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21EEE29 **ELECTRIC VEHICLE ARCHITECTURE** **L T P C**
3 0 0 3

Preamble: Electric and Hybrid vehicles are gaining popularity globally. This course introduces the fundamental concepts of electric, hybrid and autonomous vehicles, electrical machines used and different communication protocols.

Course Outcomes: Upon completion of the course, students will be able to:

1. Summarize the History and Evolution of EVs, Hybrid and Plug-In Hybrid EVs.
2. Analyse the details and Specifications for the various EVs developed.
3. Describe the various EV components.
4. Describe the hybrid vehicle control strategy.
5. Describe the concepts related in the Plug-In Hybrid Electric Vehicles.

UNIT 1 VEHICLE ARCHITECTURE AND SIZING **9**

Electric Vehicle History, and Evolution of Electric Vehicles. Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Mountain Bike - Motorcycle- Electric Cars and Heavy Duty EVs. -Details and Specifications.

UNIT 2 VEHICLE MECHANICS **9**

Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire –Road mechanics, Propulsion System Design.

UNIT 3 POWER COMPONENTS AND BRAKES **9**

Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Example

UNIT 4 HYBRID VEHICLE CONTROL STRATEGY **9**

Vehicle supervisory control, Mode selection strategy, Modal Control strategies.

UNIT 5 PLUG-IN HYBRID ELECTRIC VEHICLE **9**

Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging Mechanisms-Advantages of PHEVs.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
2. Build Your Own Electric Vehicle, Seth Leitman, Bob Brant, McGraw Hill, Third Edition 2013

REFERENCES:

1. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, First edition 2017.
2. The Electric Vehicle Conversion Handbook: How to Convert Cars, Trucks, Motorcycles, and Bicycles -- Includes EV Components, Kits, and Project Vehicles Mark Warner, HP Books, 2011.

e-RESOURCES:

1. https://nptel.ac.in/courses/108/103/108103009/ (IIT Guwahati)
2. https://nptel.ac.in/courses/108/102/108102121/ (IIT Delhi)

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21EEE30	DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLE	L T P C 3 0 0 3

Preamble: Gives an overview, topology, design, and simulation of different types of converters used in electric vehicles (EV). It covers a wide range of topics ranging from the fundamentals of EV and its stepwise approach, simulation of the proposed converters for real-time applications. It explains the need for power electronics in the improvement of performance in EV.

Course Outcomes: Upon completion of the course, students will be able to:

1. Understand the architecture and vehicle dynamics of electric vehicles.
2. Explain the working of motors used in Electric Vehicles.
3. Understand and learn the simulation basics of control systems.
4. Devise power electronics based control strategies for electric vehicles.
5. compute a power stage transfer functions for DC-DC converters

UNIT 1 ELECTRIC VEHICLE DYNAMICS 9

Standard drive cycles-Dynamics of Electric Vehicles-Tractive force-Maximum speed, torque, power, energy requirements of EVs

UNIT 2 MOTORS FOR ELECTRIC VEHICLES 9

Introduction – Speed And Torque control of above and below rated speed-Speed control of EV in the constant power region of electric motors. DC Motors, Induction Motor, Permanent Magnet Synchronous Motors (PMSM), Brushless DC Motors, Switched Reluctance Motors (SRMs). Synchronous Reluctance Machines-Choice of electric machines for EVs.

UNIT 3 BASICS OF SIMULATION IN CONTROL SYSTEMS 9

Transfer Function-How to build transfer function, identify Poles, zeros, draw time response plots, bode plot (Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions, RHP Pole and RHP Zero Functions), state space modelling-transfer function from state space Model.

UNIT 4 MODELING OF DC-DC CONVERTERS 9

Overview of PWM Converter Modelling -Power Stage Modelling - PWM Block Modelling – Voltage Feedback Circuit and Small-Signal Model of PWM Converter - Averaging Power Stage Dynamics - Average Models for buck/boost Converter - Small-Signal Model of Converter Power Stage - Frequency Response of Converter.

UNIT 5 POWER STAGE TRANSFER FUNCTIONS OF DC – DC CONVERTERS 9

Power Stage Transfer Functions of buck-boost Converter in CCM Operation, Input-to-Output Transfer Function, Duty Ratio-to-Output Transfer Function, Load Current-to-Output Transfer Function.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.
2. Emerging Power Converters for Renewable Energy and Electric Vehicles Modeling, Design, and Control, Md. Rabiul Islam,Md. Rakibuzzaman Shah, Mohd. Hasan Ali, CRC Press,2021, 1 st Edition.

REFERENCES:

1. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition" CRC Press, Taylor & Francis Group, Third Edition 2021.
2. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005,1st Edition.

e-RESOURCES:

1. Web course on "Introduction to Hybrid and Electric Vehicles" by Dr. Praveenkumar and Prof. S Majhi, IIT Guwahati available on NPTEL at https://nptel.ac.in/courses/108/103/108103009/
2. Video Course on "Electric Vehicles" by Prof. Amitkumar Jain, IIT Delhi available on NPTEL at https://nptel.ac.in/courses/108/102/108102121/

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21EEE31	ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL	L T P C 3 0 0 3

Preamble: students will have a broad and fundamental understanding of Internal Combustion Engines with EV Design, Mechanism and Controlling preliminaries.

Course Outcomes: Upon completion of the course, students will be able to:

1. Understand various types of I.C. Engines, Cycles of operation and Identify fuel supply systems for different types of engines.
2. Describe the concepts related with EV, HEV and to compare the same with internal combustion engine vehicles.
3. Explain the concepts related with batteries and parameters of battery.
4. Find gain margin & phase margin for various types of transfer functions of boost converter.
5. Demonstrate the Control of AC Machines.

UNIT 1 INTERNAL COMBUSTION ENGINES **9**

IC Engines, BMEP and BSFC, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions.

UNIT 2 ELECTRIC VEHICLES AND VEHICLE MECHANICS **9**

Electric Vehicles (EV), Hybrid Electric Vehicles (HEV), Engine ratings- Comparisons of EV with internal combustion Engine vehicles- Fundamentals of vehicle mechanics.

UNIT 3 BATTERY MODELING, TYPES AND CHARGING **9**

Batteries in Electric and Hybrid Vehicles - Battery Basics -Battery Parameters. Types- Lead Acid Battery - Nickel-Cadmium Battery - Nickel-Metal-Hydride (NiMH) Battery - Li-Ion Battery - Li-Polymer Battery, Zinc-Air Battery, Sodium-Sulphur Battery, Sodium-Metal-Chloride, Research and Development for Advanced Batteries. Battery Modelling, Electric Circuit Models. Battery Pack Management, Battery Charging.

UNIT 4 CONTROL PRELIMINARIES **9**

Control Design Preliminaries - Introduction - Transfer Functions – Bode plot analysis for First order and second order systems - Stability - Transient Performance- Power transfer function for boost converter - Gain margin and Phase margin study-open loop mode.

UNIT 5 CONTROL OF AC MACHINES **9**

Introduction- Reference frame theory, basics-modeling of induction and synchronous machine in various frames- Vector control- Direct torque control.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Electric and Hybrid Vehicles, Design Fundamentals, Third Edition, Iqbal Husain, CRC Press, 2021.
2. C.C. Chan and K.T. Chau, 'Modern Electric Vehicle Technology', OXFORD University Press, 2001, 1st Edition.

REFERENCES:

1. Power Electronic Converters,: Dynamics and Control in Conventional and Renewable Energy Applications, Teuvo Suntio, Tuomas Messo, Joonas Puukko, 1st Edition, Wiley - VCH
2. Wie Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, John Wiley & Sons, 2017, 2nd Edition.

e-RESOURCES:

1. https://nptel.ac.in/courses/108106170

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21EEE32 **DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM**

L	T	P	C
3	0	0	3

Preamble: This course is to gain a fair knowledge on charging scheme in renewable based EV charging and the wireless power transfer technique.

Course Outcomes: Upon completion of the course, students will be able to:

1. Illustrate various charging techniques and to know charging standards and regulations.
2. Demonstrate the working o DC-DC converters used for charging systems and principles
3. Illustrate the advantages of renewable system based charging systems
4. Demonstrate the principles of wireless power transfer.
5. Analyze the standards for wireless charging

UNIT 1 CHARGING STATIONS AND STANDARDS **9**

Introduction-Charging technologies- Conductive charging, EV charging infrastructure, International standards and regulations - Inductive charging, need for inductive charging of EV, Modes and operating principle, Static and dynamic charging, Bidirectional power flow, International standards and regulations.

UNIT 2 POWER ELECTRONICS FOR EV CHARGING **9**

Layouts of EV Battery Charging Systems-AC charging-DC charging systems- Power Electronic Converters for EV Battery Charging- AC–DC converter with boost PFC circuit, with bridge and without bridge circuit - Bidirectional DC–DC Converters- Non-isolated DC–DC bidirectional converter topologies- Half-bridge bidirectional converter.

UNIT 3 EV CHARGING USING RENEWABLE AND STORAGE SYSTEMS **9**

Introduction- - EV charger topologies , EV charging/discharging strategies - Integration of EV charging-home solar PV system , Operation modes of EVC-HSP system , Control strategy of EVCHSP system-fast-charging infrastructure with solar PV and energy storage.

UNIT 4 WIRELESS POWER TRANSFER **9**

Introduction - Inductive, Magnetic Resonance, Capacitive types. Wireless Chargers for Electric Vehicles - Types of Electric Vehicles - Battery Technology in EVs -Charging Modes in EVs – Benefits of WPT. - WPT Operation Modes - Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO 19363

UNIT 5 POWER FACTOR CORRECTION IN CHARGING SYSTEM **9**

Need for power factor correction- Boost Converter for Power Factor Correction, Sizing the Boost Inductor, Average Currents in the Rectifier and calculation of power losses

TOTAL:45 PERIODS

TEXT BOOKS:

1. Mobile Electric Vehicles Online Charging and Discharging, Miao Wang Ran Zhang Xuemin(Sherman) Shen, Springer 2016, 1stEdition.
2. Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration, Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, IET 2021, 1stEdition.

REFERENCES:

1. Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration, Rajiv Singh, Sanjeevikumar Padmanaban, Sanjeet Dwivedi, Marta Molinas and Frede Blaabjerg, IET 2021, 1stEdition.
2. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Electric Vehicles Modern Technologies and Trends. Springer Publisher 1stEdition, 2021.
3. Alicia Triviño-Cabrera, José M. González-González, José A. Aguado, Wireless Power Transferor Electric Vehicles: Foundations and Design Approach, Springer Publisher1stEdition 2020.

e-RESOURCES:

1. https://elearn.nptel.ac.in/shop/iit-workshops/completed/e-mobility-and-electric-vehicle-engineering/
2. https://onlinecourses.nptel.ac.in/noc22_ee53/preview

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21EEE33	TESTING OF ELECTRIC VEHICLE	L T P C 3 0 0 3

Preamble: This course is to gain a fair knowledge on functional safety and testing of electric motors.

Course Outcomes: Upon completion of the course, students will be able to:

1. Describe the status and other details of standardization of EVs
2. Illustrate the testing protocols for EVs and HEV components
3. Examine the safety cycle and need for functions safety for EVs
4. Analyze the problems related with EMC for EV components.
5. Evaluate the EMI in motor drive and DC-DC converter system.

UNIT 1 EV STANDARDIZATION 9

Introduction - Current status of standardization of electric vehicles, electric Vehicles and Standardization - Standardization Bodies Active in the Field - Standardization activities in countries like Japan. The International Electro Technical Commission - Standardization of Vehicle Components.

UNIT 2 TESTING OF ELECTRIC MOTORS AND CONTROLLERS FOR ELECTRIC AND HYBRID ELECTRIC VEHICLES 9

Test Procedure Using M-G Set, electric motor, controller, application of Test Procedure, Analysis of Test Items for the Type Test - Motor Test and Controller Test (Controller Only). - Test Procedure Using Eddy Current Type Engine Dynamometer, Test Strategy, Test Procedure, Discussion on Test Procedure. Test Procedure Using AC Dynamometer.

UNIT 3 FUNDAMENTALS OF FUNCTIONAL SAFETY AND EMC 9

Functional safety life cycle - Fault tree analysis - Hazard and risk assessment – software development - Process models - Development assessments - Configuration management - Reliability - Reliability block diagrams and redundancy - Functional safety and EMC - Functional safety and quality - Standards - Functional safety of autonomous vehicles.

UNIT 4 EMC IN ELECTRIC VEHICLES 9

Introduction - EMC Problems of EVs, EMC Problems of Motor Drive, EMC Problems of DC-DC Converter System, EMC Problems of Wireless Charging System, EMC Problem of Vehicle Controller, EMC Problems of Battery Management System, Vehicle EMC Requirements

UNIT 5 EMI IN MOTOR DRIVE AND DC-DC CONVERTER SYSTEM 9

Overview - EMI Mechanism of Motor Drive System, Conducted Emission Test of Motor Drive System, IGBT EMI Source, EMI Coupling Path, EMI Modelling of Motor Drive System. EMI in DC-DC Converter, EMI Source, The Conducted Emission High-Frequency, Equivalent Circuit of DC-DC Converter System, EMI Coupling Path.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005, 1st Edition.
2. Electromagnetic Compatibility of Electric Vehicle, Li Zhai, Springer 2021, 1st Edition.

REFERENCES:

1. EMC and Functional Safety of Automotive Electronics, Kai Borgeest, IET 2018, 1st Edition.
2. EMI/EMC Computational Modeling Handbook, Druce Archam beault, colin branch, Omar M.Ramachi ,Springer 2012, 2nd Edition.
3. Automotive EMC, Mark Steffika, Springer 2013, 1st Edition.

e-RESOURCES:

1. https://e-amrit.niti.gov.in/arai-standard
2. https://onlinelibrary.wiley.com/doi/abs/10.1002/9781118561942.ch63

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21EEE34	GRID INTEGRATION OF ELECTRIC VEHICLES	L T P C 3 0 0 3

Preamble: This course is to gain a fair knowledge on EV & V2G on the smart grids renewable energy systems.

Course Outcomes: Upon completion of the course, students will be able to:

1. Discuss the basic concepts related with V2G
2. Illustrate the technical benefits and environmental challenges of V2G
3. Analyse the technical, economics. business, regulatory & political challenges related with V2G
4. Describe the impact of EV and V2G on smart grid and renewable energy system
5. Explain the concept of grid integration and management of EVs.

UNIT 1 DEFINITION, And STATUS Of V2G **9**

Defining Vehicle to Grid (V2G) - History and Development of V2G. Incorporating V2G to the EV, Auditing and Metering, V2G in Practice , V2G - Power Markets and Applications . Electricity Markets and V2G Suitability , Long-Term Storage, Renewable Energy, and Other Grid Applications , Beyond the Grid: Other Concepts Related to V2G.

UNIT 2 BENEFITS AND CHALLENGES OF V2G **9**

Benefits of V2G, Technical Benefits: Storage Superiority and Grid Efficiency, Economic Benefits: EV Owners and Societal Savings, Environment and Health Benefits: Sustainability in Electricity and Transport, Other Benefits.

UNIT 3 CHALLENGES TO V2G **9**

Technical Challenges-Battery Degradation, Charger Efficiency, Aggregation and Communication, V2G in a Digital Society. The Economic and Business Challenges to V2G - Evaluating V2G Costs and Revenues , EV Costs and Benefits , Adding V2G Costs and Benefits , Additional V2G Costs , The Evolving Nature of V2G Costs and Benefits. Regulatory and Political Challenges to V2G , V2G and Regulatory Frameworks , Market Design Challenges. Other V2G Regulatory and Legal Challenges.

UNIT 4 IMPACT OF EV AND V2G ON THE SMART GRID AND RENEWABLE ENERGY SYSTEMS **9**

Introduction - Types of Electric Vehicles - Motor Vehicle Ownership and EV Migration - Impact of Estimated EVs on Electrical Network - Impact on Drivers and the Smart Grid - Standardization and Plug-and-Play - IEC 61850 Communication Standard and IEC 61850-7-420 Extension.

UNIT 5 GRID INTEGRATION AND MANAGEMENT OF EVS **9**

Introduction - Machine to Machine (M2M) in distributed energy management systems - M2M communication for EVs - M2M communication architecture (3GPP) - Electric vehicle data logging - Scalability of electric vehicles -M2M communication with scheduling.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press 2017, 1st Edition.
2. Plug In Electric Vehicles in Smart Grids, Charging Strategies, Sumedha Rajakaruna , Farhad Shahnia

REFERENCES:

1. ICT for Electric Vehicle Integration with the Smart Grid, Nand Kishor 1; Jesus Fraile-Ardanuy, IET 2020, 1st Edition.
2. Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid, Junwei Lu and Jahangir Hossain, IET 2015, 1st Edition.
3. Lance Noel · Gerardo Zarazua de Rubens Johannes Kester · Benjamin K. Sovacool, Vehiclcto-Grid A Sociotechnical Transition Beyond Electric Mobility, 2019, 1st Edition.

e-RESOURCES:

1. https://archive.nptel.ac.in/courses/108/106/108106170/
2. https://www.nrel.gov/transportation/project-ev-grid-integration.html

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21EEE36	ENERGY STORAGE SYSTEMS	L T P C
		3 0 0 3

Preamble: The advent of new breakthroughs and improvements in energy storage is transforming vehicular technology and energy solutions. Electric Vehicles (EVs) are a promising alternative to ICE (Internal Combustion Engine) vehicles. Innovations in battery technology, reduction in moving parts, and zero tailpipe emissions make EVs an economically viable and sustainable mobility solution.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain different types storage technologies.
2. Design a thermal storage system.
3. Model battery storage system.
4. Analyze the thermodynamics of fuel cell.
5. Analyze the appropriate storage technologies for different applications.

UNIT 1 INTRODUCTION **9**

Necessity of energy storage – types of energy storage – comparison of energy storage technologies – Applications

UNIT 2 THERMAL STORAGE SYSTEM **9**

Thermal storage – Types – Modeling of thermal storage units – Simple water and rock bed storage system – pressurized water storage system – Modelling of phase change storage system –Simple units, packed bed storage units - Modelling using porous medium approach, Use of TRNSYS.

UNIT 3 ELECTRICAL ENERGY STORAGE **9**

Fundamental concept of batteries – measuring of battery performance, charging and discharging,power density, energy density, and safety issues. Types of batteries – Lead Acid, Nickel –Cadmium, Zinc Manganese dioxide, Li-ion batteries - Mathematical Modelling for Lead Acid Batteries – Flow Batteries.

UNIT 4 FUEL CELL **9**

Fuel Cell – History of Fuel cell, Principles of Electrochemical storage – Types – Hydrogen oxygen cells, Hydrogen air cell, Hydrocarbon air cell, alkaline fuel cell, detailed analysis – advantages and disadvantages.

UNIT 5 ALTERNATE ENERGY STORAGE TECHNOLOGIES **9**

Flywheel, Super capacitors, Principles & Methods – Applications, Compressed air Energy storage,Concept of Hybrid Storage – Applications, Pumped Hydro Storage – Applications.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Ibrahim Dincer and Mark A. Rosen, 'Thermal Energy Storage Systems and Applications',John Wiley
2. Ru-shi Liu, Lei Zhang and Xueliang sun, 'Electrochemical technologies for energy storage and

REFERENCES:

1. Lunardini.V.J, 'Heat Transfer in Cold Climates', John Wiley and Sons 1981, 1st Edition.
2. Schmidt.F.W. and Willmott.A.J., 'Thermal Energy Storage and Regeneration',Hemisphere Publishing Corporation, 1981, 1st Edition.
3. James Larminie and Andrew Dicks, 'Fuel cell systems Explained', Wiley publications, 3rd Edition, 2018.

e-RESOURCES:

1. https://nptel.ac.in/courses/113105102- Electrochemical Energy Storage by Prof. Subhasish Basu Majumder, IIT Kharagpur
2. https://archive.nptel.ac.in/courses/108/106/108106182/- ElectricVehicles and Renewable Energy by Prof.Ashok Jhunjhunwala ,IIT Madras

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21EEE37 **HYBRID ENERGY TECHNOLOGY** L T P C
3 0 0 3

Preamble: The energy has become an important and one of the basic infrastructures for the economic development of the country. It is imperative for the sustained growth of the economy. This course envisages the new and renewable source of energy, available in nature and to expose the students on sources of energy crisis and the alternates available, also stress up on the application of non-conventional energy technologies.

Course Outcomes: Upon completion of the course, students will be able to:

1. Analyze the impacts of hybrid energy technologies on the environment and demonstrate them to harness electrical power.
2. Select a suitable Electrical machine for Wind Energy Conversion Systems and simulate wind energy conversion system
3. Design the power converters such as AC-DC, DC-DC, and AC-AC converters for SPV systems.
4. Analyze the power converters such as AC-DC, DC-DC, and AC-AC converters for Hybrid energy systems.
5. Interpret the hybrid renewable energy systems

UNIT 1 INTRODUCTION TO HYBRID ENERGY SYSTEMS 9

Hybrid Energy Systems – Need for Hybrid Energy Systems – Solar-Wind-Fuel Cell-Diesel, Wind-Biomass-Diesel, Micro-Hydel-PV, Ocean and geyser energy - Classification of Hybrid Energy systems –Importance of Hybrid Energy systems – Advantages and Disadvantages - Environmental aspects of renewable energy - Impacts of renewable energy generation on the environment - Present Indian and international energy scenario of conventional and RE sources - Ocean energy, Hydel Energy – Wind Energy, Biomass energy, Hydrogen energy - Solar Photovoltaic (PV) and Fuel cells: Operating principles and characteristics.

UNIT 2 ELECTRICAL MACHINES FOR WIND ENERGY CONVERSION SYSTEMS (WECS) 9

Review of reference theory fundamentals –Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG).

UNIT 3 POWER CONVERTERS AND ANALYSIS OF SOLAR PV SYSTEMS 9

Power Converters for SPV Systems - Line commutated converters (inversion-mode) - Boost and buck boost converters- selection of inverter, battery sizing, array sizing - Analysis of SPV Systems – Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems

UNIT 4 ANALYSIS OF POWER CONVERTERS FOR HYBRID ENERGY SYSTEMS 9

Introduction to Power Converters – Stand-alone Converters -AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters - Bi-Directional Converters - Grid-Interactive Inverters - Matrix converter –Merits and Limitations.

UNIT 5 CASE STUDIES FOR HYBRID RENEWABLE ENERGY SYSTEMS 9

Hybrid Systems- Range and type of Hybrid systems – Performance Analysis – Cost Analysis – Case studies of Diesel-PV, Wind-PV-Fuel-cell, Micro-hydel-PV, Biomass-Diesel-Fuel-cell systems.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Bahman Zohuri, "Hybrid Energy Systems", Springer, First Edition, 2018.
2. S.M. Muyeen, "Wind Energy Conversion Systems", Springer First Edition, 2012

REFERENCES:

1. Ernst Joshua, Wind Energy Technology, PHI, India, 2018, 3rd Edition.
2. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electrical Systems", Oxford University Press, 7th Impression, 2005.
3. Rashid.M. H "Power electronics Hand book", Academic press,4th Edition, 2018

e-RESOURCES:

1. https://nptel.ac.in/courses/103103206- Renewable Energy Engineering: Solar, Wind and Biomass Energy Systems by Prof. Vaibhav Vasant Goud, Prof. R. Anandalakshmi, IIT Guwahati.
2. https://archive.nptel.ac.in/courses/108/105/108105058/- Energy Resources and Technology by Prof.S.Banerjee,IIT,Kharagpur

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21EEE38	DESIGN AND MODELING OF RENEWABLE ENERGY SYSTEMS	L	T	P	C
		3	0	0	3

Preamble: The energy has become an important and one of the basic infrastructures for the economic development of the country. It is imperative for the sustained growth of the economy. This course envisages the new and renewable source of energy, available in nature and to expose the students on sources of energy crisis and the alternates available, also stress up on the application of non-conventional energy technologies.

Course outcomes: Upon completion of the course, students will be able to

1. Review the perspectives of renewable energy systems.
2. Integrate photovoltaic systems with grid.
3. Study inverter for PV systems.
4. Elaborate the working of small wind power systems.
5. Study the features of induction machine and doubly fed induction machine.

UNIT 1 RENEWABLE ENERGY SYSTEMS: TECHNOLOGY OVERVIEW AND PERSPECTIVES 9

Introduction-State of the Art- Examples of Recent Research and Development Challenges and Future Trends.

UNIT 2 SINGLE-PHASE GRID-CONNECTED PHOTOVOLTAIC SYSTEMS 9

Introduction- Demands for Grid-Connected PV Systems-Power Converter Technology for Single- Phase PV Systems, Transformer less AC-Module Inverters (Module-Integrated PV Converters,Transformer less Single-Stage String Inverters, DC-Module Converters in Transformer less Double-Stage PV Systems.

UNIT 3 THREE-PHASE PHOTOVOLTAIC SYSTEMS: STRUCTURES, TOPOLOGIES 9

Introduction-PV Inverter Structures, Three-Phase PV Inverter Topologies- -Control Building Blocks for PV Inverters, Modulation Strategies for Three-Phase PV Inverters, Implementation of the Modulation Strategies., Grid Synchronization, Implementation of the PLLs for Grid Synchronization, Current Control, Implementation of the Current Controllers, Maximum Power Point Tracking.

UNIT 4 SMALL WIND ENERGY SYSTEMS 9

Introduction-Generator Selection for Small-Scale Wind Energy Systems - Turbine Selection for Wind Energy- Self-Excited Induction Generators for Small Wind Energy Applications- Permanent Magnet Synchronous Generators for Small Wind Power Applications- Grid-Tied Small Wind Turbine Systems- Magnus Turbine – Based Wind Energy System.

UNIT 5 DOUBLY-FED INDUCTION GENERATOR-BASED WECS 9

Introduction – modelling of induction machine in machine variable form and arbitrary reference frame, modelling of Doubly-fed Induction Generator.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Ahmad Azar, Nashwa Kamal, "Design, Analysis and Applications of Renewable Energy Systems", Academic Press, First Edition, 2021.
2. Ahmad Azar, Nashwa Kamal, "Renewable Energy Systems", Academic Press, First Edition, 2021.

REFERENCES:

1. Power Conversion and Control of Wind Energy Systems, Bin Wu, 2011, Wiley-IEEE, 1st Edition.
2. Wind Electrical Systems, S.N. Bhadra, 2005, Oxford, 7th Impression.
3. Wind Power Integration - Connection and System Operational Aspects, Brendan Fox, 2014, IET, 2nd Edition.

e-Resources:

1. https://www.mdpi.com/journal/applsci/topical_collections/Susta_Energy
2. https://www.mathworks.com/help/sps/ug/single-phase-grid-connected-in-pv-system.html

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21EEE39 ELECTRICAL ENERGY MANAGEMENT AND AUDITING L T P C
3 0 0 3

Preamble:

Provides the basic understanding of energy auditing, energy management and energy conservation. Impart the knowledge of energy conservation measures in electrical energy systems. In addition, the economic aspects such as payback calculations, life cycle costing analysis is covered in this course.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the need of energy audit and energy management and identify the energy conservation schemes and its importance.
2. Suggest the management methods for energy systems.
3. Sequence the methods of improving efficiency of electric motor.
4. Identify the impact of power factor in electrical system for energy conservation and to design a good illumination system with energy conservation schemes.
5. Examine the economic evaluation of energy conservation solutions adopted.

UNIT 1 INTRODUCTION **9**

Basic Principle of Energy audit – definitions, Concept, types of audits and approach – Energy Conservation Schemes and its importance– Energy audit of Industries – Instruments for energy auditing.

UNIT 2 ENERGY MANAGEMENT **9**

Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting – Roles and Responsibilities of Energy manager and auditors Energy manger – Check list for top management.

UNIT 3 ENERGY EFFICIENT MOTORS **9**

Energy efficient motors - factors affecting energy efficiency and minimising motor losses in operation – Factors affecting efficiency during rewinding – Speed control of Induction motor– variable speed drives – Star Labelling of Energy Efficient Induction Motors.

UNIT 4 POWER FACTOR IMPROVEMENT AND LIGHTING **9**

Power factor – methods of improvement, location of capacitors, power factor with non-linear loads, effect of harmonics on power factor – Good lighting system design and practice, lighting control, lighting energy audit.

UNIT 5 FINANCIAL MANAGEMENT **9**

Investment – Need and Appraisal and Criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return - Cash flows – Risk and Sensitivity Analysis, Financing Options-Energy performance contracts and role of Energy Service Companies (ESCOs).

TOTAL: 45 PERIODS

TEXT BOOK:

1. W.R. Murphy and G. McKay Butter worth, "Energy management", Heinemann publications, 2014.
2. Paul o' Callaghan, "Energy management", Mc-Graw Hill Book company-1st edition, 1998.
3. General Aspects of energy audit and Management (Unit1, 2 & 5), Guide Books for National Certification Examination for Energy Managers and Energy Auditors, Bureau of Energy Efficiency, 4th edition, 2015.
4. Energy Efficiency in Electrical Utilities (Unit3 & 4), Guide Books for National Certification Examination for Energy Managers and Energy Auditors, Bureau of Energy Efficiency, 4th Edition, 2015.

REFERENCES:

1. John. C. Andreas, "Energy efficient electric motors", Marcel Dekker Inc. Ltd, 2nd edition, 1995.
2. Wayne C. Turner, "Energy management hand book", John Wiley and sons, 8th edition, 2012.
3. Sonal Desai, "Hand Book of Energy Audit", Tata McGraw hill, 2015.
4. Prasanna Chandra, "Financial Management", Tata Mc-Graw Hill, 7th Edition, 2007.

e-RESOURCES:

1. http://aipnpc.org/Guidebooks.aspx, Bureau of Energy Efficiency.
2. www.tatapower.com, TATA Power.
3. www.eeca.govt.nz, Energy Efficiency and Conservation Authority (EECA) is the government agency that works to improve the energy efficiency of New Zealand.

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21EEE40 GRID INTEGRATING TECHNIQUES AND CHALLENGES L T P C
3 0 0 3

Preamble: Grid Integrating technologies are transforming the traditional way of operation of the grid to meet the electricity demand. The smart grids have become a channel providing the way towards an environmental friendly, reliable and resilient power grid.

Course Outcomes: Upon completion of the course, students will be able to:

1. Review the power sector scenario in India
2. Understand the basic concepts of a microgrid system
3. Model a converter for power grid distributed system
4. Integrate wind energy system.
5. Describe the grid integration of WECS and PV systems

UNIT 1 PRESENT POWER SCENARIO IN INDIA **9**

Introduction - Thermal Power Plant , Components of Thermal Power Plant , Major Thermal Power Plants in India-Gas-Based Power Generation - Nuclear Power Plants -Hydropower Generation - Pumped Storage Plants - Solar Power - Wind Energy – Power plants India.

UNIT 2 POWER GRIDS **9**

Introduction -Electric Power, Background , The Construction of a Power Grid System , Basic Concepts of Power Grids -Load Models - Transformers in Electric Power Grids - Modelling a Microgrid System

UNIT 3 MODELING OF CONVERTERS IN POWER GRID DISTRIBUTED GENERATION SYSTEMS **9**

Introduction - Single-Phase DC/AC Inverters with Two Switches, Three-Phase DC/AC Inverters, Pulse Width Modulation Methods, The Triangular, The Identity Method, Analysis of DC/AC Three-Phase Inverters. Micro grid of Renewable Energy Systems- DC/DC Converters in Green Energy -Pulse Width Modulation -Sizing of an Inverter for Microgrid Operation, Sizing of a Rectifier for Microgrid Operation,The Sizing of DC/DC Converters for Micro grid

UNIT 4 WIND ENERGY SYSTEM GRID INTEGRATION **9**

Introduction- Significance of Electrical Power Quality in Wind Power System- Integration Issues in Grid-Connected Wind Energy- Effect of Power Quality Issues, Importance of Custom Power Devices- Power Quality Point of View.

UNIT 5 GRID INTER CONNECTION **9**

Grid Code requirements - Grid integration of WECS-Grid Integration of PV systems and Real-time Application.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Brian D'Andrade "The Power Grid", Academic Press, 1st Edition, 2017.
2. Yang Han, "Modeling and Control of Power Electronic Converters for Microgrid Applications",

REFERENCES:

1. Siegfried Heier, "Grid Integration of Wind Energy: Onshore and Offshore Conversion Systems", John Wiley & Sons, Ltd, 2014, 3rd Edition
2. Integration of Renewable Energy Sources with Smart Grid, M. Kathiresh, A. Mahaboob Subahani, and G.R. Kanaga chidambaresan, Scrivener & Wiley, 2021, 1st Edition
3. Control and Operation of Grid-Connected Wind Energy Systems, Ali M. Eltamaly, Almoataz Y. Abdelaziz, Ahmed G. Abo-Khalil, Springer 2021, 1st Edition.

e-RESOURCES:

1. https://www.academia.edu/14628492/Current_Power_Scenario_In_India
2. https://energyeducation.ca/encyclopedia/Electrical_grid

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21EEE41	POWER PLANT INSTRUMENTATION AND CONTROL	L T P C 3 0 0 3

Preamble: Disseminate the student with the functions and instrumentation available in a modern power generation plant.

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain about the various methods of power generation.
2. Understand about the electrical and non electrical parameters measurement in power plants.
3. Know about the various analyzers in power plant.
4. Explain about the various control methods of turbine boiler control.
5. Understand about the monitoring and control of various parameters in turbine.

UNIT 1 OVERVIEW OF POWER GENERATION **9**

Brief survey of methods of power generation – Hydro, thermal, nuclear, solar and wind power – Importance of instrumentation in power generation – Thermal power plants – Block diagram – Details of boiler processes - UP&I diagram of boiler – Cogeneration.

UNIT 2 MEASUREMENTS IN POWER PLANTS **9**

Electrical measurements – Current, voltage, power, frequency, power factor etc. – Non electrical parameters – Flow of feed water, fuel, air and steam with correction factor for temperature – Steam pressure and steam temperature – Drum level measurement – Radiation detector – Smoke density measurement – Dust monitor.

UNIT 3 ANALYSERS IN POWER PLANTS **9**

Flue gas oxygen analyser – Analysis of impurities in feed water and steam – Dissolved oxygen analyser – Chromatography – pH meter – Fuel analyser – Pollution monitoring instruments.

UNIT 4 CONTROL LOOPS IN BOILER **9**

Combustion control – Air/fuel ratio control – Furnace draft control – Drum level control – Main steam and reheat steam temperature control – Super heater control – Air temperature – Deaerator control – Distributed control system in power plants – Interlocks in boiler operation.

UNIT 5 TURBINE – MONITORING AND CONTROL **9**

Speed, vibration, shell temperature monitoring and control – Steam pressure control – Lubricant oil temperature control – Cooling system.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Sam G. Dukelow, 'The Control of Boilers', Instrument Society of America, 1991.
2. P.K. Nag, 'Power Plant Engineering', Tata McGraw Hill, 2001.

REFERENCES:

1. S.M. Elonka and A.L. Kohal, 'Standard Boiler Operations', Tata McGraw Hill, New Delhi,1994.
2. R.K.Jain, 'Mechanical and Industrial Measurements', Khanna Publishers, New Delhi, 1995.
3. E.Al. Wakil, 'Power Plant Engineering', Tata McGraw Hill, 1984.

e-RESOURCES:

1. https://nptel.ac.in/courses/112107291
2. https://www.youtube.com/watch?v=9njuNoLIADY

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21EEE42 **SMPS AND UPS** L T P C
3 0 0 3

Preamble: This course is to gain a fair knowledge on working of isolated & non-isolated DC-DC converters and study different configurations of the UPS.

Course Outcomes: Upon completion of the course, students will be able to:

1. Demonstrate the working of buck boost and buck- boost converters in continuous and discontinuous conduction mode.
2. Build buck/boost converters using suitable design method.
3. Analyze the behaviors of isolated DC-DC converters and to design SMPS for battery operated vehicle.
4. Compute state space averaged model and transfer function for buck, boost and buck-boost converters.
5. Demonstrate the P, PI and PID controller performance analytically and by simulation for buck boost and buck-boost converters.

UNIT 1 ANALYSIS OF NON-ISOLATED DC-DC CONVERTERS 9

Basic topologies: Buck, Boost and Buck-Boost - Principles of operation – Continuous conduction mode– Concepts of volt-sec balance and charge balance – Analysis and design based on steady-state relationships – Introduction to discontinuous conduction mode.

UNIT 2 ANALYSIS OF ISOLATED DC-DC CONVERTERS 9

Introduction - classification- forward- flyback- push pull – half bridge – full bridge topologies- C'uk converter as cascade combination of boost followed by buck – isolated version of C'uk converter -design of SMPS – Introduction to design of magnetic components for SMPS, using relevant software- Simulation of bidirectional DC DC converter (both non-isolated and isolated) considering EV as an example application.

UNIT 3 CONVERTER DYNAMICS 9

AC equivalent circuit analysis – State space averaging – Circuit averaging – Transfer function model for buck, boost and buck-boost converters – Simulation of basic topologies using state space model derived – Comparison with the circuit model based simulation already carried out.

UNIT 4 CONTROLLER DESIGN 9

Review of P, PI, and PID control concepts – gain margin and phase margin – Bode plot-based analysis – Design of controller for buck, boost and buck-boost converters.

UNIT 5 POWER CONDITIONERS AND UPS 9

Introduction – Power line disturbances – Power conditioners – UPS: Offline and On-line – Need for filters – Filter for PWM VSI – Front-end battery charger – boost charger.

TOTAL:45 PERIODS

TEXT BOOKS:

1. Robert W. Erickson & Dragon Maksimovic, " Fundamentals of Power Electronics", Third Edition, 2020
2. Ned Mohan," Power Electronics: A First Course", Johnwiley, 2013.

REFERENCES:

1. Marian K. Kazimierczuk and Agasthya Ayachit,"Laboratory Manual for Pulse-Width Modulated DC–DC Power Converters", Wiley 2016.
2. Power Electronics handbook, Industrial Electronics series, S.K.Varenina, CRC press, 2002.
3. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.

e-RESOURCES:

1. https://archive.nptel.ac.in/courses/108/102/108102145/
2. https://clearn.nptel.ac.in/shop/nptel/power-electronics/

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21EEO01	PLC AND SCADA	L T P C 3 0 0 3

Preamble:
Provides the knowledge of Control Elements in Industrial automation, PLC architecture and tools, PLC Programming, Human Machine Interface (HMI) systems and showcase the SCADA Architecture, Tools and its configuration, PLC and SCADA Networking protocols and PLC Applications.

Course Outcomes: Upon completion of the course, students will be able to:

1. Discuss the developments in industrial automation, evolution of PLCs and describe the fundamentals components of PLC and its architecture.
2. Describe the PLC programming fundamentals, process control programs using Relay Ladder Logic and illustrate the significance of human machine interface (HMI) in Industrial Automation.
3. Discuss the history, recent trends and architecture of SCADA, and summarize the tools and run-time packages used to design and develop the programs and SCADA HMI graphics for industrial and process automation.
4. Describe the networking standards and communication Protocols of PLC and SCADA, and illustrate the interfacing of SCADA with PLC, drive, and other field devices.
5. Design and develop a control system for industrial and process automation applications.

UNIT 1 INTRODUCTION TO PROGRAMMABLE LOGIC CONTROLLER **9**

History and developments in industrial automation – Vertical integration of industrial automation – Control elements in industrial automation – PLC introduction: Evolution of PLCs – Components of PLC – Architecture of PLC – I/O modules.

UNIT 2 PROGRAMMABLE LOGIC CONTROLLER **9**

Instructions in PLC – Program control instructions, math instructions, data manipulation Instructions, sequencer and shift register instructions. PID instructions, PTO / PWM generation - Simple process control programs using Relay Ladder Logic. Introduction to Human Machine Interface.

UNIT 3 SUPERVISORY CONTROL AND DATA ACQUISITION **9**

Overview – Developer and run-time packages – Architecture – Tools – Tags – Graphics - Alarm logging – Tag logging – Trends – History – Report generation, VB and C Scripts for SCADA application

UNIT 4 COMMUNICATION PROTOCOLS OF PLC AND SCADA **9**

PLC: Networking- Networking standards and IEEE Standard – Protocols, SCADA: Proprietary and open Protocols – OLE/OPC – DDE – Server/Client Configuration – Interfacing of SCADA with PLC, drive, and other field devices.

UNIT 5 APPLICATIONSOF PLC **9**

Case studies of Temperature control, Valve Sequencing, Conveyor Belt control, Control of a Process, Material Sorting, and Elevator System Problems

TOTAL:45 PERIODS

TEXT BOOK:

1. F.D. Petruzella, "Programmable Logic Controllers", Tata Mc-Graw Hill, Third edition, 2010.
2. David Bailey, Edwin Bright, "Practical SCADA for industry", Newness, Burlington, 2003.

REFERENCES:

1. John R Hackworth and Fredrick D Hackworth Jr.," Programmable Logic Controllers: Programming Methods and Applications", Pearson Education, 2006.
2. William T Shaw, "Cyber security for SCADA systems", PennWell, 2006.
3. Gordon Clarke, Deon Reyneders, Edwin Wright, –Practical Modern SCADA Protocols", Newness Publishing, 2004.

e-RESOURCES:

1. https://nptel.ac.in/courses/108/106/108106022/, "Supervisory Control And Data Acquisition (SCADA)", Department of electrical engineering, IIT Madras
2. https://nptel.ac.in/courses/108/105/108105088/, "Industrial Automation and Control", Department of Electrical Engineering, IIT Kharagpur.

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21EEO02	RENEWABLE ENERGY SOURCES	L T P C 3 0 0 3

Preamble:

Importance of alternative energy sources for electricity generation using solar, wind, biomass, ocean, geothermal energy sources with their types of energy conversion systems and applications are acquainted.

Course Outcomes: Upon completion of the course, students will be able to:

1. Describe the principle of solar radiation and its measurements, solar thermal collectors, solar thermal energy conversion and discuss the solar thermal energy storage options.
2. Outline the classifications of Wind Turbines, and explicate the principle of Wind Energy Conversion System and its performance, and show the options for wind energy storage.
3. Explain the production of Bio-fuels, Biogas, Ethanol and Bio diesel from Biomass using Bio-chemical conversion, Gasification, Biogas plants and Digesters, and discuss the environmental benefits of Biomass energy.
4. Discuss the principle of Power generation using Ocean energy resources such as Tidal Energy, Wave Energy and Ocean Thermal Energy and its applications.
5. Explain the principle of Geothermal Energy Conversion, fuel cell, hydrogen energy system and discuss the methods of harnessing geothermal energy and its utilization.

UNIT 1 SOLAR ENERGY 9

Solar Energy: Solar Energy – Measurements of solar Radiation – Solar Thermal Collectors – Flat Plate and Concentrating Collectors – Solar Thermal Energy Storage – Solar Thermal Energy Conversion – Solar Photovoltaic System.

UNIT 2 WIND ENERGY 9

Wind Energy: Classification of Wind Turbine – Types of Rotors – Wind Energy Conversion Systems – Wind Energy generators and its performance – Wind Energy Storage – Applications – Hybrid systems.

UNIT 3 BIOMASS ENERGY 9

Biomass Energy: Biomass – Bio fuels – Biogas – Biomass Conversion Technologies – Biomass Chemical Conversion – Biomass gasifier – Biogas plants – Digesters – Ethanol production – Bio diesel production and environmental benefits.

UNIT 4 OCEAN ENERGY 9

Tidal Energy: Tidal Energy Characteristics, Range, Estimation and Economics – Types of Tidal Power Plants; **Wave energy**: Factors affecting Wave Energy – Wave Energy Conversion Machines; **OTEC**: Working principle – Types – Applications.

UNIT 5 GEOTHERMAL, FUEL CELL& HYDROGEN ENERGY 9

Geothermal: Geothermal Resources – Geothermal Power Generation and its utilization; **Fuel Cell**: Types of Fuel Cell – Principle of operation – operating characteristics; **Hydrogen Energy System**: Hydrogen Production – Hydrogen Storage – Characteristics and Applications.

TOTAL:45 PERIODS

TEXT BOOK:

1. D.P. Kothari, K.C. Singal, Rakesh Ranjan, "Renewable Energy Sources and Emerging Technologies", PHI Learning Private Limited, New Delhi, Second Edition, 2012.
2. G.D. Rai, "Non-Conventional Energy Sources", Khanna Publishers, New Delhi, 2011.

REFERENCES:

1. Sukhatme. S.P., "Solar Energy", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.
2. Godfrey Boyle, "Renewable Energy, Power for a Sustainable Future", Oxford University Press, U.K., 3rd Edition, 2012.
3. G.N. Tiwari, "Solar Energy – Fundamentals, Design, Modelling and Applications", Narosa Publishing House, New Delhi, 2002.

e-RESOURCES:

1. http://nptel.ac.in/courses/108105058/1, Energy Resources & Technology, Prof. S. Banerjee, NPTEL Videos, IIT Kharagpur,
2. https://onlinecourses.nptel.ac.in/noc17_bt03, Bioenergy, Prof. Mainak Das NPTEL Course, IIT Delhi.

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21EEO03 **EMBEDDED AND REAL TIME SYSTEMS** **L T P C**
3 0 0 3

Preamble:
This course introduces the basic functional elements and characteristics of embedded system products. It also showcases various methods to be used to develop an Embedded product and how the testing has been carried out before launching of a products.

Course Outcomes: Upon completion of the course, students will be able to:

1. Select the Microprocessor or Microcontroller to develop the small, medium and sophisticated embedded systems.
2. Identify and select appropriate protocol from RS232, RS422, RS485, I^2C, CAN based on the communication distance, speed, size of data to be transferred between master and slave device and/or peripherals or sub-systems.
3. Apply the knowledge of different phases in Embedded Design Life Cycle and use the methods in development of embedded product development and deployment.
4. Apply the Real time operating system techniques for designing of RTOS based Embedded System.
5. Test and identify the faults in Hardware using automatic pattern generation method, and use software testing tool to find the errors in software.

UNIT 1 INTRODUCTION TO EMBEDDED SYSTEMS **9**

Definition and classification – Overview of processors – Hardware units in an Embedded system –Software embedded into system – Design technologies: Embedded Systems on Chip (SoC), Design process and challenges, Introduction to PLC.

UNIT 2 EMBEDDED NETWORKING PROTOCOLS **9**

Communication Protocols: **RS232, RS422, RS485 –** Standard, Signalling/communication Techniques, advantages, applications; **I^2C**- Master-Slave Communication, Multi-Master Communication, SDA,SCL Buses, Data Transmission speeds, Bus Interface, Frame Formats, Errors; **SPI** Bus – SPI Configuration with Master and a slave, Data Transmission, Multi-slave SPI Daisy-Chain Configuration; **CAN** bus Protocols: Overview, Frame formats of Standard and Extended CAN, Arbitration Field, Message Types, Error Checking and Fault Confinement, CAN Bus Traffic, CMRR.

UNIT 3 EMBEDDED PRODUCT DEVELOPMENT LIFE CYCLE AND MODELING **9**

Embedded Product Development Life Cycle – Objectives, Different phases of EDLC, Modeling of EDLC, Issues in Hardware-Software Co-design, Data Flow Graph, state machine model, Sequential Program Model, concurrent Model, object-oriented Model.

UNIT 4 RTOS BASED EMBEDDED SYSTEM DESIGN **9**

Introduction to basic concepts of RTOS – Task, process and threads, Interrupt Service Routines (ISR), Multi-processing and Multi-tasking, Task scheduling – Preemptive and Non-preemptive, Task communication and synchronization, shared memory, message passing, Inter-process Communication – Semaphores, Mailbox, Pipes; priority inversion, priority inheritance, comparison of Real time Operating systems: VxWorks, MicroC / OS-II, RT-Linux

UNIT 5 TESTING OF EMBEDDED SYSTEMS **9**

Introduction: Testing, Verification, Testing Vs Verification, Embedded System Testing; **Faults in Embedded Systems**- Hardware Fault Models (Gate Level Fault Models), Software/Hardware Co-validation Fault Model, Textual Fault Models, Control-Dataflow Fault Models, State Machine Fault Models, Application-Specific Fault Models, Interface Faults, Testing of Embedded Core-Based System-on-Chips (SOCs), Test Access Mechanism, Core Test Wrapper, Non-concurrent testing, Concurrent testing; **Test Pattern Generation**- Test Plan, Test Programming, Test Pattern Generation, automatic test generation for Software/Hardware Co-validation; **Embedded Software Testing** - Software Unit Testing, Software Integration Testing, Software Validation Testing, System Unit Testing, System Integration Testing, System Validation Testing, Interaction Testing Technique between Hardware and Software in Embedded Systems.

TOTAL:45 PERIODS

TEXT BOOK:

1. Rajkamal, "Embedded System-Architecture, Programming and Design", McGraw Hill, 2011.
2. Shibu. K.V, "Introduction to Embedded Systems", McGraw Hill, 2017.

REFERENCES:

1. Lyla B Das, "Embedded Systems-An Integrated Approach", Pearson, 2013
2. James K. Peckol, "Embedded systems: A contemporary Design Tool", Wiley India Pvt. Limited, 2009
3. Edward Ashford Lee, Sanjit Arunkumar Seshia, "Introduction to Embedded Systems – A Cyber Physical System Approach", Second Edition, MIT Press, 2017

e-RESOURCES:

1. https://nptel.ac.in/courses/108/105/108105057/, "Embedded Systems", Dr. Santanu Chaudhury, Department of Electrical Engineering, IIT, Delhi.
2. http://www.nptelvidcos.in/2012/11/real-time-systems.html , "Real-Time Systems", Dr. Rajib Mall, Department of Computer Science & Engineering, IIT Kharagpur

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21EEO04	ENERGY AUDITING AND CONSERVATION	L T P C 3 0 0 3

Preamble:

Provides the basic understanding of energy auditing, energy management and energy conservation. Impart the knowledge of energy conservation measures in electrical and thermal energy systems. In addition, the economic aspects such as payback calculations, life cycle costing analysis is covered in this course

Course Outcomes: Upon completion of the course, students will be able to:

1. Explain the need of energy audit, energy management and energy conservation schemes and its importance.
2. Identify the energy saving opportunities and methods of improving efficiency in electric motor and good lighting system.
3. Identify the energy conservation opportunities in thermal energy systems and need of cogeneration for energy conservation.
4. Identify the energy saving opportunities in Fans, Refrigeration Systems and Pumps.
5. Examine the economic evaluation of energy conservation solutions adopted.

UNIT 1 INTRODUCTION 9

Basic Principle of Energy audit – definitions, Concept, types of audit – Energy Conservation Schemes and its importance – Role of Energy managers and auditors – Energy audit of Industries – Instruments for energy auditing.

UNIT 2 ELECTRICAL SYSTEMS 9

Electric Motors – Energy efficient Motors, Factors affecting the efficiency, loss distribution – Concept of Capacitance – Power factor Improvement, Power factor with non-linear loads, effect of harmonics on power factor – Illumination – lux, Lumens – Good lighting System Design.

UNIT 3 THERMAL SYSTEMS 9

Boiler - Types and Classification- efficiency testing-Direct and Indirect methods - Energy Conservation opportunities in boilers- need for cogeneration- principle of cogeneration-classification- important technical parameters for cogeneration.

UNIT 4 ENERGY CONSERVATION IN FANS, REFRIGERATION SYSTEMS AND PUMPS 9

Fan Types - Fan Performance evaluation- Flow control strategies -Energy saving opportunities- Refrigeration System and its types – Selection of refrigeration system –Factors affecting performance of refrigeration and AC systems - Pumps and its types – Factors affecting pump performance- System characteristics- Efficient Pumping system operation- Flow Control Strategies- Energy saving opportunities in pumping systems.

UNIT 5 FINANCIAL MANAGEMENT 9

Investment – Need and Appraisal and Criteria, Financial analysis techniques-Simple payback period, Return on investment, Net present value, Internal rate of return - Cash flows –Risk and Sensitivity Analysis, Financing options-Energy performance contracts and role of Energy Service Companies (ESCOs).

TOTAL:45 PERIODS

TEXT BOOK:

1. General Aspects of energy audit and Management (Unit-1 & 5), Guide Books for national Certification Examination for Energy Managers and Energy Auditors, Bureau of Energy Efficiency, 4th edition, 2015.
2. Energy Efficiency in Thermal Utilities (Unit-3), Guide Books for national Certification Examination for Energy Managers and Energy Auditors, Bureau of Energy Efficiency, 4th edition, 2015.
3. Energy Efficiency in Electrical Utilities (Unit-2 & 4), Guide Books for national Certification Examination for Energy Managers and Energy Auditors, Bureau of Energy Efficiency, 4th edition, 2015.
4. W.R. Murphy and G. McKay Butter worth, "Energy management", Heinemann publications, 2014.
5. Paul o' Callaghan, "Energy management", Mc-Graw Hill Book company 1st edition, 1998.

REFERENCES:

1. Sonal Desai, "Hand book of Energy Audit", McGraw Hill Education, 2015.
2. Smith C.B., Kelly Parmenter, "Energy Management Principles", 2nd Edition, Pergamon Press, New York, 2015.
3. Wayne C. Turner, "Energy management hand book", John Wiley and sons, 8th edition, 2012.
4. Prasanna Chandra, "Financial Management", Tata Mc-Graw Hill, 7th Edition, 2007.

e-RESOURCES:

1. http://aipnpc.org/Guidebooks.aspx , Bureau of Energy Efficiency.
2. www.tatapower.com,TaTa Power.
3. www.eeca.govt.nz, Energy Efficiency and Conservation Authority (EECA) is the government agency that works to improve the energy efficiency of New Zealand
4. www.pumped101.com, Pump Ed 101, Understanding Pumps, Motors, and their Controls, Joe Evans, Ph. D

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21EEO05 **ELECTRIC VEHICLES** L T P C
3 0 0 3

Preamble:
This course is intended for learning the Fundamentals of Electric vehicles. This course explores the brief ideas of Electric vehicles propulsion methods, Energy storage technologies, Energy management strategies and electric vehicles battery charging.

Course Outcomes: Upon completion of the course, students will be able to:

1. Describe the basic components of electric vehicles, discuss the performance, challenges and benefits of electric vehicles and summarize the impacts on energy supplies
2. Illustrate the basic concept of hybrid traction and power flow control in hybrid drive-train topologies.
3. Summarize the energy storage requirements in Electric Vehicles, analyze and select the suitable energy storage device/system for electric vehicles.
4. Discuss and compare the energy management strategies adopted in electric and hybrid vehicles and its implementation issues.
5. Describe the battery charging methods and design a basic Electric Vehicle and Hybrid Electric Vehicle prototype

UNIT 1 INTRODUCTION 9

Basics of vehicle performance, History of hybrid and electric vehicles, EVs benefits, social and environmental importance of hybrid and electric vehicles, Overview of types of EVs and its challenges, impact of modern drive-trains on energy supplies.

UNIT 2 HYBRID ELECTRIC DRIVE-TRAINS 9

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

UNIT 3 ENERGY STORAGE DEVICES 9

Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Analysis of energy storage devices: Battery, Fuel Cell, Super Capacitor, and Flywheel based energy storage systems, Hybridization of different energy storage devices.

UNIT 4 ENERGY MANAGEMENT STRATEGIES 9

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

UNIT 5 BATTERY CHARGING 9

Introduction to wireless power transfer technology, Charging methods for battery: constant voltage, constant current and a combination of constant voltage/constant current, Termination methods. Case Studies: Design of Hybrid Electric Vehicle, Design of Battery Electric Vehicle.

TOTAL:45 PERIODS

TEXT BOOK:

1. Chris Mi, M. Abul. Masrur and David Wenzhong Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley and Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.

REFERENCES:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
2. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

e-RESOURCES:

1. https://nptel.ac.in/courses/108/102/108102121/ Electric vehicles – Part 1 / IIT Delhi
2. https://nptel.ac.in/courses/108/103/108103009/Introduction to Hybrid and Electric Vehicle / IIT Delhi

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21EEV01	DESIGN OF SOLAR UPS FOR HOME	L T P C 0 0 2 1

Prerequisite: 21EET51 - Power Electronics, Basic knowledge of electrical and Electronics Engineering

Preamble:

Familiarizes the power converter, battery charging circuits with switching devices and their characteristics and imparts knowledge on the operation. It also deals with design and implementation of solar UPS for home applications.

Course Outcomes: Upon completion of the course, students will be able to:

1. Describe the power supply requirements of domestic loads and home appliances.
2. Illustrate the design and implementation of power converters for home appliances.

MODULE 1 – INTRODUCTION TO INVERTER **15**

Introduction to Inverter, Block diagram of Converter–Inverter System, types and working principle, PV Systems, Filters employed in rectifiers, battery charging circuits, working of inverter oscillator, type of oscillators, square wave generator, PWM generator, AC-DC and DC-AC Converters

MODULE 2 – SOLAR UPS FOR HOME **15**

Inverter for solar UPS, working principle – Specifications – Inverter design – UPS installation –functional blocks. Selection of inverter/ UPS for home – faults in inverter andUPS – Repair and maintenance of inverter and UPS.

TOTAL: 30 PERIODS

REFERENCES:

1. Hatim Machrafi, Green Energy and Technology, Bentham Science Publishers, PearsonEducation 2nd edition, 2012.
2. D.P. Kothari, Renewable Energy Sources and Emerging Technologies, PHI Learning Pvt. Ltd., 2013

e-RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc20_ph14/preview

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21EEV02	DESIGN OF SOLAR PV SYSTEM FOR INDUSTRIES	L T P C 0 0 2 1

Prerequisite: 21EET51 - Power Electronics, Basic knowledge of electrical and Electronics Engineering

Preamble:

This course aims to impart knowledge on design and implementation of Solar PV System and its Installation.

Course Outcomes: Upon completion of the course, students will be able to:

1. Assess the industrial customer 's Solar PV System requirements.
2. Plan and arrange for Solar PV System installation.

MODULE 1 - ASSESS THE INDUSTRIAL CUSTOMER'S SOLAR PV SYSTEM REQUIREMENTS **15**

- Realize the work requirements.
- Engage with customers to value their requirements
- Visit and evaluate the site for installation.
- Assess the solar PV system required.
- Assess the cost of solar PV system installation.
- Ensure quality, standards and regulatory requirements are adhered

MODULE 2 - PLAN AND ARRANGE FOR INSTALLATION **15**

- Design the solar PV system.
- Decide the solar PV system components to be installed.
- Finalize the plan and arrange for installation.
- Supervise the installation activities.
- Report and document the completion of work.
- Ensure quality and safety procedures are followed.

TOTAL: 30 PERIODS

REFERENCES:

1. Duffie, J.A., and Beckman, W.A. Solar Energy Thermal Process, John Wiley and Sons, NewYork, Jui Sheng Hsieh, Solar Energy Engineering, Prentice-Hall, 2007.
2. Rai, G.D., Solar Energy Utilization, Khanna Publishers, N. Delhi, 2010.

e-RESOURCES:

1. https://nptel.ac.in/courses/115/107/115107116/

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21EEV03 **LABVIEW PROGRAMMING** L T P C
0 0 2 1

Prerequisite: 21EET32 - Electron devices and circuits, Basic knowledge of electronics and computer programming

Preamble:

Laboratory Virtual Instrument Engineering Workbench (LabVIEW) is a system-design platform and development environment for a visual programming language from National Instruments. Its key innovation is that it uses graphical diagrams rather than lines of text which makes it more intuitive for engineers and excellent for parallel programming. This course aims to impart knowledge about the methods and techniques used in LabVIEW programming.

Course Outcomes: Upon completion of the course, students will be able to:

1. Use LabVIEW and its programming environment.
2. Write high level LabVIEW programs that can be implemented in both research and industry.

MODULE 1 – INTRODUCTION TO MODEL BASED DESIGN **15**

- Introduction to Graphical Programming and NI tools
- Introduction to LabVIEW Programming: Controls, Indicators (data types), Plotting data
- Programming with while 'loops
- Programming with for 'loops
- String Functions
- Arrays, clusters

MODULE 2 – DATA ACQUISITION **15**

- Sub Vis
- Case structure and Formula nodes
- Sequence structures and state machines
- File I/O
- Creating an application
- Using myDAQ

TOTAL: 30 PERIODS

REFERENCES:

1. Hands-On Introduction to LabVIEW for Scientists and Engineers, ESSICK, JOHN, Oxford University Press, New Delhi, 2010.
2. LabVIEW Graphical Programming, JOHNSON GARY W & JENNINGS RICHARD, McGraw Hill, New Delhi, 2006.

e-RESOURCES:

1. https://www.smeclabs.com/labview-online-training-courses-tutorials/
2. https://www.ni.com/en-in/shop/services/education-services.html

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