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)

REGULATIONS 2022

CURRICULUM AND SYLLABUS

BE – ELECTRICAL AND ELECTRONICS ENGINEERING

(For the students admitted from 2022-23)

Choice Based Credit System (CBCS)

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	4	4					1		09	5.55	12
2	BS	11	8	4						23	14.20	25
3	ES	05	12		4					21	12.96	24
4	PC			16	20	13	11	8	-	68	41.98	48
5	PE					6	6	6	-	18	11.11	18
6	OE	-	-	-	-	3	3	3	-	9	5.55	18
7	EC						2	-	12	14	8.64	15
8	MC	✓	✓	✓	✓	✓	✓	✓		-		-
9	VC	✓								-		-
10	OC, SC, AC	✓								-		-
Total Credits / Sem		20	24	20	24	22	22	18	12	162		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

ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

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.

	VELALAR COLLEGE OF ENGINEERING AND TECHNOLOGY (Autonomous)	CURRICULUM
		UG
		R - 2022
Department	Electrical and Electronics Engineering	
Programme	BE- Electrical and Electronics Engineering	

SEMESTER 1										
S. No	Course Code	Course Title	Category	Periods / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
1	22MCT01	Induction Programme	MC	3 WEEKS						
Theory										
2	22ENT 11	Communicative English	HS	3	0	0	3	40	60	100
2.a	22ENT 11	Communicative English (For the students admitted from AY 2023-2024 onwards)	HS	3	0	0	3	40	60	100
3	22MAT11	Matrices and Differential Equations	BS	3	1	0	4	40	60	100
4	22PHT11	Engineering Physics	BS	3	0	0	3	40	60	100
5	22CYT11	Engineering Chemistry	BS	3	0	0	3	40	60	100
6	22CST11	Python Programming	ES	3	0	0	3	40	60	100
7	22HST11	தமிழர் மரபு / Heritage of Tamils (For the students admitted from AY 2023-24 onwards)	HS	1	0	0	1	40	60	100
Practical										
8	22PHL11	Physics and Chemistry Laboratory I	BS	0	0	2	1	60	40	100
9	22CSL11	Python Programming Laboratory	ES	0	0	3	1	60	40	100
10	22MEL11	Workshop Practices Laboratory	ES	0	0	3	1	60	40	100
Mandatory										
11	22MCT02	Universal Human Values	MC	2	0	0	0	100	0	100
							Total Credits	20		

SEMESTER 2										
S. No	Course Code	Course Title	Category	Periods / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
Theory										
1	22ENT21	Professional English	HS	3	0	0	3	40	60	100
2	22MAT21	Calculus and Complex Analysis	BS	3	1	0	4	40	60	100
3	22PHT23	Physics for Electrical Sciences	BS	3	0	0	3	40	60	100
4	22ITT21	C Programming	ES	3	0	0	3	40	60	100

4.a	22ITC21	Programming in C (For the students admitted from AY 2024-25 onwards)	ES	3	0	1	4	40	60	100
5	22MET11	Engineering Graphics	ES	2	0	6	4	40	60	100
6	22EET23	Electric Circuit Theory	ES	3	0	0	3	40	60	100
7	22HST11	தமிழர் மரபு / Heritage of Tamils (For the students admitted in AY 2022-2023 only)	HS	1	0	0	1	40	60	100
7	22HST21	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology (For the students admitted from AY 2023-2024 onwards)	HS	1	0	0	1	40	60	100
Practical										
8	22PHL21	Physics and Chemistry Laboratory II	BS	0	0	2	1	60	40	100
9	22EEL21	Electric Circuits Laboratory	ES	0	0	3	1	60	40	100
Mandatory										
10	22MCT03	Environmental Science and Engineering	MC	2	0	0	0	100	0	100
							Total Credits	24		

SEMESTER 3										
S. No	**Course Code**	**Course Title**	**Category**	**Periods / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
Theory										
1	22MAT33	Transform Techniques & Numerical Methods.	BS	3	1	0	4	40	60	100
2	22EET31	Electronic Devices and Circuits	PC	3	0	0	3	40	60	100
3	22EET32	Electromagnetic Field.	PC	3	1	0	4	40	60	100
4	22EET33	DC machines and Transformers	PC	3	1	0	4	40	60	100
5	22EET34	Measurement and Instrumentation Systems	PC	3	0	0	3	40	60	100
6	22HST21	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology (For the students admitted in AY 2022-23)	HS	1	0	0	1	40	60	100
Practical										
7	22EEL31	Electronic Devices and Circuits Laboratory	PC	0	0	3	1	60	40	100
8	22EEL32	DC machines and Transformers Laboratory	PC	0	0	3	1	60	40	100
							Total Credits	20		

SEMESTER 4										
S. No	**Course Code**	**Course Title**	**Category**	**Periods / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
Theory										
1	22EET41	Digital Logic Circuits	PC	3	1	0	4	40	60	100
2	22EET42	Linear Integrated Circuits and Applications	PC	3	0	0	3	40	60	100

3	22EET43	Induction and Synchronous Machines	PC	3	1	0	4	40	60	100
4	22EET44	Transmission and Distribution	PC	3	0	0	3	40	60	100
5	22EET45	Control Systems	PC	3	1	0	4	40	60	100
6	22ITT31	Object Oriented Programming using JAVA	ES	3	0	0	3	40	60	100
Practical										
7	22EEL41	Induction and Synchronous Machines Laboratory	PC	0	0	3	1	60	40	100
8	22EEL42	Linear and Digital Integrated Circuits Laboratory	PC	0	0	3	1	60	40	100
9	22ITL31	Object Oriented Programming Laboratory	ES	0	0	3	1	60	40	100
Mandatory										
10	22MCL04	English for Professionals	MC	0	0	2	0	100	0	100
						Total Credits	24			

SEMESTER 5										
S. No	**Course Code**	**Course Title**	**Category**	**Periods / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
Theory										
1	22EET51	Power Electronics	PC	3	1	0	4	40	60	100
2	22EET52	Power System Analysis	PC	3	1	0	4	40	60	100
3	22EET53	Microprocessor and Microcontroller	PC	3	0	0	3	40	60	100
4		Professional Elective - 1	PE	3	0	0	3	40	60	100
5		Professional Elective - 2	PE	3	0	0	3	40	60	100
6		Open Elective - 1	OE	3	0	0	3	40	60	100
Practical										
7	22EEL51	Microprocessor and Microcontroller Laboratory	PC	0	0	3	1	60	40	100
8	22EEL52	Control Systems and Instrumentation Laboratory	PC	0	0	3	1	60	40	100
Mandatory										
9	22MCT05	Aptitude and Logical Reasoning	MC	0	0	2	0	100	0	100
						Total Credits	22			

SEMESTER 6										
S. No	**Course Code**	**Course Title**	**Category**	**Periods / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
Theory										
1	22EET61	Solid State Drives	PC	3	0	0	3	40	60	100
2	22EET62	Digital Signal Processing	PC	3	1	0	4	40	60	100

3	22EET63	Power System Operation and Control	PC	3	0	0	3	40	60	100
4		Professional Elective - 3	PE	3	0	0	3	40	60	100
5		Professional Elective - 4	PE	3	0	0	3	40	60	100
6		Open Elective - 2	OE	3	0	0	3	40	60	100
Practical										
7	22EEL61	Power Electronics and Drives Laboratory	PC	0	0	3	1	60	40	100
8	22EEL62	Innovative Design Project	EC	0	0	6	2	40	60	100
Mandatory										
9	22MCL06	Communication Skills Laboratory	MC	0	0	2	0	100	0	100
						Total Credits	22			

SEMESTER 7										
S. No	**Course Code**	**Course Title**	**Category**	**Periods / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
Theory										
1	22EET71	Protection and Switchgear	PC	3	0	0	3	40	60	100
2	22EET72	Economics and Management for Engineers.	PC	3	0	0	3	40	60	100
3		Professional Elective - 5	PE	3	0	0	3	40	60	100
4		Professional Elective - 6	PE	3	0	0	3	40	60	100
5		Open Elective - 3	OE	3	0	0	3	40	60	100
6	22HST71	Human Values and Professional Ethics.	HS	3	0	0	1	40	60	100
Practical										
7	22EEL71	Renewable Energy Systems Laboratory	PC	0	0	3	1	60	40	100
8	22EEL72	Power System Simulation Laboratory	PC	0	0	3	1	60	40	100
Mandatory										
9	22MCT07	Indian Constitution and Traditional Knowledge	MC	2	0	0	0	100	0	100
						Total Credits	18			

SEMESTER 8										
S. No	**Course Code**	**Course Title**	**Category**	**Periods / Week**			**Credits**	**Max. Marks**		
				L	**T**	**P**		**CA**	**SE**	**Tot.**
Practical										
1	22EEL81	Internship	EC	-	-	-	2	100	0	100
2	22EEL82	Project Work	EC	0	0	20	10	40	60	100
						Total Credits	12			

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	VLSI Design
Power System Transients	Special Electrical Machines	Embedded C Programming	Principles of Robotics	Design of Motor and Power Converters for Electric Vehicle	Energy Storage Systems
Flexible AC Transmission Systems	Modern Power Converters	Embedded Processors	Sensors and Transducers	Electric Vehicle Design, Mechanics and control	Hybrid Energy Technology
Power Quality	Artificial Intelligence in Electrical Drives	Embedded control for electric drives	PLC and Automation	Design of Electric Vehicle charging system	Design and Modelling of Renewable Energy Systems
Utilization and Conservation of Electrical Energy	Power Electronics for Renewable Energy Systems	Smart System Automation	Virtual Instrumentation	Testing of Electric Vehicle	Electrical Energy Management and Auditing
High Voltage Engineering	HVDC and EHVAC Transmission	Embedded system for automotive applications	Advanced Control System	Grid Integration of Electric Vehicle	Grid integrating Techniques and challenges
Smart Grid	Multilevel Power Converters	Soft Computing Techniques	Digital Image Processing	Intelligent control of Electric Vehicles	Power Plant Instrumentation and Control

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V, VI and VII. 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.

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 Data Analytics**	**Vertical V Environmental and Sustainability**	**Vertical VI Artificial Intelligence**
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics for Management	Sustainable infrastructure Development	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 and Insurance	Creativity & Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials	Data Warehousing and Data Mining
Introduction to Block chain and its Applications	Principles of Marketing Management For Business	Administrative Theories	Digital Marketing and Social Network Analytics	Materials for Energy Sustainability	Machine Learning Techniques
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurs	Indian Administrative System	Supply Chain Analytics	Green Technology	Expert Systems
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis	Cognitive Science
-	-	-	-	Integrated Energy Planning for Sustainable Development	Gamification
-	-	-	-	Energy Efficiency for Sustainable Development	-

PROFESSIONAL ELECTIVES										
S. No	Course Code	Course Title	Category	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
VERTICAL I: POWER ENGINEERING										
1	22EEE11	Under Ground Cable Engineering	PE	3	0	0	3	40	60	100
2	22EEE12	Power System Transients	PE	3	0	0	3	40	60	100
3	22EEE13	Flexible AC Transmission Systems	PE	3	0	0	3	40	60	100
4	22EEE14	Power Quality	PE	3	0	0	3	40	60	100
5	22EEE15	Utilization and Conservation of Electrical Engineering	PE	3	0	0	3	40	60	100
6	22EEE16	High Voltage Engineering	PE	3	0	0	3	40	60	100
7	22EEE17	Smart Grid	PE	3	0	0	3	40	60	100
VERTICAL II: CONVERTERS AND DRIVES										
1	22EEE21	Design of Electrical Machines	PE	3	0	0	3	40	60	100
2	22EEE22	Special Electrical Machines	PE	3	0	0	3	40	60	100
3	22EEE23	Modern Power Converters	PE	3	0	0	3	40	60	100
4	22EEE24	Artificial Intelligence in Electrical Drives	PE	3	0	0	3	40	60	100
5	22EEE25	Power Electronics for Renewable Energy Systems	PE	3	0	0	3	40	60	100
6	22EEE26	HVDC and EHVAC Transmission	PE	3	0	0	3	40	60	100
7	22EEE27	Multilevel Power Converters	PE	3	0	0	3	40	60	100
VERTICAL III: EMBEDDED SYSTEM										
1	22EEE31	Embedded Systems	PE	3	0	0	3	40	60	100
2	22EEE32	Embedded C Programming	PE	3	0	0	3	40	60	100
3	22EEE33	Embedded Processors	PE	3	0	0	3	40	60	100
4	22EEE34	Embedded control for electric drives	PE	3	0	0	3	40	60	100
5	22EEE35	Smart System Automation	PE	3	0	0	3	40	60	100
6	22EEE36	Embedded system for automotive applications	PE	3	0	0	3	40	60	100
7	22EEE37	Soft Computing Techniques	PE	3	0	0	3	40	60	100
VERTICAL IV: INSTRUMENTATION ENGINEERING										
1	22EEE41	Biomedical Instrumentation	PE	3	0	0	3	40	60	100
2	22EEE42	Principles of Robotics	PE	3	0	0	3	40	60	100
3	22EEE43	Sensors and Transducers	PE	3	0	0	3	40	60	100
4	22EEE44	PLC and Automation	PE	3	0	0	3	40	60	100
5	22EEE45	Virtual Instrumentation	PE	3	0	0	3	40	60	100

6	22EEE46	Advanced Control System	PE	3	0	0	3	40	60	100
7	22EEE47	Digital Image Processing	PE	3	0	0	3	40	60	100
VERTICAL V: ELECTRIC VEHICLE TECHNOLOGY										
1	22EEE51	Electric Vehicle Architecture	PE	3	0	0	3	40	60	100
2	22EEE52	Design of Motor and Power Converters for Electric Vehicle	PE	3	0	0	3	40	60	100
3	22EEE53	Electric Vehicle Design, Mechanics and control	PE	3	0	0	3	40	60	100
4	22EEE54	Design of Electric Vehicle charging system	PE	3	0	0	3	40	60	100
5	22EEE55	Testing of Electric Vehicle	PE	3	0	0	3	40	60	100
6	22EEE56	Grid Integration of Electric Vehicle	PE	3	0	0	3	40	60	100
7	22EEE57	Intelligent control of Electric Vehicles	PE	3	0	0	3	40	60	100

VERTICAL VI: DIVERSIFIED COURSES										
1	22EEE61	VLSI Design	PE	3	0	0	3	40	60	100
2	22EEE62	Energy Storage Systems	PE	3	0	0	3	40	60	100
3	22EEE63	Hybrid Energy Technology	PE	3	0	0	3	40	60	100
4	22EEE64	Design and Modelling of Renewable Energy Systems	PE	3	0	0	3	40	60	100
5	22EEE65	Electrical Energy Management and Auditing	PE	3	0	0	3	40	60	100
6.	22EEE66	Grid integrating Techniques and challenges	PE	3	0	0	3	40	60	100
7.	22EEE67	Power Plant Instrumentation and Control	PE	3	0	0	3	40	60	100

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	22ITM11	Financial Management	PE	3	0	0	3	40	60	100
2	22ITM12	Fundamentals of Investment	PE	3	0	0	3	40	60	100
3	22ITM13	Banking, Financial Services and Insurance	PE	3	0	0	3	40	60	100
4	22ITM14	Introduction to Block chain and its Applications	PE	3	0	0	3	40	60	100
5	22ITM15	Fintech Personal Finance and Payments	PE	3	0	0	3	40	60	100
6	22ITM16	Introduction to Fintech	PE	3	0	0	3	40	60	100
VERTICAL 2: Entrepreneurship										
1	22MEM21	Foundations of Entrepreneurship	PE	3	0	0	3	40	60	100
2	22MEM22	Team Building & Leadership Management for Business	PE	3	0	0	3	40	60	100
3	22MEM23	Creativity & Innovation in Entrepreneurship	PE	3	0	0	3	40	60	100

4	22MEM24	Principles of Marketing Management For Business	PE	3	0	0	3	40	60	100
5	22MEM25	Human Resource Management for Entrepreneurs	PE	3	0	0	3	40	60	100
6	22MEM26	Financing New Business Ventures	PE	3	0	0	3	40	60	100
VERTICAL 3: Public Administration										
1	22ECM31	Principles of Public Administration	PE	3	0	0	3	40	60	100
2	22ECM32	Constitution of India	PE	3	0	0	3	40	60	100
3	22ECM33	Public Personnel Administration	PE	3	0	0	3	40	60	100
4	22ECM34	Administrative Theories	PE	3	0	0	3	40	60	100
5	22ECM35	Indian Administrative System	PE	3	0	0	3	40	60	100
6	22ECM36	Public Policy Administration	PE	3	0	0	3	40	60	100
VERTICAL 4: Business Data Analytics										
1	22CSM41	Statistics for Management	PE	3	0	0	3	40	60	100
2	22CSM42	Data mining for Business Intelligence	PE	3	0	0	3	40	60	100
3	22CSM43	Human Resource Analytics	PE	3	0	0	3	40	60	100
4	22CSM44	Digital Marketing and Social Network Analytics	PE	3	0	0	3	40	60	100
5	22CSM45	Supply Chain Analytics	PE	3	0	0	3	40	60	100
6	22CSM46	Financial Analytics	PE	3	0	0	3	40	60	100
VERTICAL 5: Environmental and Sustainability										
1	22CEM51	Sustainable infrastructure Development	PE	3	0	0	3	40	60	100
2	22CEM52	Sustainable Agriculture and Environmental Management	PE	3	0	0	3	40	60	100
3	22CEM53	Sustainable Bio Materials	PE	3	0	0	3	40	60	100
4	22CEM54	Materials for Energy Sustainability	PE	3	0	0	3	40	60	100
5	22CEM55	Green Technology	PE	3	0	0	3	40	60	100
6	22CEM56	Environmental Quality Monitoring and Analysis	PE	3	0	0	3	40	60	100
7	22CEM57	Integrated Energy Planning for Sustainable Development	PE	3	0	0	3	40	60	100
8	22CEM58	Energy Efficiency for Sustainable Development	PE	3	0	0	3	40	60	100
VERTICAL 6: Artificial Intelligence										
1	22ADM61	Introduction to Data Science	PE	3	0	0	3	40	60	100
2	22ADM62	Principles of Artificial Intelligence	PE	3	0	0	3	40	60	100
3	22ADM63	Data Warehousing and Data Mining	PE	3	0	0	3	40	60	100
4	22ADM64	Machine Learning Techniques	PE	3	0	0	3	40	60	100
5	22ADM65	Expert Systems	PE	3	0	0	3	40	60	100
6	22ADM66	Cognitive Science	PE	3	0	0	3	40	60	100
7	22ADM67	Gamification	PE	3	0	0	3	40	60	100

OPEN ELECTIVES										
S. No	Course Code	Course Title	Category	Periods / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
OFFERED BY DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE										
1	22ADO01	Fundamentals of Database	OE	3	0	0	3	40	60	100
2	22ADO02	Data Science for Engineers	OE	3	0	0	3	40	60	100
3	22ADO03	Cyber-Security	OE	3	0	0	3	40	60	100
4	22ADO04	Data Visualization	OE	3	0	0	3	40	60	100
5	22ADO05	Business Analytics	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF BIO MEDICAL ENGINEERING										
1	22BMO01	Biometric systems and their applications	OE	3	0	0	3	40	60	100
2	22BMO02	Healthcare Management Systems	OE	3	0	0	3	40	60	100
3	22BMO03	Basics of Bioinformatics	OE	3	0	0	3	40	60	100
4	22BMO04	Biology for Engineers	OE	3	0	0	3	40	60	100
5	22BMO05	Regulatory Requirements in Pharmaceutical Industries	OE	3	0	0	3	40	60	100
6	22BMO06	Rapid Prototyping	OE	3	0	0	3	40	60	100
7	22BMO07	Radiotheraphy Basics and Applications	OE	3	0	0	3	40	60	100
8	22BMO08	Nanotechnology and Applications	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF CIVIL ENGINEERING										
1	22CEO01	Civil and Infrastructure Engineering	OE	3	0	0	3	40	60	100
2	22CEO02	Environmental Pollution and Waste management	OE	3	0	0	3	40	60	100
3	22CEO03	Disaster Management and Mitigation	OE	3	0	0	3	40	60	100
4	22CEO04	Building Services	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING										
1	22CSO01	Foundation of AR/VR	OE	3	0	0	3	40	60	100
2	22CSO02	Web Designing	OE	3	0	0	3	40	60	100
3	22CSO03	Block Chain fundamentals	OE	3	0	0	3	40	60	100
4	22CSO04	Knowledge Management	OE	3	0	0	3	40	60	100
5	22CSO05	Cloud Computing Essentials	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING										
1	22ECO01	Consumer Electronics	OE	3	0	0	3	40	60	100
2	22ECO02	Advanced Mobile Communication	OE	3	0	0	3	40	60	100
3	22ECO03	Optoelectronics	OE	3	0	0	3	40	60	100
4	22ECO04	IOT System Design and Applications	OE	3	0	0	3	40	60	100
5	22ECO05	5G Technologies	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING										
1	22EEO01	Domestic and Industrial Electrical Installations	OE	3	0	0	3	40	60	100
2	22EEO02	Renewable Energy Sources	OE	3	0	0	3	40	60	100

3	22EEO03	Electric Vehicles	OE	3	0	0	3	40	60	100
4	22EEO04	Energy Auditing and Conservation	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF MECHANICAL ENGINEERING										
1	22MEO01	Industrial Instrumentation	OE	3	0	0	3	40	60	100
2	22MEO02	Product Design and Development	OE	3	0	0	3	40	60	100
3	22MEO03	Sustainable Manufacturing	OE	3	0	0	3	40	60	100
4	22MEO04	Entrepreneurship Development	OE	3	0	0	3	40	60	100
5	22MEO05	Fundamentals of Ergonomics	OE	3	0	0	3	40	60	100
6	22MEO06	Principles of Management and Industrial Psychology	OE	3	0	0	3	40	60	100
7	22MEO07	Safety Measures for Engineers	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF MEDICAL ELECTRONICS										
1	22MDO01	Introduction to Medical Electronics	OE	3	0	0	3	40	60	100
2	22MDO02	Hospital Waste Management	OE	3	0	0	3	40	60	100
3	22MDO03	Hospital Information System	OE	3	0	0	3	40	60	100
4	22MDO04	IoT Applications in Healthcare	OE	3	0	0	3	40	60	100
OFFERED BY DEPARTMENT OF INFORMATION TECHNOLOGY										
1	22ITO01	Basics of Java Programming	OE	3	0	0	3	40	60	100
2	22ITO02	Ethical Hacking	OE	3	0	0	3	40	60	100
3	22ITO03	E-Commerce and Applications	OE	3	0	0	3	40	60	100
4	22ITO04	Basics of Android Application Development	OE	3	0	0	3	40	60	100
5	22ITO05	Web Essentials	OE	3	0	0	3	40	60	100
6	22ITO06	Digital Video Editing	OE	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	22MCT01	Induction Programme	MC	-	-	-	-	-	-	100
2	22MCT02	Universal Human Values	MC	1	0	1	0	100	0	100
3	22MCL03	Environmental Science and Engineering	MC	2	0	0	0	100	0	100
4	22MCL04	English for Professionals	MC	0	0	2	0	100	0	100
5	22MCL05	Aptitude and Logical Reasoning	MC	0	0	2	0	100	0	100
6	22MCT06	Communication Skills Laboratory	MC	0	0	2	0	100	0	100
7	22MCT07	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	22ECV01	Hands on Training on Design of Controllers for Power Converters	VC	0	0	2	1	100	0	100
2	22VAC02	Automotive Embedded Hardware Development	VC	0	0	2	1	100	0	100
3	22VAC03	Automotive Embedded Software Development	VC	0	0	2	1	100	0	100
4	22VAC04	Design of Solar UPS for Home	VC	0	2	1	100	0	100	0
5	22VAC04	Design of Solar PV System for Industries	VC	0	2	1	100	0	100	0

OTHER COURSES										
S. No	Course Code	Course Title	Category	Hours / Week			Credits	Max. Marks		
				L	T	P		CA	SE	Tot.
1	22HST11	தமிழர் மரபு (Heritage of Tamils)	HS	1	0	0	1	40	60	100
2	22HST21	தமிழரும் தொழில்நுட்பமும் (Tamils and Technology)	HS	1	0	0	1	40	60	100

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

CA - Continuous Assessment
SE - Semester Examination
Tot - Total

22MCT01	INDUCTION PROGRAMME (Common to all Branches)	L	T	P	C
		-	-	-	0

Preamble:
This is a mandatory 2-week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

"Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed."
"One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. "Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program:

(i) Physical Activity
This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts
Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it every day for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values
This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and don'ts, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real-life activities rather than lecturing. Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity
Literary activity would encompass reading, writing and possibly, debating, enacting a

play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering /Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Programme is totally an activity-based programme and therefore there shall be no tests / assessments during this programme.

References:

- Guide to Induction program from AICTE

22MAT11	MATRICES AND DIFFERENTIAL EQUATIONS	L	T	P	C
	(Common to B.E.- BM, EC, EE and MD Programmes)	3	1	0	4

Preamble

The course aims at achieving conceptual understanding of topics in Differential Calculus, Differential equations and computation of Matrix. The syllabus is designed to provide the skills for modeling engineering problems and understand the role of single variable and multi variables in the discipline of engineering.

UNIT 1 MATRICES **9+3**

Characteristic equation – Statement and application of Cayley Hamilton Theorem – Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors (without proof) – Orthogonal transformation of a symmetric matrix to diagonal form – Quadratic form – Nature of Quadratic forms - Reduction of quadratic form to canonical form by orthogonal transformation.

UNIT 2 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.

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

Partial derivatives – 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 4 ORDINARY DIFFERENTIAL EQUATIONS **9+3**

Linear higher order differential equations with constant coefficients – Particular Integrals for the types: $e^{ax}, \cos ax \text{ or } \sin ax,\ x^n,\ e^{ax}V(X)$ – Method of variation of parameters –Applications of differential equations: Simple harmonic motion – Electric circuits (Differential equations and associated conditions need to be given).

UNIT 5 PARTIAL DIFFERENTIAL EQUATIONS **9+3**

Formation of partial differential equations – Solving partial differential equations of first order: Clairaut's form, Lagrange's linear equation – Solving Linear partial differential equations of second and higher order with constant coefficients of homogeneous type - Particular Integrals for the types: $e^{ax+by}, x^m y^n,\ \sin(ax+by) \text{ or } \cos(ax+by)\ , e^{ax+by}V(x,y)$.

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOKS:

1. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. George B, Thomas, Joel Hass, Christopher Heil and Maurice D. Weir "Thomas' Calculus". Pearson 14th Edition, 2018

REFERENCES:

1. N.P. Bali, Manish Goyal, "Engineering Mathematics", Lakshmi Publications (Pvt) Ltd, 4th Edition, 2014.
2. Grewal B.S., "Higher Engineering Mathematics" 43rd Edition, Khanna Publishers, New Delhi, 2014.

e-Resources:

1. https://nptel.ac.in/courses/122104018, Mathematics II, Prof. P. Chandra, Prof. A.K. Lal, Prof. V. Raghavendra, Prof. G. Santhanam, IIT Kanpur.
2. https://nptel.ac.in/courses/111106139, Laplace Transform, Prof. Indrava Roy, IIT Madras.

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

CO1 Determine eigenvalues and eigenvectors of real symmetric matrices and reduce the quadratic form to canonical form by orthogonal transformation.
CO2 Compute curvature, Centre of curvature, evolute and envelope of curves.
CO3 Express functions of two variables in Taylor's series and compute Jacobians, maximum and minimum values.
CO4 Solve linear differential equations with constant coefficients and apply them in solving real problems.
CO5 Compute the solution for the standard forms of linear partial differential equations of first order and solve homogeneous partial differential equations of first and higher order with constant coefficients.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2	2	-	-	-	-	-	-	-	1	-	-
CO 2	3	3	2	2	-	-	-	-	-	-	-	1	-	-
CO 3	3	3	2	2	-	-	-	-	-	-	-	1	-	-
CO 4	3	3	2	2	-	-	-	-	-	-	-	1	-	-
CO 5	3	3	2	2	-	-	-	-	-	-	-	1	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22PHT11	ENGINEERING PHYSICS	L	T	P	C
	(Common to all B.E/B.Tech Programmes)	3	0	0	3

Preamble

This course aims to impart the essential concepts of laser, fibre optics, ultrasonics, quantum physics and crystal structure and crystal defects. It also describes the physical phenomena related to the above-mentioned concepts and their applications in engineering and provides motivation towards innovations.

UNIT 1 LASER **9**

Introduction –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.

UNIT 2 FIBRE OPTICS **9**

Principle and propagation of light in optical fibres – numerical aperture and acceptance angle - types of optical fibres (material, refractive index, mode) – double crucible technique of fibre drawing - splicing, losses in optical fibre, dispersion - fibre optical communication system (Block diagram) - light sources - detectors - fibre optic sensors – temperature & displacement - endoscope.

UNIT 3 ULTRASONICS **9**

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

UNIT 4 QUANTUM PHYSICS **9**

Black body radiation – Planck's theory (derivation) – deduction of Wien's displacement law and Rayleigh – Jeans' law from Planck's theory – Compton effect - theory and experimental verification – matter waves – Schrödinger's wave equation – time independent and time dependent equations – physical significance of wave function – particle in a one-dimensional box.

UNIT 5 CRYSTAL PHYSICS **9**

Lattice – unit cell – Bravais lattice – lattice planes – Miller indices – d spacing in cubic lattice – calculation of number of atoms per unit cell – atomic radius – coordination number – packing factor for SC, BCC, FCC and HCP structures – NaCl, ZnS, diamond and graphite structures – polymorphism and allotropy - crystal defects – point, line and surface defects.

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. Palanisamy P.K., "Engineering Physics", 2nd Edition, Scitech Publications, 2011

3. Chitra Shadrach and Sivakumar Vadivelu, "Engineering Physics", 1st Edition, Pearson Education, 2007.

e-Resources:

1. http://oupinheonline.com/book/bhattacharya-tandon-engineering-physics/9780199452811.
2. https://www.khanacademy.org/science/physics/quantum-physics.

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

CO1 Compare Nd-YAG, CO_2 and Semiconductor lasers for welding, heat treatment, cutting, medical applications and holography using Stimulated Emission.

CO2 Demonstrate the knowledge of wave optics using light waves for communication system.

CO3 Describe the production and applications of ultrasonics.

CO4 Examine the dual nature of light waves using quantum theory for Black body radiation and Schrodinger's wave equations in particle in a one- and three-dimensional box.

CO5 Explain the description of a crystal structure in terms of atom positions, unit cells, and crystal symmetry; and to relate the crystal symmetry to the symmetry observed in a diffraction experiment.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	1	1	1	1	1	-	-	1	1	1	-	-
CO 2	3	2	1	1	1	1	1	-	-	1	1	1	-	-
CO 3	3	2	1	1	1	1	1	-	-	1	1	1	-	-
CO 4	3	2	1	1	1	1	1	-	-	1	1	1	-	-
CO 5	3	2	1	1	1	1	1	-	-	1	1	1	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22CYT11	ENGINEERING CHEMISTRY (Common to all B.E/B.Tech Programmes)	L	T	P	C
		3	0	0	3

Preamble

The study of water technology enables engineers to acquire skills to choose the appropriate method of water treatment for industrial and domestic purposes. Electrochemistry and corrosion explain the fundamentals, identification and corrosion prevention for solving electrochemical and corrosion problems. The study of energy storage devices exposes some of the most commonly used energy storage devices. Nano chemistry empowers engineers to acquire knowledge about nanomaterials and their applications in various fields. Polymeric materials aim to equip the engineering students to realize the importance of chemistry in composites and conducting polymers.

UNIT 1 WATER TECHNOLOGY **9**

Hardness – types and its units – Boiler troubles – scale and sludge, boiler corrosion, caustic embrittlement, priming and foaming – Internal conditioning – Carbonate and Calgon conditioning - External conditioning – demineralization process – Desalination – electrodialysis, reverse osmosis - Treatment of water for municipal water supply (Removal of suspended particles and disinfection methods – Ozonisation).

UNIT 2 ELECTROCHEMISTRY AND CORROSION **9**

Electrochemistry – Emf Series and its applications. Metal Finishing – Manufacture of Printed Circuit Board. Corrosion – mechanism – Galvanic, atmospheric (O_2) and Pitting corrosion. Protective coating – electroplating of nickel and electroless copper plating on printed circuit board.

UNIT 3 ENERGY STORAGE DEVICES **9**

Batteries – types – Construction and working of Primary battery – Zinc-Air/carbon, Secondary batteries – Lead-acid battery and Lithium-ion battery, Fuel cells – H_2-O_2 fuel cell and Microbial fuel cell.

UNIT 4 NANOCHEMISTRY **9**

Nanomaterials –Types – Synthesis – sol-gel and laser ablation – Characterization – Scanning Electron Microscope and Transmission Electron Microscope – Principle and instrumentation (block diagram) – Properties – optical, electrical, mechanical and magnetic and Applications of nanomaterials – medicine, agriculture, electronics and catalysis.

UNIT 5 POLYMERS **9**

Polymers – thermoplastics and thermosetting plastics – polymerization – types (definition only) – Compounding of plastics – fabrication – compression and injection – Composites – polymer matrix composites (Fibre reinforced composites) and metal matrix composites – Conduction polymers – General mechanism of conduction in polymers.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Engineering chemistry, 17th Edition. P. C. Jain & Monica Jain, Dhanpat Rai Publishing Company, 2021.
2. Applied chemistry, 2nd Edition. P. N. Palanisamy, P. Manikandan, A. Geetha, K. Manjula Rani, McGraw Hill Education (India) Private Limited, 2019.

REFERENCES:

1. Wiley Engineering Chemistry, 2nd Edition, Wiley, Wiley India Pvt. Ltd, New Delhi, 2014.
2. Engineering chemistry, 2nd Edition. O. G. Palanna, McGraw Hill Education (India) Private Limited, New Delhi, 2017.
3. A Textbook of NanoScience, 2nd Edition, Dr. Rakesh Kumar, Dr. Kamala Pati Tiwary, S. K.

Kataria & Sons, New Delhi, 2013.

e-Resources:

1. http://nptel.ac.in/courses/113105028/, "Science and Technology of Polymers"- Prof. Basudam Adhikari, Materials Science Centre, IIT Kharagpur
2. https://archive.nptel.ac.in/courses/118/102/118102003/, "Nano structured materials-Synthesis, Properties, Self-Assembly and Applications" - Prof. Ashok K Ganguli, Department of Chemistry, IIT Delhi

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

CO1 Evaluate the process to purify hard water using internal and external treatment.
CO2 Apply the principle of electrochemistry in PCB etching and surface coating to prevent corrosion.
CO3 Compare and contrast the performance of primary, secondary and flow battery.
CO4 Analyze the characteristics of nanomaterials synthesized by top down and bottom-up process with the aid of SEM and TEM.
CO5 Categorize the types of polymeric materials and fabrication of plastic by injection and compression molding for engineering applications.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	2	1	1	1	2	-	1	1	1	1	-	-
CO2	3	2	2	1	1	1	2	-	1	1	1	1	-	-
CO3	3	2	2	1	1	1	2	-	1	1	1	1	-	-
CO4	3	2	2	1	1	1	2	-	1	1	1	1	-	-
CO5	3	2	2	1	1	1	2	-	1	1	1	1	-	-

1: Slight (Low) ***2: Moderate (Medium)*** ***3: Substantial (High)*** ***"-"*** ***No correlation***

22CST11	PYTHON PROGRAMMING Common to all branches	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

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.

UNIT 1 COMPUTING FUNDAMENTALS 9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion).

UNIT 2 INTRODUCTION TO PYTHON 9

Python interpreter, data types: int, float, boolean, string, and list; variables, expressions, statements, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT 3 CONTROL FLOW, FUNCTIONS, STRINGS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT 4 LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

UNIT 5 FILES, MODULES AND PACKAGES 9

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages, Introduction to Pygame tool; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

TOTAL: 45 PERIODS

TEXT BOOKS:

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, O'Reilly Publishers, 2016.

REFERENCES:

1. E Balagurusamy, "Problem Solving and Python Programming", McGraw Hill Education, 2018
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.

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.

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

CO1	Use the basics of algorithmic problem-solving techniques (pseudo code, flow chart, language basics) for a given problem.
CO2	Apply suitable python conditional and looping statements to solve a given problem.
CO3	Define Python functions and use function calls to solve problems.
CO4	Use Python data structures (lists, tuples, and dictionaries) to represent complex data.
CO5	Create python packages, modules and files for a given scenario.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	2	2	1	-	-	-	-	-	1	1	-	-
CO2	3	2	2	2	1	-	-	-	-	-	1	1	-	-
CO3	3	2	2	2	1	-	-	-	-	-	1	1	-	-
CO4	3	2	2	2	1	-	-	-	-	-	1	1	-	-
CO5	3	2	2	2	1	-	-	-	-	-	1	1	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22HST11	HERITAGE OF TAMILS	L	T	P	C
		1	0	0	1

UNIT 1 LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT 2 HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT 3 FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT 4 THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNIT 5 CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL: 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே. கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம், (தொல்லியல் துறை வெளியீடு).
5. Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr. S.V. Subatamanian, Dr. K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr. K.K. Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)

22MCT02 **UNIVERSAL HUMAN VALUES** **L T P C**
(Common to All programmes in first year) **3 0 0 0**

Preamble:

- To develop the understanding as physical health and factors for strengthening life force.
- To expose the students on to areas of mediation and impart the knowledge on social virtues and 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 – Blessingsthe 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 InstitutionalEducation, Aliyar, Pollachi, 1st Edition 2016.
2. "Yoga for Human Excellence", compiled by Vethathiri Maharishi Institute for Spiritual and InstitutionalEducation, Aliyar, Pollachi 1st Edition 2009.

e-RESOURCE:

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

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

1. Demonstrate the knowledge on physical health
2. Discuss the various 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.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	-	-	-	-	-	3	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	3	-	2	-	-	-	-	-	-
CO3	-	-	-	-	-	3	-	2	-	-	-	-	-	-
CO4	-	-	-	-	-	3	-	2	2	-	-	-	-	-
CO5	-	-	-	-	-	3	-	-	2	-	-	-	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) "-" No correlation

22PHL11	PHYSICS AND CHEMISTRY LABORATORY I (Common to all B.E/B.Tech Programmes)	L 0	T 0	P 2	C 1

Preamble

This course aims to impart knowledge in the determination of the physical parameters such as wavelength of laser and mercury spectrum, Numerical aperture and acceptance angle of an optical fiber, velocity of ultrasonic waves and thermal conductivity of bad conductor and additionally necessitate the practical skills in determination of rate of corrosion in mild steel, water quality parameters and amount of iron in the given sample.

PHYSICS LABORATORY I
LIST OF EXPERIMENTS

1. Determination of Optical property of Laser and Particle size of Lycopodium powder.
2. Determination of Numerical aperture and acceptance angle of an optical fiber.
3. Determination of velocity of ultrasonic waves- Ultrasonic Interferometer.
4. Determination of wavelength of mercury spectrum- Spectrometer grating.
5. Determination of Thermal conductivity of Bad conductor.

CHEMISTRY LABORATORY I
LIST OF EXPERIMENTS

1. Determination of alkalinity in water sample.
2. Determination of Calcium and Magnesium hardness in water by EDTA method.
3. Determination of rate of corrosion in Mild steel by weight loss method.
4. Determination of iron content of the water sample using spectrophotometer (1,10-phenanthroline / thiocyanate method).
5. Determination of iron content of the given solution using a potentiometer

TOTAL: 45 PERIODS

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

CO1	Experiment and determine the optical property of light sources and acceptance angle of optical fiber using Laser and Spectrometer.
CO2	Experiment and determine the velocity of ultrasonic waves and thermal conductivity of a given bad conductor using ultrasonic interferometer and Lee's disc.
CO3	Experiment and estimate type and amount of alkalinity, Calcium and Magnesium hardness in water sample using titrimetry.
CO4	Experiment and determine the rate of corrosion in mild steel by weight loss method.
CO5	Experiment and determine the amount of iron content present in the given sample using potentiometer and spectrophotometer.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	1	-	3	-	1	1	-	1	1	1	1	-	-
CO2	2	1	-	3	-	1	1	-	1	1	1	1	-	-
CO3	2	1	-	3	-	1	1	-	1	1	1	1	-	-
CO4	2	1	-	3	-	1	1	-	1	1	1	1	-	-
CO5	2	1	-	3	-	1	1	-	1	1	1	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) "-" No correlation

22CSL11	PYTHON PROGRAMMING LABORATORY (Common to all B.E, B.Tech Programmes)	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.

LIST OF EXPERIMENTS

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same.
   (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions
   (exchange the values of two variables, circulate the values of n variables, distance between two points)
3. Scientific problems using Conditionals and Iterative loops.
   (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples.
   (Items present in a library/Components of a car/ Materials required for construction of a building – operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries.
   (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions.
   (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings.
   (reverse, palindrome, character count, replacing characters)
8. Implementation of searching algorithms using linear and binary search technique.
9. Implementation of sorting algorithms using selection sort and insertion sort method.
10. Implementing programs using written modules and Python Standard Libraries
    Libraries (pandas, numpy. Matplotlib, scipy)
11. Implementing real-time/technical applications using File handling.
12. Developing a game activity using Pygame like bouncing ball, car race.

SOFTWARE

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

TOTAL: 45 PERIODS

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

CO1	Design flowcharts using Raptor.
CO2	Develop programs using expressions and Control statements in Python.
CO3	Develop programs using functions, packages for a given problem..
CO4	Process compound data using Python data structures
CO5	Utilize Python packages in developing software applications.

Mapping of COs with POs and PSOs

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2	2	3	-	-	-	-	1	-	-	1	-	-
CO2	2	2	2	3	-	-	-	-	1	-	-	1	-	-
CO3	2	2	2	3	-	-	-	-	1	-	-	1	-	-
CO4	2	2	2	3	-	-	-	-	1	-	-	1	-	-
CO5	2	2	2	3	-	-	-	-	1	-	-	1	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22ENT11	**COMMUNICATIVE ENGLISH** ***(Common to all B.E./B. Tech Programmes)*** ***(Students admitted during 2023- 24 onwards)***	**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 aims at developing Communication Skills in English which is essential for the learner to handle English language for a variety of everyday purposes through acquisition of basic grammar and vocabulary along with LSRW skills.

UNIT 1 INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 9

Listening: Listening for General Information - Specific Details – Conversations - Telephone Conversation - Listening to Voicemail and Messages – Gap Filling **Speaking**: Self Introduction – Expressing Opinions - Introducing a Friend - Telephone Conversation - Leave a Message - **Reading:** Reading Brochures and Pamphlets **Writing:** Writing Reviews - Book/Movie – Writing about Oneself **Grammar & Vocabulary:** Parts of Speech - Tenses - Contextual Meaning of Words - Abbreviations and Acronyms.

UNIT 2 EXPRESSING CASUAL CONVERSATIONS 9

Listening: Information about Hotels and Accommodation - Recipes and Food Items - Listening to Conversations Asking for and Giving Directions – Making an Enquiry **Speaking:** Talking about Daily Routine - Talking about Food - Making Conversation using Asking for and Giving Directions - Making an Enquiry - Role Plays - Dialogues **Reading**: International Recipes - Reading a Print Interview and Answering Comprehension Questions **Writing**: E- Mail to a Friend – E-Mails about Food and Recipes, Inviting Dignitaries, Accepting and Declining Invitations **Grammar & Vocabulary**: Evaluations and Comparisons with Adjectives - Word Formation.

UNIT 3 CLARIFICATIONS AND RECOMMENDATIONS 9

Listening: Listening to Short Talks and Fill a table – Gap Filling Exercises - Note Taking **Speaking:** Group Discussion - Agreeing and Disagreeing - Tips and Strategies for GD **Reading:** Articles - Essays drawn from various sources - Note Making **Writing:** Writing Recommendations - Giving Instructions – Itinerary - Process Description **Grammar & Vocabulary**: Prepositions - Modifiers - Phrasal Verbs.

UNIT 4 PUBLIC SPEAKING AND BUSINESS COMMUNICATION 9

Listening: Listening to Speeches by Famous People and Identifying the Central Message of the Speech - Answering Multiple Choice Questions **Speaking**: Welcome Address - Vote of Thanks - Special Address on Specific Topic **Reading**: Life and Achievements of Famous People **Writing:** Checklists – Personal Letters **Grammar & Vocabulary**: Modal Verbs and Probability - Collocations – Fixed Expressions - Semi-Fixed Expressions.

UNIT 5 WRITING DEFINITIONS AND PRODUCT DESCRIPTIONS 9

Listening: Listening to Product Description - Labeling and Gap Filling Exercises - Seeking help with Office Equipment - Job Details **Speaking:** Describe a Product - Compare and Contrast with other Products - Buying a Product - Selling a Product - Cancelling and Fixing Appointments - Hotel Accommodation **Reading:** Reading Graphical Material for Comparison - Tables - Pie Charts **Writing:** Writing Definitions – Single Line Definition and Extended Definition - Compare and Contrast Paragraphs - Clarifying an Error in the Bill **Grammar & Vocabulary**: Types of Questions - Use of Discourse Markers – One Word Substitution.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Richards, Jack. C with Jonathan Hull and Susan Proctor New Interchange: English for International Communication. (Level 1, Student's Book) Cambridge University Press, New Delhi: 2017.

REFERENCES:

1. M Ashraf Rizvi, "Effective Technical Communication", McGraw-Hill, 2nd Edition, New Delhi, 2018.
2. Sanjay Kumar and Pushp Lata, "Communication Skills: A Workbook, Oxford University Press, 2020.
3. J K Gangal, "A Practical course in Spoken English", PHI Learning Pvt. Ltd., 1st Edition, Delhi, 2014.

e. RESOURCES :

1. https://learnenglish.britishcouncil.org
2. https://www.usingenglish.com

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

CO1 Converse and read fluently using basic grammar components.
CO2 Communicate through writing without any grammatical errors.
CO3 Write clear, coherent and organized passages adhering to instructions.
CO4 Speak effectively in real-time and business situations.
CO5 Enhance vocabulary through listening and reading.

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	-	-	-	-	1	3	-	-	2	3	-	1	-	-
CO 2	-	-	-	-	1	3	-	-	2	3	-	1	-	-
CO 3	-	-	-	-	1	3	-	-	2	3	-	1	-	-
CO 4	-	-	-	-	1	3	-	-	2	3	-	1	-	-
CO 5	-	1	-	-	1	1	-	-	2	3	-	1	-	-
Mapping Average	-	1	-	-	1	2.6	-	-	2	3	-	1	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22ENT21	**PROFESSIONAL ENGLISH** ***(Common to all B.E./B. Tech Programmes)*** ***(Students admitted during 2023- 24 onwards)***	**L T P C** **3 0 0 3**

Preamble:

The course Professional English aims at developing LSRW skills which are essential for the learners to communicative effectively and appropriately in professional contexts through acquisition of grammar and vocabulary.

UNIT 1 ANALYTICAL READING 9

Listening: Listening to Anecdotes - Stories - Event Narration – Documentaries and Interviews with Celebrities - Advertisements - Listening and Gap Filling Exercises **Speaking**: Conversation Skills – Initiating - Turn Taking - Closing – Explaining how something works - Persuasive Speech Techniques **Reading:** Reading Advertisements - User Manuals - Analytical Reading - Deductive and Inductive Reasoning **Writing**: Professional E-mails – E-mail Etiquette – Compare and Contrast Essays **Grammar & Vocabulary**: Prepositional Phrases –Same Word used as Different Parts of Speech.

UNIT 2 SUMMARISING 9

Listening: Listening to Lectures - Talks and Completing Gap Filling Exercises on Science and Technology – Listening Technical Information from Podcasts **Speaking**: Summarizing - Oral Reporting – Narrating Personal Experiences – Events – Interviewing a Celebrity **Reading:** Reading Scientific and Technical Articles - Texts **Writing:** Lab Reports - Summary Writing. **Grammar & Vocabulary**: Impersonal Passive Voice - Purpose Expressions.

UNIT 3 DESCRIBING VISUAL MATERIALS 9

Listening: Listening to the Panel Discussion **Speaking**: Speaking at Formal Situations –Mini Presentation and Making Recommendations **Reading:** Reading Journal Articles - Speed Reading - Interpretation of Graphics – Flow Chart - Bar Chart **Writing**: Data Commentaries - Describing Visual Materials – Mechanics of Writing - Writing Complaints to Editorial Columns **Grammar & Vocabulary:** Subject-Verb Agreement – Pronouns - Relative Pronouns - Numerical Adjectives.

UNIT 4 WRITING E-MAILS AND JOB APPLICATION LETTERS 9

Listening: Listening to Model Interviews **Speaking**: Speaking at Interviews – Role Play Practice **Reading:** Reading Job Advertisements and Company Profile - Statement of Purpose (SOP) **Writing:** Filling up the Job Application – Cover Letter – Résumé Preparation – Internship Application **Grammar & Vocabulary:** 'If' Conditionals – Infinitives – Gerunds - Compound Nouns.

UNIT 5 REPORT WRITING 9

Listening: Viewing a Model Group Discussion **Speaking**: Participating in a Group Talk –
Reading: Cause and Effect Essays – Business Letters **Writing:** Types of Reports - Report Format - Industrial Accident Report - Industrial Visit Report – Feasibility Report - Designing and Reporting Surveys – Writing Discursive Essays **Grammar & Vocabulary:** Reported Speech – Idioms and Phrases.

TOTAL: 45 PERIODS

TEXT BOOK:

1. 'English for Engineers and Technologists' Volume 1 published by Orient Black Swan Limited .2019.

REFERENCES:

1. Richards, Jack. C with Jonathan Hull and Susan Proctor New Interchange: English for International Communication. (Level2, Student's Book) Cambridge University Press, New Delhi: 2017.
2. Sanjay Kumar and Pushp Lata, "Communication Skills: A Workbook , Oxford University Press, 2020.
3. J K Gangal, "A Practical course in Spoken English", PHI Learning Pvt. Ltd., 1st Edition, Delhi, 2014.

e. RESOURCES :

1. www.eslgold.com
2. www.usingenglish.com

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

CO1 Read for gathering and understanding information using narrative techniques.

CO2 Develop and demonstrate listening skills for academic and professional purposes.

CO3 Apply apt vocabulary and construct grammatically correct sentences in professional situations.

CO4 Face interviews with communicative competence and confidence with a good knowledge of career skills.

CO5 Enhance writing skills for essays and for preparing reports.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	-	-	-	-	1	3	-	-	2	3	-	1	-	-
CO 2	-	-	-	-	1	3	-	-	2	3	-	1	-	-
CO 3	-	1	-	-	1	3	-	-	2	3	-	1	-	-
CO 4	-	-	-	-	1	3	-	-	2	3	-	1	-	-
CO 5	-	-	-	-	1	1	-	-	2	3	-	1	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MAT21	CALCULUS AND COMPLEX ANALYSIS	L	T	P	C
	(Common to B.E - BM, EC, EE and MD Programmes)	3	1	0	4

Pre-requisites: Matrices and Differential Equations

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.

UNIT 1 INTEGRAL CALCULUS **9+3**

Double and Triple Integrals in Cartesian coordinates – Evaluation of Double Integrals by Change of order of Integration – Applications of Multiple Integrals to find Area and Volume

UNIT 2 DIFFERENTIATION OF VECTORS **9+3**

Del Operator – Del applied to scalar point function: Gradient and its applications to find unit normal vector, Directional derivative and Angle between two surfaces – Del applied to vector point function: Divergence, Curl and their applications to find Irrotational and Solenoidal vector fields - Vector operator identities (Statement only) - Simple Problems.

UNIT 3 INTEGRATION OF VECTORS **9+3**

Line, Surface and Volume integrals – Vector Integral Theorems (without proof): Green's theorem in a plane – Gauss Divergence Theorem – Stoke's theorem – Simple applications involving squares, rectangles, cubes and rectangular parallelepipeds.

UNIT 4 ANALYTIC FUNCTIONS **9+3**

Functions of a complex variable – Limit and continuity of f(z) – Derivative of f(z) – Cauchy-Riemann equations – Analytic functions – Harmonic and orthogonal properties of analytic function – Construction of analytic functions by Milne's method – Conformal mapping -Translation w=z+k, Magnification and Rotation w=kz, Inversion and Reflection w=1/z and bilinear transformation.

UNIT 5 COMPLEX INTEGRATION **9+3**

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

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOKS:

1. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. George B, Thomas, Joel Hass, Christopher Heil and Maurice D. Weir "Thomas' Calculus". Pearson 14th Edition, 2018

REFERENCES:

1. N.P. Bali, Manish Goyal, "Engineering Mathematics", Lakshmi Publications (PVT) Ltd,4th edition, 2014.
2. Grewal B.S., "Higher Engineering Mathematics" 43rd Edition, Khanna Publishers, New Delhi, 2014.

e-Resources:

1. https://nptel.ac.in/courses/111105122 "Integral and Vector Calculus", Prof. Hari Shankar Mahato,

Department of Mathematics, IIT Kharagpur.

2. https://nptel.ac.in/courses/111103070 "Complex Analysis" Prof. P. A. S. Sree Krishna, Department of Mathematics, IIT Guwahati.

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

CO1 Apply multiple integrals to determine area and volume in Cartesian coordinates.
CO2 Apply the concepts of vector calculus in vector differentiation.
CO3 Apply the concepts of vector calculus in vector integration.
CO4 Represent the analytic functions using conformal mapping and bilinear transformation.
CO5 Classify the singularities and evaluate complex integration.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2	2	-	-	-	-	-	-	-	1	-	-
CO 2	3	3	2	2	-	-	-	-	-	-	-	1	-	-
CO 3	3	3	2	2	-	-	-	-	-	-	-	1	-	-
CO 4	3	3	2	2	-	-	-	-	-	-	-	1	-	-
CO 5	3	3	2	2	-	-	-	-	-	-	-	1	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22PHT23	PHYSICS FOR ELECTRICAL SCIENCES (Common to B.E – EC and EE Programmes)	L	T	P	C
		3	0	0	3

Prerequisites: Engineering Physics

Preamble

Knowledge about the electronic structure of Metals, Semiconductors, Magnetic materials, Superconductors, Dielectrics and New Engineering materials has manifested as a technology to design materials of desired properties with applications.

UNIT 1 CONDUCTING MATERIALS **9**

Conductors – Classical free electron theory of metals – Electrical and thermal conductivities -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 –Solar cell

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 T_c superconductors – Josephson effect - 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 – $BaTiO_3$ and KDP.

UNIT 5 NEW ENGINEERING 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, Opto electronic Devices- LED – LCD -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, 2015.

2 S.O. Pillai “Solid State Physics”,9th Edition, New Age International(P) Ltd, Publishers, New Delhi, 2020.

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", 4th Edition, Tata McGraw-Hill 2012.
3. Richard J.D. Tilley, "Understanding Solids", 2nd Edition, John Wiley & Sons –India, 2013

e-Resources:

1. https://www.coursera.org/specializations/semiconductor-devices
2. https://nptel.ac.in/courses/113102080

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

CO1 Explain the behavior of conducting materials based on classical and Quantum theory for Electrical and Thermal conductors.

CO2 Demonstrate the knowledge on semiconductors with respect to carrier concentration and hall effect using density of energy states

CO3 Compare the properties of magnetic materials for dia, para and ferro magnets and discuss the applications of superconductors using SQUID, Cryotron and MAGLEV

CO4 Analyze the performance of dielectric materials using polarization and Piezo, Pyro, Ferroelectric properties of crystals.

CO5 Explore the properties of optical devices using refractive index, dispersive power, group velocity, group index, complex refractive index, light absorption for an application.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	1	1	1	1	1	-	-	1	1	1	-	-
CO 2	3	2	1	1	1	1	1	-	-	1	1	1	-	-
CO 3	3	2	1	1	1	1	1	-	-	1	1	1	-	-
CO 4	3	2	1	1	1	1	1	-	-	1	1	1	-	-
CO 5	3	2	1	1	1	1	1	-	-	1	1	1	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22ITT21	C PROGRAMMING	L	T	P	C
		3	0	0	3

Pre-requisites: Nil

Preamble

This course aims at giving adequate exposure to students on the principles of procedural programming language. The course is intended to introduce the students to computational thinking and make the students develop C Programs using basic programming constructs. The course will enable the students to apply the fundamentals of C programming to solve Engineering problems.

UNIT 1 BASICS OF C PROGRAMMING 9

Introduction to Programming – Introduction to C - Structure of C program – Compilation and Execution - C Tokens –Keywords, Variables, Constants - Data Types – Input/output statements - Operators: Precedence and Associativity - Expressions – Type Conversion and Typecasting - Decision control and Looping statements - Preprocessor directives. Case study: EB Bill Generation.

UNIT 2 ARRAYS AND STRINGS 9

Introduction to Arrays: Declaration, Initialization – One dimensional array –Linear Search, Binary Search. Two dimensional arrays – Matrix Operations (Addition, Multiplication and Transpose) – Strings - String operations: length, compare, concatenate, copy, reverse – Array of Strings. Case Study: Sorting of student name list in a classroom.

UNIT 3 FUNCTIONS AND POINTERS 9

Introduction to functions - Built-in functions (string functions, math functions) -– User-defined functions - Function prototype, function definition, function call – Parameter passing: Pass by value, Pass by reference - Recursion. Pointers – Declaration – Pointer expression and Pointer arithmetic – Array of pointers –Function Pointers – Case Study: Scientific calculator using built-in functions and user defined functions

UNIT 4 STRUCTURES, UNION AND ENUMERATED DATATYPES 9

Structure - Nested structures – Pointer and Structures – Array of structures – Structure and Functions – Union - Example Programs using structures and Unions – Enumerated Data types. Case Study: Create employee datasheet using Structure, Union.

UNIT 5 FILE PROCESSING 9

Introduction to Files – Using Files in C – Reading and writing Files –Types of file processing: Sequential access, Random access - Functions for selecting a record - Command line arguments - Storage classes – Dynamic memory allocation. Case study: Processing stock details of Library.

TOTAL: 45 PERIODS

TEXT BOOKS:

1 Reema Thareja, “Programming in C”, Oxford University Press, Second Edition, 2016.
2 Pradip Dey, Manas Ghosh, “Fundamentals of Computing and Programming in C”, 3rd Edition, Oxford University Press, 2013.

REFERENCES:

1. Paul Deitel and Harvey Deitel, C How to Program with an Introduction to C++, Eighth edition, Pearson Education, 2018.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.

3. Byron S Gottfried, “Programming with C”, Schaum’s Outlines, Second Edition, Tata McGraw-Hill, 2006.

e-Resources:

1. https://onlinecourses.nptel.ac.in/noc22_cs40/preview
2. https://onlinecourses.nptel.ac.in/noc22_cs45/preview

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

CO1 Develop program in C, equivalent to a given problem statement and solve it by applying appropriate data types and control statements.

CO2 Reproduce and process the given list or table of data using sorting or searching techniques in C.

CO3 Categorize the given problem statement into functions and synthesize a complete program using procedural approach of C language and develop C programs using pointers to access arrays and functions.

CO4 Apply user defined data types like structures and unions to solve problems.

CO5 Develop C programs to store and process the given data using files.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	3	2	-	-	3	-	-	-	-	1	-	-
CO 2	3	2	3	2	-	-	3	-	-	-	-	1	-	-
CO 3	3	2	3	2	-	-	3	-	-	-	-	1	-	-
CO 4	3	2	3	2	-	-	3	-	-	-	-	1	-	-
CO 5	3	2	3	2	-	-	3	-	-	-	-	1	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22ITC21	PROGRAMMING IN C	L T P C
	(B.E-EEE Students admitted during 2024- 25 onwards)	3 0 1 4

Preamble:

This course aims at giving adequate exposure to students on the principles of procedural programming language. The course is intended to introduce the students to computational thinking and make the students develop C Programs using basic programming constructs. The course will enable the students to apply the fundamentals of C programming to solve Engineering problems.

UNIT 1 BASICS OF C PROGRAMMING 9

Introduction to Programming – Introduction to C - Structure of C program – Compilation and Execution - C Tokens –Keywords, Variables, Constants - Data Types – Input/output statements - Operators: Precedence and Associativity - Expressions – Type Conversion and Typecasting - Decision control and Looping statements - Preprocessor directives.

UNIT 2 ARRAYS AND STRINGS 9

Introduction to Arrays: Declaration, Initialization – One dimensional array –Linear Search, Binary Search. Two dimensional arrays – Matrix Operations (Addition, Multiplication and Transpose) – Strings - String operations: length, compare, concatenate, copy, reverse – Array of Strings.

UNIT 3 FUNCTIONS AND POINTERS 9

Introduction to functions - Built-in functions (string functions, math functions) – User-defined functions - Function prototype, function definition, function call – Parameter passing: Pass by value, Pass by reference - Recursion. Pointers – Declaration – Pointer expression and Pointer arithmetic – Array of pointers –Function Pointers.

UNIT 4 STRUCTURES, UNION AND ENUMERATED DATATYPES 9

Structure **-** Nested structures – Pointer and Structures – Array of structures – Structure and Functions – Union - Example Programs using structures and Unions – Enumerated Data types.

UNIT 5 FILE PROCESSING 9

Introduction to Files – Using Files in C – Reading and writing Files –Types of file processing: Sequential access, Random access - Functions for selecting a record - Command line arguments - Storage classes – Dynamic memory allocation.

LIST OF EXPERIMENTS

1. Write a C program to generate EB Bill.
2. Create a C program for Sorting of student names in a classroom
3. Develop a C Program to do scientific calculation using built-in functions and user defined functions.
4. Write a C program to create employee details using Structure and Union.
5. Construct a C program for processing stock details of Library.

Total : (L:45+P:15) 60 PERIODS

TEXT BOOKS:

1. Reema Thareja, "Programming in C", Oxford University Press, Second Edition, 2016.
2. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C", 3rd Edition, Oxford University Press, 2013.

REFERENCES:

1. Paul Deitel and Harvey Deitel, C How to Program with an Introduction to C++, Eighth edition, Pearson Education, 2018.
2. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.
3. Byron S Gottfried, "Programming with C", Schaum's Outlines, Second Edition, Tata McGraw-Hill, 2006.

e-RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc22_cs40/preview
2. https://onlinecourses.nptel.ac.in/noc22_cs45/preview

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

1. Apply suitable data type and control statements in C language to solve the given problem.
2. Experiment the given list of data through sorting or searching techniques in C.
3. Develop C programs using functions and pointers to access arrays.
4. Apply user defined data types like structures and unions to solve problems.
5. Develop C programs to store and process the given data using files.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	2	3	2	-	2	1	-	-	-	-	1	-	-
CO2	3	2	3	2	-	2	1	-	-	-	-	1	-	-
CO3	3	2	3	2	-	2	1	-	-	-	-	1	-	-
CO4	3	2	3	2	-	2	1	-	-	-	-	1	-	-
CO5	3	2	3	2	-	2	1	-	-	-	-	1	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MET11	ENGINEERING GRAPHICS	L	T	P	C
		2	0	6	4

Pre-requisites: Basic Geometry

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.

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 – Diagonal scales and vernier scales- Lines, lettering and dimensioning - Basic geometrical constructions (circular and polygonal surfaces). (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 PLANE SURFACES 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 and trapezoidal method. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT 3 PROJECTION OF SOLIDS 12

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 FREE HAND SKETCHING 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. Visualization concepts- Free hand sketching – Conversion of Isometric view to orthographic views. Perspective projection of simple solids (Qualitative only).

Introduction to CAD software (Not for Examinations)

Lecture: 45, Practical: 15, Total: 60

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.

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

CO1 Draw the various conic sections and Engineering curves
CO2 Sketch projections of lines and planes with vertical and inclined positions
CO3 Draw the projections of solids kept in various positions.
CO4 Sketch sectioned views of solids and development of surfaces.
CO5 Draw the isometric and orthographic views from given pictorial views.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	1							2		1		
CO 2	3	2	1							2		1		
CO 3	3	2	1							2		1		
CO 4	3	2	1							3		2		
CO 5	3	2	1							3		2		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET23	ELECTRIC CIRCUIT THEORY	L	T	P	C
		3	1	0	4

Pre-requisites: HSC Physics

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 provides path to the better understanding of the fundamentals of electrical circuits.

UNIT 1 FUNDAMENTALS OF ELECTRIC CIRCUITS 9+3

Basics of D.C circuits - Voltage and current sources - Ohm's law - Resistors in series and parallel circuits – Star Delta transformation of resistance - Voltage and current division rule - Source transformation - Kirchhoff's laws - Mesh current and Node voltage method of analysis for D.C circuits.

UNIT 2 A.C CIRCUITS AND NETWORK THEOREMS 9+3

Introduction to Sinusoids and Phasors - Impedance and Admittance - Equations of Alternating quantity- RMS and Average Value of Sinusoids - Form factor and peak factor - Real Power, Reactive Power and Apparent Power Calculations and Power Factor - Mesh current and Node voltage method of analysis for A.C circuits using Kirchhoff's laws - Network Theorem: Thevenin, Norton, Superposition, Reciprocity and Maximum power transfer theorem.

UNIT 3 RESONANT AND COUPLED CIRCUITS 9+3

Resonant circuits: Series, Parallel and Series-Parallel circuits - Effect of variation of Q-factor on resonance - Relations between Q-factor, Resonant frequency and Bandwidth - Self-inductance and Mutual inductance - Dot rule - Coupled circuits - Single tuned circuits.

UNIT 4 TRANSIENT CIRCUIT ANALYSIS 9+3

Transient and Steady state Response – Time constant - Transient response of RL, RC and RLC Circuits using Laplace transformation for DC and Sinusoidal input -Problems related to transient response of RL, RC and RLC Circuits using Laplace transform method for DC input.

UNIT 5 THREE PHASE AC CIRCUITS 9+3

Three phase balanced and 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.

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOKS:

1. Sudhakar A and Shyammohan 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.

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

CO1 Analyze electrical circuits using mesh current and nodal voltage method of analysis.
CO2 Apply network theorems to analyze various electrical circuits.
CO3 Describe the phenomenon of resonance in RLC circuits.
CO4 Determine the transient response of electrical circuits for AC and DC input.
CO5 Analyze three phase star and delta connected electrical circuits.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	1	3	2	-	-	-	-	-	-	1	-	1	1	-
CO 2	1	3	2	-	-	-	-	-	-	1	-	1	1	-
CO 3	-	3	-	-	-	-	-	-	-	1	-	1	1	-
CO 4	1	3	-	-	-	-	-	-	-	1	-	1	1	-
CO 5	-	3	-	-	-	-	-	-	-	1	-	1	1	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22HST21	TAMILS AND TECHNOLOGY	L	T	P	C
		1	0	0	1

UNIT 1 WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT 2 DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT 3 MANUFACTURING TECHNOLOGY 3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads - Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT 4 AGRICULTURE AND IRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.

UNIT 5 SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL: 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே. கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை - ஆற்றங்கரை நாகரிகம், (தொல்லியல் துறை வெளியீடு).
5. Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by: International Institute of Tamil Studies.
7. Historical Heritage of the Tamils (Dr. S.V. Subatamanian, Dr. K. D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies.)
9. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr. K.K. Pillay) (Published by: The Author)
11. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu.
12. Journey of Civilization Indus to Vaigai (R. Balakrishnan) (Published by: RMRL) – Reference Book.

22MCT03	ENVIRONMENTAL SCIENCE AND ENGINEERING (Common to all B.E/B.Tech Programmes)	L	T	P	C
		2	0	0	0

Preamble

The study of biodiversity reflects the level of national interest in natural resources and heritage, which is considered as an important part of a country's wealth. As India is one of the world's 12 giant diversity hubs, we need to focus on understanding, preserving and utilizing the biodiversity of our biological resources. Environmental protection is an important issue for today's society, as scientific research provides evidence of increased global warming, ozone depletion and increased pollution. Engineers need to learn the importance of green synthesis in the design, development and evaluation of structures, devices and systems to provide practical solutions to the problems caused by the pollution and depletion of natural resources.

UNIT 1 NATURAL RESOURCES, ECOSYSTEM AND BIODIVERSITY 6

Forest Resources – use and over exploitation – Water Resources – use and over utilization – Dams – benefits and problems – Ecosystem – structure and function – Biodiversity – types – threats to biodiversity – Biodiversity conservation–In-situ and Ex-situ – Role of an individual in conservation of natural resources.

UNIT 2 ENVIRONMENTAL POLLUTION 6

Definition – causes, effects and control measures – Air Pollution, Water Pollution, Soil Pollution – Solid waste – methods of disposal – sanitary landfill, incineration and composting – Environmental Impact Assessment and ISO 14000.

UNIT 3 E-WASTE AND ITS MANAGEMENT 6

E-Waste – sources of e-waste – hazardous substances in e-waste – effects of e-waste on environment and human health – need for e-waste management – disposal treatment methods of e-waste – Global scenario of e-waste – e-waste in India- case studies.

UNIT 4 SOCIAL ISSUES AND THE ENVIRONMENT 6

Social issues – Sustainable development – Water conservation – rain water harvesting. Disaster Management – floods, earthquake, cyclone and landslides. Role of IT in environment and human health.

UNIT 5 GREEN CHEMISTRY 6

Green Chemistry – twelve principles of green chemistry – Importance of green synthesis – Green synthesis – dimethyl carbonate – Bio-catalysts – extraction of gold – Applications of green synthesis.

TOTAL: 30 PERIODS

TEXT BOOKS:

1. Environmental Science, 5th Edition. P. N. Palanisamy, P. Manikandan, A. Geetha, K. Manjula Rani, V. N. Kowshalya, Pearson India Education services Private Limited, 2020.
2. Environmental Science and Engineering, 2nd edition, Dr. T. Arun Luiz, V K publications, 2018.

REFERENCES:

1. Environmental Science and Engineering, 3rd reprint, Benny Joseph, McGraw Hill Education (India) Private Limited, New Delhi, 2015.
2. Engineering Chemistry, 1st Impression, K. Sesha Maheswaramma, Mridula Chugh, Pearson India Education Services Private Limited, 2016.
3. Introduction to Environmental Engineering and Science, 2nd edition, Gilbert M. Masters, Prentice Hall of India Private Limited, 2015.

e-Resources:

1. https://www.digimat.in/nptel/courses/video/105105169/L01.html, "Electronic waste management-issues and challenges"- Prof. Brajesh Kumar Dubey, Department of Civil Engineering, IIT Kharagpur.
2. https://archive.nptel.ac.in/courses/105/103/105103205/, "Municipal solid waste management"- Prof. Ajay Kalamdhad, Department of Civil Engineering, IIT Guwahati.

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

CO1	Recognize the biodiversity threats, overexploitation of forest and overutilization of water to conserve biodiversity.
CO2	Analyze sources, impacts, air and water pollution control measures and solid waste management to maintain a green environment.
CO3	Identify the Environmental impacts of e-waste and its management.
CO4	Explain human health, environment and disaster management through information technology.
CO5	Apply the principles of green chemistry to green synthesis for a sustainable environment.

Mapping of COs with POs and PSOs

COs\POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
CO1	3	2	1	1	1	2	3	2	1	1	1	2	-	-
CO2	3	2	1	1	1	2	3	2	1	1	1	2	-	-
CO3	3	2	1	1	1	2	3	2	1	1	1	2	-	-
CO4	3	2	1	1	1	2	3	2	1	1	1	2	-	-
CO5	3	2	1	1	1	2	3	2	1	1	1	2	-	-
Mapping Average	**3**	**2**	**1**	**1**	**1**	**2**	**3**	**2**	**1**	**1**	**1**	**2**	**-**	**-**

1: Slight (Low) ***2: Moderate (Medium)*** ***3: Substantial (High)*** ***"-"*** ***No correlation***

22PHL21	PHYSICS AND CHEMISTRY LABORATORY II (Common to all B.E/B.Tech Programmes)	L 0	T 0	P 2	C 1

Preamble

This course aims to impart knowledge in the determination of the physical parameters such as young's modulus, band gap, Co-efficient of viscosity, thickness of thin wire and Rigidity modulus of wire. This course also aims to impart the significance and estimation of DO and Cl^- content in water sample by titrimetric method. Amount of Na^+, $Ba^{2+}$and acid with electroanalytical techniques such as flame photometry, conductometry and pH metry in the aqueous solutions has been quantitatively analyzed.

PHYSICS LABORATORY II -LIST OF EXPERIMENTS

1. Determination of Young's modulus by Uniform bending method.
2. Determination of bandgap of semiconductors.
3. Determination of co-efficient of viscosity by Poiseuille's method.
4. Determination of thickness of thin wire by Air wedge method.
5. Determination of rigidity modulus-torsion pendulum.

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. Estimation of dissolved metal ions present in wastewater using flame photometer.
4. Conductometric precipitation titration of $BaCl_2$ vs Na_2SO_4 using conductivity meter.
5. Determination of acid strength in waste water using pH meter.

TOTAL: 45 PERIODS

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

CO1 Experiment and determine the physical characteristics of given solid materials using Young's modulus-Uniform bending method, Air wedge and Torsion Pendulum

CO2 Experiment and determine the band gap energy of a given semiconducting material using Zener diode.

CO3 Experiment and determine the physical characteristics of a given liquid using Poiseuille's method.

CO4 Experiment and estimate the amount of dissolved oxygen by Winkler's method and Chloride content by Mohr's method.

CO5 Analyse the concentration of metal ions and acid present in the wastewater with the aid of Flame photometer, Conductivity meter and pH meter.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	1	-	3	-	1	1	-	1	1	1	1	-	-
CO2	2	1	-	3	-	1	1	-	1	1	1	1	-	-
CO3	2	1	-	3	-	1	1	-	1	1	1	1	-	-
CO4	2	1	-	3	-	1	1	-	1	1	1	1	-	-
CO5	2	1	-	3	-	1	1	-	1	1	1	1	-	-

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) "-" No correlation

22EEL21 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.

LIST OF EXPERIMENTS:

1. Verification of Kirchhoff's voltage law and Kirchhoff's current law
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. Determination of transient response of Series R-C and R-L circuit
8. Determination of frequency response of RLC circuit
9. Simulation of series and parallel resonance circuit using suitable simulation software
10. Simulation of low pass and high pass passive filter 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

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

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

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	1	2		3					2				1	
CO 2	1	2		3					2				1	
CO 3	1	2		3					2				1	
CO 4	1	2		3					2				1	
CO 5	1	2		3					2				1	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MAT33 TRANSFORM TECHNIQUES AND NUMERICAL METHODS **L T P C**
(B.E. Electrical and Electronics Engineering programme in third semester) **3 1 0 4**

Pre-requisites: 22MAT11-Matrices and Differential Equations, 22MAT21- Calculus and Complex analysis

Preamble: The aim of this course is to learn Transform techniques, which is essential for many engineering applications. The course is designed to aid students in understanding the behavior of frequent transforms used in signal processing, such as the Laplace and Z transforms. Additionally, it aims to acquaint students with a range of numerical analysis techniques, such as the numerical solution of differential equations, and the solution of linear systems of equations.

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 LAPLACE TRANSFORMS **9+3**

Laplace transform: Sufficient conditions – Transform of elementary functions – Basic Properties— Transform of periodic functions. Inverse Laplace transform: Standard results – Statement of Convolution theorem and its applications – Solution of linear second order ODE with constant coefficients using Laplace transformation techniques.

UNIT 3 Z TRANSFORMS **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.

UNIT 4 SOLUTION OF ALGEBRAIC AND TRANSCENDENTAL EQUATIONS **9+3**

Algebraic and Transcendental equations – Newton Raphson method – System of Simultaneous equations – Direct Methods: Gauss Jordan and Crout's methods – Iterative method: Gauss Seidel

UNIT 5 NUMERICAL SOLUTIONS TO 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 method: Milne's predictor and corrector methods for solving first order equations

Lecture: 45; Tutorial :15; Total: 60

TEXT BOOKS:

1. Kreyszig Erwin, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal B.S., "Higher Engineering Mathematics" 43rd Edition, Khanna Publishers, New Delhi, 2014
3. Grewal. B.S., and Grewal. J.S. "Numerical methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2014.
4. Gerald. C.F and Wheatley. P. O., "Applied Numerical Analysis", Pearson Education, Asia, 7th Edition, New Delhi, 2013.

REFERENCES:

1. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, 26th Reprint, New Delhi, 2016

2. N.P. Bali, Manish Goyal, “Engineering Mathematics”, Lakshmi Publications(PVT) Ltd, 4th Edition, 2014.
3. Chapra. S.C., and Canale. R.P, "Numerical Methods for Engineers", 7th Edition, McGraw Hill Education India Private Limited,2016.

e-Resources:

1. nptel.ac.in/courses/111/106/111106111/, “Transform Techniques for Engineers”, Dr. Srinivasa Rao Manam, Department of Mathematics, Indian Institute of Technology Madras, Chennai
2. https://nptel.ac.in/courses/111106139, Laplace Transform, Prof. Indrava Roy, IIT Madras
3. nptel.ac.in/courses/111/107/111107105/, “Numerical Methods”, Dr. Ameeya Kumar Nayak and Dr.Sanjev Kumar, Department of Mathematics, Indian Institute of Technology, Roorkee.
4. nptel/courses/video/111107105/L01, “Numerical Methods”, Dr. Ameeya Kumar Nayak and Dr. Sanjev Kumar, Department of Mathematics, Indian Institute of Technology, Roorkee.

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

CO1	Compute the trigonometric form of the Fourier series for periodic waveforms satisfying the Dirichlet’s conditions and using them to evaluate infinite series.
CO2	Solve linear second order ordinary differential equations with constant coefficients using the properties of Laplace transform.
CO3	Solve the difference equations of first and second order using Z-transform techniques.
CO4	Compute the real root of the algebraic and transcendental equations and solve the system of linear equations numerically.
CO5	Compute the numerical solutions for the Initial value problems involving ordinary differential equations using single step and multi-step methods.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2	2								1		
CO 2	3	3	2	2								1		
CO 3	3	3	2	2								1		
CO 4	3	3	2	2								1		
CO 5	3	3	2	2								1		

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET31	ELECTRONIC DEVICES AND CIRCUITS	L	T	P	C
		3	0	0	3

Pre-requisites: 22PHT-11Engineering Physics, 22PHT23- Physics for Electrical Sciences, 22EET23-Electric Circuit Theory.

Preamble:

Equipping the students with basic components of electronics engineering with their device structure(s), configuration(s), operation(s) and characteristics.

UNIT 1 DIODES **9**

P-N diode - P & N type material, Formation of P-N junction diode, Operation of P-N junction diode, Voltage and current characteristics of P-N junction diode; Zener Diode - Forward characteristics, Revere breakdown region, Zener as voltage regulator; Rectifier circuits, Clipping and clamping circuits.

UNIT 2 TRANSISTORS **9**

BJT, JFET, MOSFET, UJT - Device structure, configurations, operation, characteristics.

UNIT 3 AMPLIFIERS **9**

BJT Amplifier - Biasing types, classifications; Modelling of transistor - Hybrid-π model.

UNIT 4 DIFFERENTIAL AND MULTISTAGE AMPLIFIER **9**

Differential amplifier; Cascade and Cascode amplifier; Tuned amplifier; Power amplifier.

UNIT 5 FEEDBACK AMPLIFIERS AND OSCILLATORS **9**

Feedback amplifiers – voltage/current, Series, Shunt feedback; Oscillators: Phase shift, Wien Bridge, Hartley.

Lecture: 45, Total: 45

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. S. Salivahanan, N. Suresh Kumar, “Electronic Devices and Circuits” McGraw Hill,5th Edition,2022.
2. Floyd, “Electron Devices” Pearson Asia 5th Edition, 2001
3. Donald A Neamen, “Electronic Circuit Analysis and Design” Tata McGraw Hill, 3rd Edition, 2003.

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

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

CO1 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.

CO2 Describe the structure and operation of BJT, JFET, MOSFET and UJT analyze it's input and output characteristics.

CO3 Analysis the frequency response characteristics of Common emitter amplifier and calculate the voltage gain using BJT small signal model.

CO4 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.

CO5 Discuss about the positive and negative feedback amplifiers and determine the frequency of oscillation using RC, Wein bridge, Hartley oscillators.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3		1										3	
CO 2	3		1										3	
CO 3	3		1										3	
CO 4	3		1										3	
CO 5	3		1										3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET32	ELECTROMAGNETIC FIELDS	L	T	P	C
		3	1	0	4

Pre-requisites: 22PHT23**-** Physics for Electrical Sciences

Preamble

The purpose of this course is to provide students with an introduction to the basics of vector calculus, electrostatics, magneto statics, and electrodynamic fields. 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.

UNIT 1 VECTOR CALCULUS **9+3**

Vector fields – Different co-ordinate systems – Rectangular, Cylindrical, Spherical co-ordinate systems – Gradient, Divergence and Curl – Divergence Theorem – Stoke's Theorem.

UNIT 2 ELECTROSTATICS - I **9+3**

Sources and effects of electromagnetic fields – Coulomb's Law – Electric field intensity – Field due to point and continuous charges –Gauss's law and applications –. Electric potential.

UNIT 3 ELECTROSTATICS - II **9+3**

Electric field in free space, conductors, dielectric - Dielectric polarization - Dielectric strength - Electric field in multiple dielectrics – Boundary conditions– Poisson's and Laplace's equations – Capacitance - Energy density.

UNIT 4 MAGNETOSTATICS **9+3**

Magnetic field intensity – Biot-Savart Law - Ampere's Law and applications - Magnetic field due to straight conductors, circular loop, infinite sheet of current – Magnetic flux density (B) –Magnetization –Boundary conditions – Scalar and vector potential –Inductance – Energy density.

UNIT 5 ELECTRODYNAMIC FIELDS **9+3**

Magnetic force – Lorentz Law of force –Torque –Faraday's laws, induced emf – Transformer and motional EMF – Maxwell's equations (differential and integral forms) –Displacement current – Derivation of generalized Wave Equations from Maxwell's equations.

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOKS:

1. K.A. Gangadhar, P.M. Ramanathan, "Electromagnetic Field Theory", Khanna Publishers, 16th Edition, 2015**.**
2. Mathew N. O. SADIKU, "Elements of Electromagnetics", Oxford University Press Inc., Seventh Edition, 2018.

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. Kraus and Fleish, “Electromagnetics with Applications”, McGraw Hill International Editions, Fifth Edition, 2010.
4. Ashutosh Pramanik, “Electromagnetism – Theory and Applications”, Prentice-Hall of India Private Limited, New Delhi, Second Edition 2008.
5. 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.

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

CO1	Apply the basic mathematical concepts related to electromagnetic vector fields in field calculations.
CO2	Apply the basic concepts about electrostatic fields for the calculation of electric field intensity, electrical potential and energy density.
CO3	Explain Electric field in free space, conductors, dielectric and multiple dielectrics and apply the basic concepts in Capacitance calculations.
CO4	Apply the basic concepts about magneto static fields for the calculation of magnetic flux density, scalar potential, vector potential and energy density.
CO5	Explain the different methods of emf generation and Maxwell’s equations.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	3								1	2	
CO 2	3	3	3	3								1	2	
CO 3	3	3	3	3								1	2	
CO 4	3	3	3	3								1	2	
CO 5	3	3	3	3								1	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET33	DC MACHINES AND TRANSFORMERS	L	T	P	C
		3	1	0	4

Pre-requisites: 22EET23 – Electric Circuit Theory

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.

UNIT 1 MAGNETIC CIRCUITS AND CONCEPTS OF ROTATING MACHINES 9+3

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 winding. Introduction to Indian Standard Specifications (ISS) - Role and significance in testing.

UNIT 2 DC GENERATORS 9+3

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

UNIT 3 DC MOTORS 9+3

Principle and operations – Back EMF and Torque Equation – Characteristics of series, shunt and compound Motors – starting of DC motors– Types of starters– Speed control methods of DC shunt & series motors – Losses and efficiency in DC machine, condition for maximum efficiency – applications.

UNIT 4 TRANSFORMERS 9+3

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 – Inrush current – Three phase transformers-connections – Parallel operation of three phase transformers – Auto transformer – Tap changing transformers.

UNIT 5 TESTING OF DC MACHINES AND TRANSFORMERS 9+3

Testing of DC Machines: Brake 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.

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOKS:

1. I. J. Nagrath and D. P. Kothari, "Electric Machines", McGraw Hill Education, 5th Edition, 2017.
2. P. S. Bimbhra, "Electric Machinery", Khanna Publishers, 2nd Edition, 2021

REFERENCES:

1. A. E. Fitzgerald and C. Kingsley, "Electric Machinery", New York, McGraw Hill Education, 6th Edition 2017.
2. A. E. Clayton and N. N. Hancock, "Performance and design of DC machines", CBS Publishers, 2018.
3. M. G. Say, "Performance and design of AC machines", CBS Publishers, First Edition 2008. 4. Sahdev S. K. "Electrical Machines", Cambridge University Press, 2018.

e-Resources:

1. https://nptel.ac.in/courses/108106023 - Modelling and Analysis of Electric Machines by Dr. Krishna Vasudevan, IIT Madras.
2. https://archive.nptel.ac.in/courses/108/105/108105155/ - Electrical Machines -I by Prof. Tapas Kumar Bhattacharya, Department of Electrical Engineering, IIT Kharagpur
3. https://archive.nptel.ac.in/courses/108/102/108102146/- Electrical Machines Prof. G. Bhuvaneshwari, Department of Electrical Engineering, IIT Delhi.

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

CO1	Apply the laws governing the electromechanical energy conversion for singly and multiple excited systems.
CO2	Explain the construction and working principle of DC machines.
CO3	Interpret various characteristics of DC machines.
CO4	Describe the working principle of transformer with different types of connections and draw the equivalent circuit of transformer and predetermine the efficiency and regulation.
CO5	Compute various performance parameters of the machine, by conducting suitable tests.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	3								1	2	
CO 2	3	3	3	3								1	2	
CO 3	3	3	3	3								1	2	
CO 4	3	3	3	3								1	2	
CO 5	3	3	3	3								1	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET34	MEASUREMENT AND INSTRUMENTATION SYSTEMS	L	T	P	C
		3	0	0	3

Pre-requisites: 22EET23 – Electric Circuit Theory

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.

UNIT 1 MEASUREMENT SYSTEMS AND ITS CHARACTERISTICS 9

Instruments: classification, applications -Functional elements of a generalized measurement system-Static and dynamic Characteristics-Errors in measurement-Statistical evaluation of measurement data-Standards and Calibration.

UNIT 2 ELECTRICAL MEASURING INSTRUMENTS 9

Classification of instruments-Moving Coil and Moving Iron Instruments-Electrodynamometer type wattmeter-Energy meters –Instrument transformers (CT & PT) – Frequency Meters – Phase meters - Digital voltmeters and Multimeters.

UNIT 3 BRIDGE MEASUREMENTS AND INSTRUMENTATION AMPLIFIERS 9

D.C Bridges: Wheatstone Bridge, Kelvin's bridge- **A.C bridges:** Maxwell bridge, Anderson bridge, Hays bridge, Schering bridge, Wein's Bridge-Instrumentation Amplifiers.

UNIT 4 TRANSDUCERS FOR MEASUREMENT OF NON- ELECTRICAL PARAMETERS 9

Classification of transducers – Measurement of pressure, temperature, displacement, flow, angular velocity – Digital transducers – Smart Sensors.

UNIT 5 DIGITAL INSTRUMENTATION 9

A/D converters: types and characteristics – Sampling, Errors- Measurement of voltage, Current, frequency and phase - **D/A converters**: types and characteristics- DSO- Data Loggers – Basics of PLC programming and Introduction to Virtual Instrumentation - Instrument standards.

Lecture: 45, Tutorial:0, Total:45

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.
2. D.V.S. Murty, "Transducers and Instrumentation", Prentice Hall of India Pvt. Ltd, 2016.
3. David A Bell, Electronic Instrumentation and Measurement, Third Edition, Oxford University Press, 2008.
4. R. K. Rajput, "Electrical and Electronics Measurements and Instrumentation", Chand Pub, 2016.
5. R.B. Northrop, 'Introduction to Instrumentation and Measurements', Taylor & Francis, New Delhi, 3rd Edition 2014.
6. Martin Reissland, 'Electrical Measurements', New Age International (P) Ltd., Delhi, 2001.

7. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010.
8. M.M.S. Anand, 'Electronics Instruments and Instrumentation Technology', Prentice Hall India, New Delhi, 2009

e-Resources:

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

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

CO1	Identify and explain the characteristics of instruments and statistical evaluation of data for measurement.
CO2	Classify the electrical instruments based on the principle of operation.
CO3	Outline the methods of measurements using bridge circuits and Instrumentation amplifiers.
CO4	Infer the operation of storage and display devices for the measurement systems.
CO5	Identify and explain the selection and classification of transducers for the given applications.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO 3	3	2	2	-	-	-	-	-	-	-	-	1	2	-
CO 4	3	2	2	-	-	-	-	-	-	-	-	1	2	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	1	2	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEL31	ELECTRONIC DEVICES AND CIRCUITS LABORATORY	L	T	P	C
		0	0	3	1

Preamble

Supplement the theory course electron devices and circuits to assist the students in obtaining a better understanding of the operation of electronic circuits.

LIST OF EXPERIMENTS:

1. Characteristics of PN Junction diode.
2. Characteristics of Zener diode and Zener diode as a voltage regulator.
3. Characteristics of photo transistor.
4. Characteristics of CB and CE configuration.
5. Characteristics of FET.
6. Characteristics of UJT.
7. Half wave and Full wave Rectifier with capacitive filter.
8. Clipper and Clamper circuits.
9. Frequency response of CE amplifier.
10. Differential amplifiers using BJT.
11. Oscillators: RC phase shift, LC oscillators.
12. Astable and Monostable Multivibrator.

TOTAL: 45 PERIODS

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

CO1 Experiment and determine the forward and reverse characteristics of PN, zener, photo transistor and the input and output characteristics of NPN and FET.

CO2 Experiment and test the half-wave and full-wave rectifier circuit determine the efficiency.

CO3 Experiment and test the differential amplifier circuit and determine the voltage gain.

CO4 Experiment and test the RC phase shift and LC oscillators.

CO5 Experiment and test mono stable and astable multivibrator circuits.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	2		3					1	1		1	3	
CO 2	2	2		3					1	1		1	3	
CO 3	2	2		3					1	1		1	3	
CO 4	2	2		3					1	1		1	3	
CO 5	2	2		3					1	1		1	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEL32	DC MACHINES AND TRANSFORMERS LABORATORY	L	T	P	C
		0	0	3	1

Preamble

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

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. Sumpner‘s test on single phase transformer.

TOTAL: 45 PERIODS

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

CO1 Experiment to determine the performance characteristics of DC separately excited and DC self- excited generator using load test

CO2 Experiment to determine the performance characteristics of DC motors using direct load test

CO3 Experiment to determine the performance characteristics of transformer using direct load test

CO4 Experiment to determine the performance characteristics of DC shunt motor using Swinburne‘s test and Hopkinson‘s test

CO5 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

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1				3					2			1	3	
CO 2				3					2			1	3	
CO 3				3					2			1	3	
CO 4				3					2			1	3	
CO 5				3					2			1	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET41 **DIGITAL LOGIC CIRCUITS**

L	T	P	C
3	1	0	4

Pre-requisites:

22EET31-Electronic Devices and Circuits

Preamble

Serves as a foreword to the principles of digital electronics engineering by enabling students to understand combinational logic design and sequential logic design using logic gates, flip-flops with realization techniques.

UNIT 1 NUMBER SYSTEMS **9+3**

Number systems; 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 **9+3**

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 **9+3**

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

UNIT 4 SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS **9+3**

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

UNIT 5 PROGRAMMABLE LOGIC DEVICES AND VHDL: **9+3**

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)

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOKS:

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

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

CO1	Determine the minimized expression for the given logic function using karnaugh map, Quine–Mccluskey methods and realize using NAND and NOR gates.

CO2 Design adders, subtractors, multiplexers, demultiplexers, encoder, decoder, code converters, and realize boolean expression using multiplexers and demultiplexers.

CO3 Design the SISO, SIPO, PISO, PIPO shift registers using flipflops.

CO4 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.

CO5 Implement PLA and PAL using Boolean functions and develop the dataflow, structural and behavioral model of combinational and sequential circuits using VHDL.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3		3										3	
CO 2	3		3										3	
CO 3	3		3										3	
CO 4	3		3										3	
CO 5	3		3										3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET42 LINEAR INTEGRATED CIRCUITS AND APPLICATIONS

L	T	P	C
3	0	0	3

Pre-requisites : 22EET31-Electronic Devices and Circuits

Preamble

This course discusses the building blocks and applications of the Integrated circuits through the fundamental concepts of electronic circuits with operational amplifiers.

UNIT 1 OPERATIONAL AMPLIFIERS **9**

Basic information of Operational Amplifier – Ideal Operational Amplifier – Operational Amplifier internal circuit: Differential Amplifier. DC characteristics: input bias, offset current, input offset voltage, Thermal drift . AC characteristics: Frequency Response, Frequency Compensation- External and Internal, Slew rate.

UNIT 2 APPLICATIONS OF OPERATIONAL AMPLIFIERS **9**

Inverting Amplifier – Non-inverting Amplifier – Voltage follower – Adder – Subtractor – Difference Amplifier – Instrumentation Amplifier - Differentiator – Integrator – Comparator – Schmitt trigger. Mulitvibrators: Monosatable, Astable. Waveform generators: Triangular Wave generator.

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.

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 IC555 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.

Lecture : 45, Total : 45

TEXT BOOKS:

1. David A. Bell, ‘Op-amp & Linear ICs’, Oxford, Third Edition, 2011.
2. D. Roy Choudhary, Shail B. Jani, ‘Linear Integrated Circuits’, , New Age, Fourth Edition, 2018.
3. Ramakant A.Gayakward, ‘Op-amps and Linear Integrated Circuits’, IV edition, Pearson Education, PHI 2021.

REFERENCES:

1. Fiore,”Opamps& Linear Integrated Circuits Concepts & applications”, Cengage, 2010.
2. Floyd ,Buchla,”Fundamentals of Analog Circuits, Pearson, 2013
3. Jacob Millman, Christos C.Halkias, ‘Integrated Electronics - Analog and Digital circuits system’, McGraw Hill, 2nd Edition, 2017.

4. Robert F.Coughlin, Fredrick F. Driscoll, 'Op-amp and Linear ICs', Pearson, 6th edition,2012.
5. Sergio Franco, 'Design with Operational Amplifiers and Analog Integrated Circuits', McGraw Hill, 2016 – Fourth Edition.
6. Muhammad H. Rashid,' Microelectronic Circuits Analysis and Design' Cengage Learning, 2nd Edition, 2012.

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.

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

CO1	Summarize the characteristics of op-amp in DC and AC
CO2	Analyze the characteristics and basic applications (inverting/non-inverting amplifier, summer, Difference Amplifier, Instrumentation Amplifier, Differentiator, Integrator, Comparator, Schmitt trigger and multi vibrators) of Op-Amp
CO3	Explain circuit and applications of op-amp based active filters, PLL and its applications
CO4	Explain Functional blocks, characteristics and applications of A/D and D/A converters.
CO5	Explain the applications of 555 Timer ICs are Astable and Monostable multivibrators. fixed and variable voltage regulator.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2	2								1	3	3
CO 2	3	3	2	2								1	3	3
CO 3	3	3	2	2								1	3	3
CO 4	3	3	2	2								1	3	3
CO 5	3	3	2	2								1	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET43	INDUCTION AND SYNCHRONOUS MACHINES	L	T	P	C
		3	1	0	4

Pre-requisites: 22EET33 DC machines and Transformers

Preamble

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

UNIT 1 SYNCHRONOUS GENERATOR **9+3**

Constructional details – Types of rotors –winding factors- EMF equation – Synchronous reactance – Armature reaction – Phasor diagrams of non-salient pole synchronous generator connected to infinite bus–Synchronizing and parallel operation – Synchronizing torque -Change of excitation and mechanical input- Voltage regulation – EMF, MMF, ZPF and A.S.A method – steady state powerangle characteristics– Two reaction theory –slip test -short circuit transients

UNIT 2 SYNCHRONOUS MOTOR **9+3**

Principle of operation – Torque equation – Operation on infinite bus bars – V and Inverted V curves – Power input and power developed equations – Starting methods – Current loci for constant power input, constant excitation and constant power Developed-Hunting – natural frequency of oscillations – damper windings- synchronous condenser.

UNIT 3 THREE PHASE INDUCTION MOTOR **9+3**

Constructional details – Types of rotors –- Principle of operation – Slip –cogging and crawling Equivalent circuit – Torque-Slip characteristics – Condition for maximum torque – Losses and efficiency – Load test – No load and blocked rotor tests – Circle diagram – Separation of losses – Double cage induction motors –Induction generators – Synchronous induction motor.

UNIT 4 STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR **9+3**

Need for starting – Types of starters – DOL, Rotor resistance, Autotransformer and Star delta starters – Speed control – Voltage control, Frequency control and pole changing – Cascaded Connection-V/f control – Slip power recovery Scheme-Braking of three phase induction motor: Plugging, dynamic braking and regenerative braking.

UNIT 5 SINGLE PHASE INDUCTION MOTORS AND SPECIAL MACHINE **9+3**

Constructional details of single phase induction motor – Double field revolving theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods of single-phase induction motors – Capacitor-start capacitor run Induction motor- Shaded pole induction motor – Linear induction motor – Repulsion motor – Hysteresis motor – AC series motor- Servo motors-Stepper motors.

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOKS:

1. D P Kothari, I J Nagrath, "Electric Machines", McGraw Hill Education (India) Private Limited, New Delhi, 2017
2. Stephen J. Chapman, ‘Electric Machinery Fundamentals’4th edition, McGraw Hill Education Pvt. Ltd, 4th Edition 2017.

REFERENCES:

1. P.S. Bhimbhra, ‘Electrical Machinery’, Khanna Publishers, edition 2, 2021.
2. A E Fitzgerald, Charles Kingsley Jr, Stephen D. Umans, "Electric Machinery", Tata McGraw-

Hill, New Delhi, 2011.
3. K Murugesh Kumar, "Electrical Machines - II", Vikas Publishing House, New Delhi, 2010.
4. Bhattacharya S K, "Electrical Machines", Tata McGraw-Hill, New Delhi, 2011.

e-Resources:

1. https://archive.nptel.ac.in/courses/108/105/108105131/
2. https://onlinecourses.nptel.ac.in/noc22_ee06/preview

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

CO1	Compare the Performance characteristics of Squirrel cage and slip ring Induction motor with respect to the speed, slip, frequency, power, torque, losses and efficiency.
CO2	Evaluate the Voltage control, frequency control, cascade control and slip power recovery Scheme for speed control of Induction motors.
CO3	Select appropriate of single-phase induction motor and special motor for any application and analyze its significance.
CO4	Analyze Synchronous Impedance method, Ampere Turn method and Potier's Triangle method to determine the voltage regulation of Synchronous Generator.
CO5	Derive the power equation of synchronous motor based on torque and analyze the performance using V and Inverted V curves.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	-	-	-	-	-	-	-	-	1	3	-
CO 2	3	3	3	-	-	-	-	-	-	-	-	1	3	-
CO 3	3	3	3	-	-	-	-	-	-	-	-	1	3	-
CO 4	3	3	3	-	-	-	-	-	-	-	-	1	3	-
CO 5	3	3	3	-	-	-	-	-	-	-	-	1	3	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET44	TRANSMISSION AND DISTRIBUTION	L	T	P	C
		3	0	0	3

Pre-requisites: 22EET23-Electric Circuit Theory & 22EET32-Electromagnetic Fields

Preamble

This course is to gain a fair knowledge on generation, transmission and distribution of electric power.

UNIT 1 POWER GENERATION **9**

Structure of Power System - Indian energy scenario – sources of electric energy - schematic arrangement of Steam power station, Hydro-electric power station, Nuclear power station and Gas power plant.

UNIT 2 TRANSMISSION AND DISTRIBUTION SYSTEMS **9**

Transmission: EHVAC and HVDC transmission - FACTS devices

Distribution: Components of distribution system - Types of distributors: DC and AC distributor (Qualitative treatment only)

UNIT 3 TRANSMISSION LINE PARAMETERS **9**

Types of Conductors: 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 lines - Skin effect - Proximity effect - Corona effect.

UNIT 4 ANALYSIS 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 5 INSULATORS AND CABLES **9**

Insulators: Types, Voltage distribution over a string of suspension insulators, Methods of increasing string efficiency; Underground cables: Types & materials; Types of towers; Types of substations and substation bus schemes - Sag and tension calculations for different weather conditions.

Lecture: 45, Total: 45

TEXT BOOKS:

1. V K Mehta, Rohit Mehta, “Principles of Power Systems”, S. Chand & Co., New Delhi, 2022.
2. S.N. Singh, ‘Electric Power Generation, Transmission and Distribution’, Prentice Hall of India Pvt. Ltd., New Delhi, Second Edition, 2012.

REFERENCES:

1. Wadhwa C.L., "Electrical Power Systems", 7th Edition, New Age International Publishers, New Delhi, 2017
2. Kothari D.P & Nagrath I.J, "Power System Engineering", 3rd Edition, Mc Graw Hill Education (India) Pvt. Ltd., New Delhi, 2019.
3. Gupta J. B, "A Course in Power Systems", 11th Edition, S.K. Kataria & Sons, New Delhi, 2021.

e-Resources:

1. https://archive.nptel.ac.in/courses/108/102/108102047/
2. https://www.academia.edu/22504154/Power_System_Generation_Transmission_and_Distribution
3. https://nptel.ac.in/courses/108107112

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

CO1 Describe the methods of generating electricity using conventional energy sources

CO2 Elucidate the structure of power system, types of AC and DC distributors and high voltage transmission system.

CO3 Compute the transmission line parameters of single phase, three phase symmetrical circuit and three phase unsymmetrical circuit.

CO4 Analyze the efficiency and voltage regulation of short, medium and long transmission lines with its equivalent circuits.

CO5 Discuss the types of insulators, cables and substation and calculate the sag and tension for different weather conditions.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	-	2	-	-	-	-	-	-	-	-	-	1	3	-
CO 2	-	2	-	-	-	-	-	-	-	-	-	1	3	-
CO 3	1	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 4	-	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 5	-	2	2	-	-	-	-	-	-	-	-	1	3	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET45 **CONTROL SYSTEMS**

L	T	P	C
3	2	0	4

Pre-requisites: 22EET23-Electric Circuit Theory

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.

UNIT 1 SYSTEMS AND THEIR REPRESENTATION 9+3

Introduction – Basic elements in control systems – Open and closed loop systems – Electrical analogy of mechanical 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 9+3

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 9+3

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

UNIT 4 STABILITY ANALYSIS AND COMPENSATOR DESIGN 9+3

Characteristics equation – Routh-Hurwitz criterion – Nyquist stability criterion – Root locus construction – Compensator Design: Lag, Lead and Lead-Lag compensator using Bode plot.

UNIT 5 STATE VARIABLE ANALYSIS 9+3

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.

Lecture: 45, Tutorial: 15, Total: 60

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 HoupisSttuart, 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

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

CO1 Determine the transfer function of electrical and mechanical systems.

CO2 Analyze the time response of first order and second order system with step, ramp and parabolic inputs.
CO3 Analyze the frequency response of open loop and closed loop systems.
CO4 Determine the stability of open loop and closed loop system using RH criterion, Nyquist stability criterion and Root locus technique techniques.
CO5 Determine the state space model of electrical and mechanical systems and test its controllability and observability.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO 4	3	2	1	-	-	-	-	-	-	-	-	1	2	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	1	2	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22ITT31 OBJECT ORIENTED PROGRAMMING USING JAVA

L	T	P	C
3	0	0	3

Pre-requisites: -

Preamble

This course focuses on the fundamentals of object-oriented programming and Java programming language. Students will also be able to understand the fundamentals of packages, inheritance, and interfaces. The ability to create Java applications with threads, generic classes, exceptions, and I/O streams will be taught to the students. Additionally, using JAVAFX, students will be able to create graphic user interface applications.

UNIT 1 INTRODUCTION TO OOP AND JAVA 9

Overview of OOP – Object oriented programming paradigms – Features of Object Oriented Programming – Java Buzzwords – Overview of Java – Data Types, Variables and Arrays – Operators – Control Statements – Programming Structures in Java – Defining classes in Java – Constructors-Methods -Access specifiers - Static members- JavaDoc comments- I/O Basics – Reading and Writing Console I/O.

UNIT 2 INHERITANCE, PACKAGES AND INTERFACES 9

Overloading Methods – Objects as Parameters – Returning Objects –Static, Nested and Inner Classes. Inheritance: Basics– Types of Inheritance -Super keyword -Method Overriding – Dynamic Method Dispatch – Abstract Classes – final with Inheritance. Packages and Interfaces: Packages – Packages and Member Access – Importing Packages – Interfaces.

UNIT 3 EXCEPTION HANDLING AND MULTITHREADING 9

Exception Handling basics – Multiple catch Clauses – Nested try Statements – Java's Built-in Exceptions – User defined Exception. Multithreaded Programming: Java Thread Model–Creating a Thread and Multiple Threads – Priorities – Synchronization – Inter Thread Communication Suspending –Resuming, and Stopping Threads –Multithreading. Wrappers – Auto boxing.

UNIT 4 FILE I/O, GENERICS, STRING HANDLING 9

Reading and Writing Files. Generics: Generic Programming – Generic classes – Generic Methods – Bounded Types – Restrictions and Limitations. Strings: Basic String class, methods and String Buffer Class.

UNIT 5 JAVAFX EVENT HANDLING, CONTROLS AND COMPONENTS 9

JAVAFX Events and Controls: Event Basics – Handling Key and Mouse Events. Controls: Checkbox, ToggleButton – RadioButtons – ListView – ComboBox – ChoiceBox – Text Controls – ScrollPane. Layouts – FlowPane – HBox and VBox – BorderPane – StackPane – GridPane. Menus – Basics – Menu – Menu bars – MenuItem.

Total : 45 Periods

TEXT BOOKS:

1. Herbert Schildt, "Java: The Complete Reference", 11th Edition, McGraw Hill Education, New Delhi, 2019
2. Herbert Schildt, "Introducing JavaFX 8 Programming", 1st Edition, McGraw Hill Education, New Delhi, 2015

REFERENCES:

1. Cay S. Horstmann, "Core Java Fundamentals", Volume 1, 11th Edition, Prentice Hall, 2018

e-RESOURCES:

1. https://archive.nptel.ac.in/courses/106/105/106105191/
2. https://www.w3resource.com/java-tutorial/java-object-oriented-programming.php

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

CO1	Apply the concepts of classes and objects to solve simple problems.
CO2	Discuss the basic principles of inheritance, packages and interfaces in Java programming.
CO3	Make use of exception handling mechanisms and multithreaded model to solve real world problems.
CO4	Develop a Java application using I/O packages, string classes, generics concepts for the given problem.
CO5	Integrate the concepts of event handling, JavaFX components and controls for developing GUI based applications.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	1	3	2	3	1	1	1	-	-	-	-	2	-	-
CO2	2	3	2	3	1	1	1	-	-	-	-	3	-	-
CO3	2	3	2	3	1	1	1	-	-	-	-	2	-	-
CO4	2	3	2	3	1	1	1	-	-	-	-	3	-	-
CO5	1	3	2	3	1	1	1	-	-	-	-	2	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEL41 INDUCTION AND SYNCHRONOUS MACHINES LABORATORY

L	T	P	C
0	0	3	1

Preamble

The purpose of this lab is to provide practical experience in the operation and testing of synchronous and induction machines.

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. Synchronization of two Three Phase Alternators by Two bright one dark lamp Method
9. Load test on single phase induction motor.
10. No load and blocked rotor test on single phase induction motor.

TOTAL: 45 PERIODS

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

CO1 Experiment to determine the performance characteristics of alternator using EMF, MMF, ZPF and Slip test methods.

CO2 Experiment to determine the performance characteristics of synchronous motor

CO3 Experiment to determine the performance characteristics of induction motor by conducting load test.

CO4 Experiment to determine the equivalent circuit parameters and losses of induction motor

CO5 Experiment to determine the performance characteristics and the equivalent circuit parameters of single-phase induction motor.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2							1			3	3
CO 2	3	3	2							1			3	3
CO 3	3	3	2							1			3	3
CO 4	3	3	2							1			3	3
CO 5	3	3	2							1			3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEL42	LINEAR AND DIGITAL INTEGRATED CIRCUITS LABORATORY	L	T	P	C
		0	0	3	1

Preamble

This course provides hands-on experience in designing, implementing, and analysing the properties and applications of linear and digital integrated circuits.

LIST OF EXPERIMENTS:

1. Realization of Adders and Subtractors.
2. Realization of Multiplexers and Demultiplexers.
3. Encoders and Decoders.
4. Realization of Flip-flops.
5. Synchronous and Asynchronous Counters.
6. Shift Registers: SISO, SIPO, PISO, PIPO.
7. Op-Amp: Realization of Adder/Subtractor.
8. Op-Amp: Integrator/Differentiator.
9. Timer Application: Astable, Monostable Multivibrator.

TOTAL: 45 PERIODS

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

CO1 Design a combinational logic function described by a truth table using and/or/inversion gates and analyze its behavior.

CO2 Analyze the operations and characteristics of flip-flops.

CO3 Design a Sequential logic circuits described by a state table using flip-flops.

CO4 Analyze and implement various circuits Applications like Adder/Subtractor, integrator/differentiator using Op-amp.

CO5 Design and test the performance of multi-vibrators for given specifications using timer IC.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3		3						1			1	3	
CO 2	3		3						1			1	3	
CO 3	3		3						1			1	3	
CO 4	3		2	3					1			1	3	
CO 5	3		2	3					1			1	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22ITL31	OBJECT ORIENTED PROGRAMMING LABORATORY	L	T	P	C
		0	0	2	1

Preamble

The goal of the course is to give students the ability to construct software using Java programming for practical applications. The ideas of classes, packages, interfaces, inheritance, exception handling, and file processing will be understood and applied by the students. Students are also capable of creating applications using event handling and general programming.

LIST OF EXPERIMENTS:

1	Solve problems by using sequential search, binary search, and quadratic sorting algorithms (selection, insertion)
2	Develop stack and queue data structures using classes and objects.
3	Develop a java application with an Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile_no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club funds. Generate pay slips for the employees with their gross and net salary.
4	Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named printArea(). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method print Area ( ) that prints the area of the given shape.
5	Solve the above problem using an interface.
6	Implement exception handling and creation of user defined exceptions.
7	Write a java program that implements a multi-threaded application that has three threads. First thread generates a random integer every 1 second and if the value is even, the second thread computes the square of the number and prints. If the value is odd, the third thread will print the value of the cube of the number.
8	Write a program to perform file operations.
9	Develop applications to demonstrate the features of generics classes.
10	Develop applications using JavaFX controls, layouts and menus.

SOFTWARE

- Operating Systems: Linux / Windows
- Front End Tools: Eclipse IDE / Netbeans IDE

TOTAL: 45 PERIODS

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

CO1	Design and develop java programs using object-oriented programming concepts.
CO2	Develop simple applications using object-oriented concepts such as packages and exceptions.
CO3	Implement multithreading and generics concepts for the given problem.
CO4	Create GUIs and event driven programming applications for real world problems.

CO5 Implement and deploy web applications using Java

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	1	2	1	-	1	1	-	1	2	2	2	-	-
CO 2	2	1	3	1	-	1	1	-	2	3	3	2	-	-
CO 3	2	2	1	2	1	1	1	-	1	2	1	3	-	-
CO 4	2	2	1	3	-	1	1	-	3	1	1	1	-	-
CO 5	1	3	3	1	3	2	2	-	1	1	1	1	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MCL04	ENGLISH FOR PROFESSIONALS (III / IV Semester) (Students admitted during 2023-2024 onwards)	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.

UNIT 1 LISTENING **5**

Listening to Casual Conversation- Note-Taking on TED Talks – Summarizing

UNIT 2 READING **7**

Reading for gist - Biographies of Famous Personalities - Reading and Note Making on News Articles

UNIT 3 WRITING **5**

Letter Writing - Seeking Permission- Seeking Apology - Letters Requesting Certificates – Analytical Writing and Issue based writing

UNIT 4 SPEAKING **9**

Presentation Techniques - Presentation with visual aids – Extempore and Impromptu talk

UNIT 5 VERBAL ABILITY **4**

Parajumbles - Sentence Completion - Identifying Common Errors

TOTAL: 30 PERIODS

REFERENCES:

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

e. RESOURCES :

3. https://agendaweb.org/listening/audio-books-mp3.html
4. https://www.ndtv.com/world-news
5. http://learnenglishteens.britishcouncil.org/skills/reading
6. https://www.bbc.com/

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

CO1	Analyze the given listening material and answer the questions correctly employing listening techniques.
CO2	Analyze the given reading material and answer the questions correctly employing reading techniques.
CO3	Write within the stipulated time syntactically and semantically correct sentences to present ideas in the form of essays and letters.
CO4	Take part effectively in group discussion, conforming to professional norms and to give extemporaneous presentation.
CO5	Identify within the stipulated time syntactically and semantically correct sentences for a variety of language exercises.

Cos/POs	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	-	-	-	-	3	-	-	-	-	3	-	-	-	-
CO 2	-	-	-	-	-	-	-	-	-	3	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	3	3	-	1	-	-
CO 4	-	-	-	-	-	-	-	-	3	3	-	1	-	-
CO 5	-	-	-	-	-	-	-	-	-	3	-	1	-	-
Mapping Average	-	-	-	-	3	-	-	-	3	3	-	1	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET51 **POWER ELECTRONICS**

L	T	P	C
3	0	0	3

Pre-requisites: 22EET31-Electronic Circuits and Devices

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.

UNIT 1 POWER SEMICONDUCTOR DEVICES 9

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

UNIT 2 AC TO DC CONVERTERS 9

Single phase converter: Half controlled bridge converter and full controlled bridge converter with R, RL Load – Estimation of average & RMS values of load voltage, load current and input power factor.
Three phase converter: Half controlled and fully controlled converter with R, RL Load – Estimation of average & RMS values of load voltage, load current for R load – Gate drive circuit schemes for Phase Control – Dual converters.

UNIT 3 DC TO DC CONVERTERS 9

DC Choppers : Principle of step up, step down chopper and Step Up/Down Chopper operation – Control strategies – Classification & operation of choppers class (A,B,C,D,E) – Operation of voltage, current and load commutated choppers.

UNIT 4 DC TO AC CONVERTERS 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 – Concept of space vector modulation, UPS – Types of UPS – Introduction to Multilevel Inverter.

UNIT 5 AC TO AC CONVERTERS 9

AC Voltage Controllers : Single phase voltage regulators – half wave and full wave with R, RL loads – sequence control of AC regulators – two stage sequence regulator with R, RL load – Multistage sequential control of AC regulators – Introduction to three phase regulators.
Cycloconverters: Single phase to single phase cycloconverter – three phase to single phase and three phase to three phase cycloconverters – Introduction to Matrix Converters.

Lecture: 45, Total: 45

TEXT BOOKS:

1. Singh M.D & Khanchandani K.B, “Power Electronics” McGraw Education (India) Private limited, New Delhi 2006.
2. P.S. Bimbra “Power Electronics”, Khanna Publishers, 7th Edition, Reprint 2022.

REFERENCES:

1. M.H. Rashid, "Power Electronics: Circuits, Devices and Applications", Pearson Education, 3rd Edition, 2014.
2. Ned Mohan, Tore. M. Undeland, William. P. Robbins, “Power Electronics: Converters,

Applications and Design", John Wiley and sons, Third Edition, 2003, 2013 Reprint.
3. Joseph Vithayathil, "Power Electronics, Principles and Applications", McGraw Hill Series, 8th Reprint, 2015.

e-Resources:

1. https://onlinecourses.nptel.ac.in/noc22_ee03/preview - "Fundamental of Power Electronics", Prof. L Umanand, IISc Bangalore.
2. https://ocw.mit.edu/courses/6-334-power-electronics-spring-2007/ - "Power Electronics", Prof.David Perreault

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

CO1 Describe the basic structure, static and dynamic characteristics of power semiconductor switching devices.
CO2 Illustrate the operation, characteristics and performance parameters of Phase Controlled Converters.
CO3 Analyze the operation, switching techniques of available topologies of DC-DC Converters.
CO4 Explain the different modulation techniques of PWM inverters and discuss various harmonic reduction.
CO5 Describe the operation of various configurations of AC-AC Converters.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	3										1	3	
CO 2	2	3										1	3	
CO 3	2	3										1	3	
CO 4	2	3										1	3	
CO 5	2	3										1	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantal (High).

22EET52	POWER SYSTEM ANALYSIS	L	T	P	C
		3	1	0	4

Pre-requisites: 22EET44-Transmission and Distribution

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.

UNIT 1 PER UNIT REPRESENTATION AND TOPOLOGY PER UNIT QUANTITIES **9+3**

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 – construction of Y-bus using inspection and singular transformation methods .

UNIT 2 POWER FLOW STUDIES **9+3**

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 **9+3**

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 **9+3**

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.

UNIT 5 STABILITY ANALYSIS **9+3**

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.

Lecture: 45, Tutorial: 15, Total: 60

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

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

CO1 Formulate bus admittance matrices and bus impedance matrices using single line representation in power system network.

CO2 Compare and contrast the load flow solution using Gauss-Seidel method, Newton-Raphson method and Fast decoupled method in power flow problem.

CO3 Calculate the post fault voltage and current using Thevenin's theorem in short circuit power system.

CO4 Classify the single Line-to-Ground fault, Line-to-Line fault, Double Line-to-Ground fault using Symmetrical components in power system network.

CO5 Infer the voltage stability and transient stability analysis of power system using swing equation by Euler's method and Runge-Kutta method.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 2	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 3	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 4	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 5	3	2	2	-	-	-	-	-	-	-	-	1	3	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantal (High).

22EET53	MICROPROCESSOR AND MICROCONTROLLER	L	T	P	C
		3	0	0	3

Pre-requisites : 22EET31-Electronic Circuits and Devices,22EET41-Digital Logic Circuits

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.

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.

Lecture: 45, Total: 45

TEXT BOOKS:

1. Krishna Kant, ‘Microprocessor and Microcontrollers’, Eastern Company Edition, Prentice Hall of India, 2012.
2. Muhammad Ali Mazidi. Janice GillispieMazidi. 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.

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

CO1	Illustrate the architecture and timing diagram of memory read, write and I/O read, write and interrupt acknowledge machine cycles of 8085 Microprocessor.
CO2	Develop the 8085 assembly language programs for the simple applications using available addressing modes.
CO3	Explain the architecture of 8051 Microcontroller and illustrates the memory organization, I/O port features and interrupts.
CO4	Draw and explain the interfacing diagram of 8255, 8254, 8251, 8279 and data converters with 8085 microprocessor.
CO5	Develop assembly language programs for given applications using 8051 Microcontroller.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3							2			1	3	3
CO 2	3	3							2			1	3	3
CO 3	3	3							2			1	3	3
CO 4	3	3							2			1	3	3
CO 5	3	3							2			1	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEL51	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.

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.

TOTAL: 45 PERIODS

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

CO1	Write the assembly language programs for 8085 Microprocessor and test using trainer kits with assembler.
CO2	Write the assembly language programs for 8051 Microcontroller and test using trainer kits with assembler.
CO3	Experiment the Stepper motor, DC motor, ADC and DAC interfacing with 8051Microcontroller and 8085 Microprocessor.
CO4	Experiment the keyboard and display interface, and develop a traffic light controller, time delay circuit and event counter using 8085 Microprocessor.
CO5	Simulate a DC motor and stepper motor interface with Arduino platform using open-source software.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2		3					2	1			2	2
CO2	2	2		3					2	1			2	2
CO3	2	2		3					2	1		1	2	2
CO4	2	2		3					2	1		1	2	2
CO5	2	2		3	2				2	1		1	2	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEL52	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.

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	Design of Lag, Lead and Lag-Lead Compensators.
4	Measurement of Impedance using AC Bridge.
5	Measurement of Resistance using DC Bridges.
6	Measurement of Strain using Strain gauge.
7	Study the characteristics of inductive transducer and light transducers.
8	Measurement of Temperature using (RTD / Thermocouple / Thermistor).
9	Measurement of pressure using Pressure transducer.
10	Measurement of flow using flow meters.
11	Simulate the response of first and second order system using step, ramp and impulse inputs by using suitable software.
12	Simulation of P, PI and PID controllers by using suitable simulation software.

TOTAL: 45 PERIODS

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

CO1	Experiment and determine the transfer function of DC motor and AC servo motor.
CO2	Experiment and test Wheatstone bridge, Kelvin's double bridge and Maxwell's bridge to determine the value of unknown resistance, inductance and capacitance.
CO3	Experiment and test the temperature, pressure, flow, strain, displacement and light transducer.
CO4	Determine the time and frequency response of first order and second order system with step, ramp and impulse inputs using suitable simulation software.
CO5	Simulate the Proportional, Proportional Integral, Proportional, Integral and derivative controllers and lag, lead and lag-lead compensators using suitable simulation software.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	2		3					2	1			2	2
CO2	2	2		3					2	1			2	2
CO3	2	2		3					2	1			2	2
CO4	2	2		3	2				2	1			2	2
CO5	2	2		3	2				2	1			2	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET61 SOLID STATE DRIVES L T P C
3 0 0 3

Pre-requisites: 22EET33-DC Machines and Transformers, 22EET43-Induction and Synchronous Machines , 22EET51-Power Electronics .

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

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.

Lecture: 45, Total: 45

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

Course Outcomes: Upon completion of this 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

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	2	-	-	-	-	-	-	-	2	-	-	3	-
CO 2	2	1	-	-	-	-	-	-	-	2	-	-	3	-
CO 3	2	2	-	-	-	-	-	-	-	2	-	-	3	-
CO 4	2	1	-	-	-	-	-	-	-	2	-	-	3	-
CO 5	2	1	-	-	-	-	-	-	-	2	-	-	3	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantal (High).

22EET62 **DIGITAL SIGNAL PROCESSING**

L	T	P	C
3	1	0	4

Pre-requisites: 22MAT31 - Transform Techniques & Numerical Methods

Preamble

Digital 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.

UNIT 1 SIGNALS AND SYSTEMS **9+3**

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 **9+3**

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 **9+3**

Discrete Fourier Transformation: Need for DFT; 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 **9+3**

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 **9+3**

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

Lecture: 45, Tutorial: 15, Total: 60

TEXT BOOKS:

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.

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

CO1 Comprehend 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.

CO2 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.

CO3 Discuss the periodicity and symmetry properties of forward and inverse Discrete Fourier Transformation (DFT) and their computation by using Fast Fourier Transformation (FFT) algorithms.

CO4 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.

CO5 Illustrate the architectural features, addressing formats and functional modes of fixed-point and a floating-point digital signal processor with their commercial applications.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3	-	2	-	-	-	-	-	-	-	3	3
CO 2	3	3	3	-	2	-	-	-	-	-	-	-	3	3
CO 3	3	3	3	-	2	-	-	-	-	-	-	-	3	3
CO 4	3	3	3	-	2	-	-	-	-	-	-	-	3	3
CO 5	2	2	2	-	3	-	-	-	-	-	-	-	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET63	POWER SYSTEM OPERATION AND CONTROL	L	T	P	C
		3	0	0	3

Pre-requisites:22EET52- Power System Analysis

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.

UNIT 1 UNIT I INTRODUCTION 9

Types of load –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 tariff–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 UNIT II 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 .

UNIT 3 UNIT III 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). 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 UNIT V 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

Lecture: 45,Total: 45

TEXT BOOKS:

1. 1. Olle.I.Elgerd, _Electric Energy Systems theory – An introduction‘, Tata McGraw Hill Education Pvt. Ltd., New 2. Delhi, 34th reprint, 2010.
2. 2.S.Sivanagaraju, G.Sreenivasan., ―Power System Operation and Control‖, Pearson Education India, 2009

REFERENCES:

1. 1.AbhijitChakrabarti, SunitaHalder, _Power System Analysis Operation and Control‘, PHI learning Pvt. Ltd., New Delhi, Third Edition, 2010.
2. 2. Kundur P., _Power System Stability and Control, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 10th reprint, 2010.
3. 3. Nagrath I.J. and Kothari D.P., _Modern Power System Analysis‘, Tata McGraw-Hill, Fourth Edition, 2011

e-Resources:

1. 1.https://nptel.ac.in/courses/108104052/, ―Power system operation and control‖, Prof S.N.Singh,IIT-Kanpur
2. 2. https://www.btechguru.com/engineeringvideos/video-lesson/power-systems-operation-and-control/electricalengineering/bc3c42e6c23f23ed~c6c45d988f670c72.html

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

CO1 Understand the types of load ,components of system loads and tariff in power systems.
CO2 Acquire the knowledge of turbine speed governing system and model LFC,AGC for single area and two area system.
CO3 Discriminate and find errors in reactive power voltage control
CO4 Classify and apply the economic dispatch and unit commitment in thermal power plants
CO5 Integrate and categorize the computer control of power system

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	-	-	-	-	-	-	-	-	-	-	2	1
CO 2	2	2	3	-	-	-	-	-	-	-	-	-	3	3
CO 3	2	2	3	-	-	-	-	-	-	-	-	-	3	2
CO 4	3	2	3	-	-	-	-	-	-	-	-	-	3	2
CO 5	3	-	-	-	-	-	-	-	-	-	-	-	2	1

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantal (High).

22EEL61	POWER ELECTRONICS AND DRIVES LABORATORY	L	T	P	C
		0	0	3	1

Preamble:

In the many technical application domains, the power electronics lab is widely recognized for its importance. Possessing practical knowledge of power electronics circuits is a must for an electrical engineer. We have presented a Laboratory manual/Observation for power electronics from this angle.

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 Speed control of Brush Less DC motor drive.
10	PLC based three phase Induction motor drive.
11	Simulation of 1Φ and 3Φ half and fully controlled converter.
12	Simulation of 1Φ and 3Φ AC Voltage controllers
13	Simulation of DC-DC converters.

TOTAL: 45 PERIODS

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

CO1	Experiment and test the characteristics of power semiconductor switching devices and triggering Circuit for AC-DC converters.
CO2	Experiment and test the Static and dynamic characteristics of power semiconductor switching devices.
CO3	Experiment and test the operation of Power converters such as AC-DC converter, Inverter, DC-DC Converter, AC Voltage controller and Cyclo-converter.
CO4	Experiment to determine the speed control of DSP based Brush Less DC motor and PLC based Induction motor drives.
CO5	Simulate and analyze the response of power converters.

Mapping of COs with POs and PSOs

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	1	2		3					2			1	2	
CO2	1	2		3					2			1	2	
CO3	1	2		3					2			1	2	
CO4	1	2		3					2			1	2	
CO5	1	2		3	3				2			1	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEL62 **INNOVATIVE DESIGN PROJECT** **L T P C**
0 0 6 2

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.

22MCL06 **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.

UNIT 1 RECEPTIVE SKILLS 6

LISTENING & READING – Developing Listening & Reading Skills - Comprehension and Analysis – Listening & Reading for Main Idea - Specific Information - Cloze Test- Rearranging words and sentences

UNIT 2 PRODUCTIVE SKILLS 8

SPEAKING & WRITING - Group Discussion and Practice – Mock GD - Structure – Types - Techniques - Keywords -Vital qualities - Attitude and Opinion - Expository and Persuasive Paragraphs – Picture Description

UNIT 3 ENGLISH FOR NATIONAL AND INTERNATIONAL EXAMINATIONS 4

Orientation to International English Language Testing System (IELTS) and other Competitive Examinations – MCQs

UNIT 4 CAREER SKILLS 6

Types of Interviews - FAQ's - Mock Interviews - Body Language - Team Work - Managing Time - Managing Stress - Negotiation Skills - Networking – Profile Creation (Linked in, Portfolio)

UNIT 5 VERBAL ABILITY 6

Synonyms and Antonyms - Idioms and Phrases - Sentence Construction and Improvement- Paraphrasing - Contextual Vocabulary - Verbal Analogy

TOTAL: 30 PERIODS

REFERENCES:

1. M Ashraf Rizvi "Effective Technical Communication", Tata McGraw-Hill, 2st Edition, New Delhi, 2018.
2. Koneru Aruna 'Professional Communication' MC Graw Hill Education, Chennai, 2008.
3. Upadhyay Meenakshi & Arun Sharma 'Comprehension Interpersonal & Communication Skills for General Studies Civil Services Preliminary Examination' MC Graw Hill Education, New Delhi, 2012.

e. RESOURCES :

1. https://www.teachingenglish.org.uk/article/email-writing
2. http://www.oxforddictionaries.com/words/writing-job-applications
3. https://www.fresherslive.com/online-test/verbal-ability-test/questions-and-answers
4. www.cambridgeenglish.org

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

CO1	Respond quickly and correctly to questions from different types of scripts, exhibiting good comprehension and analyzing skills
CO2	Participate effectively in formal group discussions and prepare professional e mails, persuasive and expository paragraphs to establish and meet organizational needs and goals.
CO3	Fare well in IELTS and other English language assessment segments of competitive examinations within the stipulated time.
CO4	Write effective résumés, and face interviews with communicative competence and confidence, with a good knowledge of career skills .
CO5	Select appropriate vocabulary and idiomatic expressions, identify errors in syntax, and arrange sentences to make meaningful paragraphs, without any aid.

Cos/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	-	-	-	-	3	-	-	-	-	3	-	-	-	-
CO 2	-	-	-	-	-	-	-	-	3	3	-	-	-	-
CO 3	-	-	-	-	-	-	-	-	-	3	-	1	-	-
CO 4	-	-	-	-	-	-	-	-	3	3	-	1	-	-
CO 5	-	-	-	-	-	-	-	-	-	3	-	1	-	-
Mapping Average	-	-	-	-	3	-	-	-	3	3	-	1	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET71	PROTECTION AND SWITCHGEAR	L	T	P	C
		3	0	0	3

Pre-requisites: 22EET23- Electric Circuit Theory22EET33- DC machines and Transformers, 22EET43- Induction and Synchronous Machines, 22EET44- Transmission and Distribution ,22EET52-Power System Analysis,

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.

UNIT 1 PROTECTION SCHEMES **9**

Significance and need for protective schemes – nature and causes of faults – types of faults Effects of faults - Zones of protection and essential qualities of protection – Types of Protection schemes - Power system Grounding and Methods of Grounding.

UNIT 2 BASICS OF RELAYS **9**

Operating principles of relays –Universal torque equation - R-X diagram –Electromagnetic Relays – Over current, Directional and non-directional, Distance, Differential, Negative sequence and Under frequency relays.

UNIT 3 OVERVIEW OF EQUIPMENT PROTECTION **9**

Current transformers and Potential transformers and their applications in protection schemes - Protection of transformer, generator, motor, bus bars and transmission line

UNIT 4 STATIC RELAYS AND NUMERICAL PROTECTION **9**

Static relays – Phase, Amplitude Comparators – Synthesis of various relays using Static comparators – Block diagram of Numerical relays – Over current protection, transformer differential protection, and distance protection of transmission lines.

UNIT 5 CIRCUIT BREAKERS **9**

Physics of arcing phenomenon and arc interruption – DC and AC circuit breaking – re-striking voltage and recovery voltage - rate of rise of recovery voltage - current chopping - interruption of capacitive current - resistance switching - Types of circuit breakers – air blast, oil, SF6 and vacuum circuit breakers – comparison of different circuit breakers – HVDC Breaker

Lecture: 45, Total: 45

TEXT BOOKS:

1. B.Rabindranath and N.Chander, ‘Power System Protection and Switchgear’, New Age International (P) Ltd., Second Edition, 2018.
2. Sunil S.Rao, ‘Switchgear and Protection’, Khanna Publishers, New Delhi, Four Edition, 2010

REFERENCES:

1. Bhavesh Bhalja, R.P. Maheshwari, Nilesh G. Chotani,’Protection and Switchgear’ Oxford University Press, 2nd Edition 2018
2. C.L.Wadhwa, ‘Electrical Power Systems’, 6th Edition, New Age International (P) Ltd., 2018
3. Badri Ram ,B.H. Vishwakarma, ‘Power System Protection and Switchgear’, New Age International Pvt Ltd Publishers, Second Edition 2011.

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

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

CO1	Understand and select proper protective scheme and type of earthing
CO2	Classify and describe the working of various relaying schemes.
CO3	Identify and implement an appropriate relaying scheme for different power apparatus
CO4	Analyze the importance of static relays and numerical relays in power system protection.
CO5	Illustrate the function of various CBs and related switching issues.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 2	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 3	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 4	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 5	3	2	2	-	-	-	-	-	-	-	-	1	3	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantal (High).

22EET72	ECONOMICS AND MANAGEMENT FOR ENGINEERS	L	T	P	C
		3	0	0	3

Pre-requisites: -

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.

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.

Lecture : 45,Total : 45

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.

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

CO1 Summarize how to solve economics principles to solve economic problems in engineering discipline by satisfying the economic laws.

CO2 Discuss the demand and supply process for a market analysis using Price elasticity, Cross elasticity and Income elasticity.

CO3 Interpret short run and long run costs in the process of production for carrying out a business.

CO4 Apply managerial skills to make decisions and solve problems for achieving organizational objectives.

CO5 Express the principles of effective planning for survival and success of all organizations using standing and single use planning methods.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	3	-	2	-	2	1	-	-	-	-	-	-	2
CO 2	2	3	-	2	-	2	1	-	-	-	-	-	-	2
CO 3	2	3	-	2	-	2	1	-	-	-	-	-	-	2
CO 4	2	3	-	2	-	2	1	-	-	-	-	-	-	2
CO 5	2	3	-	2	-	2	1	-	-	-	-	-	-	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantal (High).

22HST71	HUMAN VALUES AND PROFESSIONAL ETHICS	L	T	P	C
		1	0	0	1

Pre-requisites: Universal Human Values

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.

UNIT 1 INTRODUCTION TO UNIVERSAL HUMAN VALUES 3

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 3

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 3

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 3

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 3

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: 15 PERIODS

TEXT BOOKS:

1. Gaur R R, Sangal R, Bagaria G P, "A Foundation Course in Human Values and Professional Ethics". 3rd Revised Edition, 2023

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.

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

CO1 Relate the significance of value inputs in a classroom and start applying them in their life and profession.

CO2 Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual.

CO3 Interpret the value of harmonious relationships based on the trust and respect in their life and profession.

CO4 Discuss the ethical issues related to Engineering.

CO5 Discuss Engineer’s work in the context of its impact on society.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	-	-	-	-	-	2	3	2	2	-	-	2	-	-
CO 2	-	-	-	-	-	3	-	3	1	-	-	2	-	-
CO 3	-	-	-	-	-	2	2	3	3	3	-	2	-	-
CO 4	1	2	-	-	-	3	-	2	-	-	-	2	-	-
CO 5	2	2	1	-	-	3	2	2	-	-	-	2	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22MCT07 INDIAN CONSTITUTION AND TRADITIONAL KNOWLEDGE L T P C
3 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 upkeeping 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 the functions of Centre, States and District Administrations
3. Elaborate the roles of Panchayatiraj
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- Staterelationship, 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, Blocklevel: 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, StateElection 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

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

CO1	Describe the emergence and evolution of Indian Constitution, structure and composition of Indian Constitution and federalism in the Indian context.
CO2	List the functions of Centre, States and District Administrations, Fundamental rights needed to develop human personality in free society.
CO3	Identify different levels of Panchayat Raj system and its working.
CO4	Elaborate the role of Election Commission and its power to conduct free and fair election

throughout India.

CO5 Develop a broad understanding of Indian society and intercultural literacy through cultural immersion.

CO – PO Mapping:

Course outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1						3	2	2	2	2		2		
CO2						3	2	2	2	2		2		
CO3						3	2	2	2	2		2		
CO4						3	2	2	2	2		2		
CO5						3	2	2	2	2		2		

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) "-" No correlation

22EEL71 RENEWABLE ENERGY SYSTEMS LABORATORY

L	T	P	C
0	0	3	1

Preamble:

The purpose of this lab is to provide adequate inputs on a variety of issues in harnessing Renewable Energy from various sources and train the students in Renewable Energy Sources and its technologies. This course also enables the students to recognize current and possible future role of Renewable energy sources.

LIST OF EXPERIMENTS:

1. Simulation study on Solar PV Energy System.
2. Experiment on V-I Characteristics and Efficiency of 1-kWp Solar PV System.
3. Experiment on Shadowing effect and diode based solution in 1-kWp Solar PV System.
4. Experiment on Performance assessment of Grid-connected and Stand-alone 1-kWp Solar Power System.
5. Simulation study on Wind Energy Generator.
6. Experiment on Performance assessment of micro Wind Energy Generator.
7. Simulation study on Hybrid (Solar-Wind) Power System.
8. Experiment on Performance Assessment of Hybrid (Solar-Wind) Power System.
9. Experiment on Performance Assessment of 100 W Fuel Cell.
10. Simulation study on Intelligent Controllers for Hybrid Power Systems.

TOTAL: 45 PERIODS

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

CO1 Identify the renewable energy sources and analyze the methods to harness the Renewable Energy using Renewable energy systems.

CO2 Experiment the Grid-connected and Stand-alone Solar PV System and assess the Performance characteristics.

CO3 Model, Simulate and experiment the Wind Energy Generator and assess the Performance characteristics of Hybrid (Solar-Wind) energy conversion system.

CO4 Recognize current and possible future role of Hydro Power and the scope of Fuel Cell.

CO5 Illustrate basics of Intelligent Controllers for Hybrid Renewable energy conversion system

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	-	-	-	1	1	-	-	-	3	2	-	-	-	-
CO2	-	-	-	1	1	-	-	-	3	2	-	-	-	-
CO3	-	-	-	3	3	-	-	-	2	2	-	-	-	-
CO4	-	-	-	1	1	-	-	-	3	2	-	-	-	-
CO5	-	-	-	1	1	-	-	-	3	2	-	-	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEL72	POWER SYSTEM SIMULATION LABORATORY	L	T	P	C
		0	0	3	1

Preamble:

The purpose of this laboratory course is to provide better understanding of power system modelling and analysis through digital simulation.

LIST OF EXPERIMENTS:

1. Modeling of Transmission Lines and Computation of Transmission Line Parameters.
2. Formation of Bus Admittance and Impedance Matrices and Solution of Power System Networks.
3. Power Flow Analysis using Gauss-Seidel Method.
4. Power Flow Analysis using Newton-Raphson Method.
5. Symmetric and Unsymmetrical fault analysis.
6. Transient Stability Analysis of Single Machine Infinite Bus System.
7. Economic Load Dispatch in Power Systems.
8. Load-Frequency Dynamics of Single-Area and Two-Area Power Systems.
9. Electromagnetic Transients in Power Systems : Transmission Line Energization

TOTAL: 45 PERIODS

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

CO1 Model the Transmission Lines and Simulate the solution of power system network by forming bus impedance and bus admittance matrix.

CO2 Simulate and analyze the solution of power flow problems in power system networks using Gauss-Seidel and Newton-Raphson method.

CO3 Simulate and analyze the Symmetric and Unsymmetrical faults and protection, Small Signal and Transient Stability of Single-Machine Infinite Bus System using simulation tools.

CO4 Simulate and analyze Economic load dispatch in power systems and the Load-Frequency dynamics of Single-area and Two-area Power Systems.

CO5 Simulate and analyze the electromagnetic Transients due to Transmission Line Energization.

Mapping of COs with POs and PSOs

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2
-	-	-	1	1	-	-	-	3	2	-	-	-	-	-
-	-	-	1	1	-	-	-	3	2	-	-	-	-	-
-	-	-	3	3	-	-	-	2	2	-	-	-	-	-
-	-	-	1	1	-	-	-	3	2	-	-	-	-	-
-	-	-	1	1	-	-	-	3	2	-	-	-	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEL81	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.

22EEE11 **UNDER GROUND CABLE ENGINEERING**

L	T	P	C
3	0	0	3

Pre-requisites : 22EET44-TRANSMISSION AND DISTRIBUTION

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

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 ARCHITECHTURE, DIELECTRIC THEORY AND CABLE CHARACTERISTICS (7+2 SKILL) **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.

Lecture : 45,Total : 45

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-cable-engineeringhandbook.pdf.
4. Handbook on Cable Fault Localization (April 2020) https://rdso.indianrailways.gov.in/works/uploads/File/Handbook%20on%20Cable%20Fault%20Localization(2).pdf
5. K. H. Ali et al.: Industry Practice Guide for Underground Cable Fault-Finding in the LVDN: https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=9807279, June 2022.
6. R. W. Deltenre, J. J. Schwarz, and H. J. Wagnon, ''Underground cable fault location: A handbook to TD-153,'' BDM Corp., Albuquerque, NM, USA, Final Rep. EPRI EL-363, 1977.[Online]. Available: https://www.osti.gov/servlets/purl/7233049, doi: 10.2172/7233049,January 1997.

e-Resources:

1.

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

CO1	Ability to understand the fundamental of underground cable system.
CO2	Ability to gain knowledge on the architecture of UG cable and physical and electrical characteristics of the UG cable.
CO3	Ability to understand different types of cable used in distribution system.
CO4	Ability to acquire knowledge on Underground cables used in transmission system.
CO5	Ability to understand the cable installations procedures and practices, the theory / methodology of cable fault detection and rectification, testing and maintenance.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	1	3	2	-	-	-	-	-	-	-	-	1	3	-
CO 2	1	3	2	-	-	-	-	-	-	-	-	1	3	-
CO 3	1	3	2	-	-	-	-	-	-	-	-	1	3	-
CO 4	1	3	2	-	-	-	-	-	-	-	-	1	3	-
CO 5	1	3	2	-	-	-	-	-	-	-	-	1	3	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE12 **POWER SYSTEM TRANSIENTS**

L	T	P	C
3	0	0	3

Pre-requisites: 22EET23 - Electric Circuit Theory, 22EET32 - Electromagnetic Fields , 22EET44 - Transmission and Distribution, 22EET51 - Power Electronics , 22EET52 - Power System Analysis

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.

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.

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

CO1 Analyze power system operation, stability, control, protection and identify the causes for transients, effect of transients on power system.
CO2 Demonstrate the transients over voltages due to switching and explain the effect of source regulation
CO3 Describe the mechanism of lightning discharges, characteristics of lightning strokes and interaction between lightning and power system
CO4 Explain the concept of Travelling waves, wave propagation and analyze the transient response of a power system.
CO5 Investigate transients in integrated power system and Compute transients using EMTP.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	1	2	-	-	-	-	-	-	-	-	-	1	3	-
CO 2	1	2	-	-	-	-	-	-	-	-	-	1	3	-
CO 3	1	2	-	-	-	-	-	-	-	-	-	1	3	-
CO 4	1	2	-	-	-	-	-	-	-	-	-	1	3	-
CO 5	1	2	-	-	-	-	-	-	-	-	-	1	3	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE13 **FLEXIBLE AC TRANSMISSION SYSTEMS**

L	T	P	C
3	0	0	3

Pre-requisites: 22EET23- Electric Circuit, 22EET44- Transmission and Distribution, 22EET51- Power Electronics, 22EET51-Power System Analysis.

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.

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.

Lecture : 45,Total : 45

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

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

CO1 Explain the concepts of FACTS and describe the necessity, importance, types and benefits of FACTS controllers.

CO2 Summarize the objectives of static shunt compensators and describe the characteristics of shunt compensation devices used in power system network.

CO3 Illustrate the control schemes for Grid Side Converter (GSC), Thyristor Switched Series Capacitor (TSSC), Thyristor Controlled Series Capacitor (TCSC) and compare their operating characteristics.

CO4 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.

CO5 Illustrate the interaction and co-ordination of multiple FACTS controllers using linear control techniques and genetic algorithms.

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 2	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 3	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 4	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 5	3	2	2	-	-	-	-	-	-	-	-	1	3	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantal (High).

22EEE14 **POWER QUALITY**

L	T	P	C
3	0	0	3

Pre-requisites: 22EET34 **-** Measurement and Instrumentation Systems , 22EET44 - Transmission and Distribution, 22EET51 - Power Electronics , 22EET52 - Power System Analysis

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.

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.

Lecture : 45, Total : 45

TEXT BOOKS:

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).

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

CO1 Recognize and explain various power quality issues, sources and effects of power qualityproblems.
CO2 Identify the origin of voltage sag and interruptions and analyzethe influence on the performance of electric machines in transmission system distribution system.
CO3 Discuss the sources of transient overvoltage’s, identifies the device for over voltage protection and apply the principles of over voltage protection.
CO4 Describe the sources of harmonics, effects of harmonics on utility and facility equipment’s, and apply the principles to control the power system harmonics.
CO5 Illustrate the needs and various methods of power quality monitoring using PQ measurement equipment’s.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	1	3	-	-	-	-	1	-	-	-	1	1	2	2
CO 2	1	3	-	-	-	-	1	-	-	-	1	1	2	2
CO 3	1	3	-	-	-	-	1	-	-	-	1	1	2	2
CO 4	1	3	-	-	-	-	1	-	-	-	1	1	2	2
CO 5	1	3	-	-	-	-	1	-	-	-	1	1	2	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET15	UTILIZATION AND CONSERVATION OF ELECTRICAL ENERGY	L	T	P	C
		3	0	0	3

Pre-requisites : 22EET31-Electronic Circuits and Devices,22EET41-Digital Logic Circuits

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.

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-Energyconservation 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 andOFF-line UPS, Batteries - Power quality aspects – nonlinear and domestic loads – Earthing system for Domestic, Industrial and Substation.

Lecture : 45, Total : 45

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. D.P.Kothari, K.C.Singal, Rakesh Ranjan, “Renewable Energy Sources and Emerging Technologies”, PHI Learing Private Limited, 3rd Edition 2022.
4. Industrial Energy Conservation, Volume I-II, S C Bhatia, Sarvesh Devraj, Energy Conservation and Managment by Akshay A pujara1st edition, June 2018.
5. G.D.Rai, “Non-Conventional Energy sources”, Khanna publications Ltd., New Delhi 1998

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.
   http://aipnpc.org/Guidebooks.aspx, Bureau of Energy Efficiency.
   www.eeca.govt.nz, Energy Efficiency and Conservation Authority (EECA) is the government agency that works to improve the energy efficiency of New Zealand.

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

CO1	Ability to choose suitable electric drives for different applications.
CO2	Ability to design the illumination systems for energy saving.
CO3	Ability to demonstrate the utilization of electrical energy for heating and welding purposes.
CO4	To illustrate the need for energy conservation and to simulate three phase power control.
CO5	Ability to do electric connection for any domestic appliance like refrigerator, battery, charging circuit for a specific household application.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3							2			1	3	3
CO 2	3	3							2			1	3	3
CO 3	3	3							2			1	3	3
CO 4	3	3							2			1	3	3
CO 5	3	3							2			1	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE16 **HIGH VOLTAGE ENGINEERING**

L	T	P	C
3	0	0	3

Pre-requisites :22EET51-Power Electronics

Preamble

High Voltage Engineering aims to cover the fundamentals of high –voltage laboratory techniques, to provide an understanding of high - voltage phenomena and testing with various types of voltage. It also provides fundamental introduction about the dielectric properties of different materials and various diagnostic methods for basic high voltage insulation design.

UNIT 1 OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS 9

Causes of over voltages and its effects on power system – Lightning, switching surges and temporary over voltages – Reflection and Refraction of Travelling waves- protection against over voltages_ Insulation Coordination.

UNIT 2 DIELECTRIC BREAKDOWN 9

Properties of Dielectric materials - Gaseous breakdown in uniform and non-uniform fields – Corona discharges – Vacuum breakdown – Conduction and breakdown in pure and commercial liquids, Maintenance of oil Quality – Breakdown mechanisms in solid and composite dielectrics- Applications of insulating materials in electrical equipment.

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

Generation of High DC, AC, impulse voltages and currents - Analysis of DC/AC and Impulse generator circuits - Tripping and control of impulse generators, Measurement of High voltages and High currents – High Resistance with series ammeter – Dividers - Resistance, Capacitance and Mixed dividers - Peak Voltmeter, Generating Voltmeters, Electrostatic Voltmeters – Sphere Gaps, High current shunts- Digital techniques in high voltage measurement.

UNIT 4 HIGH VOLTAGE TESTING & INSULATION COORDINATION 9

High voltage testing of electrical power apparatus- International and Indian standards – Power frequency, impulse voltage and DC testing of Insulators, circuit breakers, bushing, isolators and transformers - Insulation Coordination.

UNIT 5 APPLICATION IN INDUSTRY 9

Introduction – electrostatic applications- electrostatic precipitation, separation, painting / coating, spraying, imaging, printing, Transport of materials – manufacturing of sand paper – Smoke particle detector – Electrostatic spinning, pumping, propulsion – Ozone generation – Biomedical applications.

Lecture : 45, Total : 45

TEXT BOOKS:

1. M.S.Naidu and V. Kamaraju, ‘High Voltage Engineering’, Tata McGraw Hill, Fifth Edition, 2013.
2. E. Kuffel and W.S. Zaengl, J.Kuffel, ‘High voltage Engineering fundamentals’, Newnes Second Edition, Elsevier , New Delhi, 2005.
3. C.L. Wadhwa, ‘High voltage Engineering’, New Age International Publishers, Fourth Edition, 2020.

REFERENCES:

1. L.L.Alston, High Voltage Technology, Oxford University Press, First Indian Edition 2006.
2. C.L.Wadhwa, High voltage Engineering, New Age International Publishers, Fourth Edition,2020.
3. Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, Roshday Radwan, High Voltage Engineering – Theory &Practice,Second Edition, Taylor & Francis Gourp, 2019.
4. Subir Ray." An Introduction to High Voltage Engineering "PHI Learning Private Limited, NewDelhi,Second Edition-201.

e-Resources:

1. http://environmentclearance.nic.in/writereaddata/FormB/EC/Risk_Assessment/01012016WU3QV8EJa11 stdcode.pdf

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

CO1	Explain various overvoltages and its effects on power systems.
CO2	Understand the breakdown phenomena in different medium under uniform and non-uniform fields.
CO3	Explain the methods of generating and measuring High DC, AC, Impulse voltage and currents.
CO4	Suggest and Conduct suitable HV testing of Electrical power apparatus as per Standards.
CO5	Explain the Industrial Applications of Electrostatic Fields.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	3	-	-	-	-	-	-	-	-	-	1	3	-
CO 2	2	3	-	-	-	-	-	-	-	-	-	1	3	-
CO 3	2	3	2	-	-	-	-	-	-	-	-	1	3	-
CO 4	2	3	2	-	-	-	-	-	-	-	-	1	3	-
CO 5	2	3	2	-	-	-	-	-	-	-	-	1	3	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE17	SMART GRID	L	T	P	C
		3	0	0	3

Pre-requisites :

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.

UNIT 1 INTRODUCTION TO SMART GRID 9

Evolution of Energy Systems, Concept, Definitions and Need, Difference between Conventional and Smart Grid, Drivers, structures, functions, opportunities, challenges and benefits of Smart Grid, Basics of Micro grid, National and International Initiatives in Smart Grid.

UNIT 2 SMART METERING 9

Introduction to Advanced Metering infrastructure (AMI) - drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Real time management and control, Phasor Measurement Unit (PMU)

UNIT 3 SMART GRID TECHNOLOGIES (Transmission) 9

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, Wide area Monitoring, Protection and control.

UNIT 4 SMART GRID TECHNOLOGIES (Distribution) 9

Distribution Management System , Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers.

UNIT 5 HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Computing technologies for Smart Grid applications (Web Service to CLOUD Computing), Role of big data and IoT, Cyber Security for Smart Grid.

Lecture : 45, Total : 45

TEXT BOOKS:

1. Smart Grids Advanced Technologies and Solutions, Second Edition, Edited by Stuart Borlase,CRC, 2018.
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.

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

CO1 Explain the Smart Grid interoperability Standards, architecture and describe the functions of Smart Grid Components, Challenges and Benefits of planning the smart grid.

CO2 Illustrate the distribution system equipment's and intelligent devices used in smart grid distribution for power flow monitoring, management and control.

CO3 Explain the advanced metering infrastructure for smart grid monitoring and measurement, and illustrate the Multi-Agent System Technologies for smart grid implementation.

CO4 Describe the types of power electronic converters employed in smart grid for power quality improvement and bulk power flow.

CO5 Explain the appropriate information and communication technologies and Standards for information exchange in smart grid.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3							2			1	3	3
CO 2	3	3							2			1	3	3
CO 3	3	3							2			1	3	3
CO 4	3	3							2			1	3	3
CO 5	3	3							2			1	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE21	DESIGN OF ELECTRICAL MACHINES	L	T	P	C
		3	0	0	3

Pre-requisites : 22EET33 –DC machines and Transformers, 22EET43-Induction and Synchronous Machines

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.

UNIT 1 INTRODUCTION 9

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.

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**

Permanent Magnet ac Machines, Machine Configurations, PMSM - Principle of operation – EMF and Torque equations - Phasor diagram - Torque speed characteristics –evaluation of control characteristics- design of current and speed controllers- Constructional features, operating principle and characteristics of synchronous reluctance motor

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..

Lecture : 45, Tutorial : 0, Total : 45

TEXT BOOKS:

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, 2008.2.

e-Resources:

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

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

CO1 Discuss Magnetic circuit parameters and thermal rating of various types of electrical machines.
CO2 Summarize the various designs in Core, yoke, windings and cooling systems of transformers.
CO3 Interpret the design of stator and rotor of induction machines
CO4 Explain the concerned design of synchronous machines and Turbo alternators
CO5 Able to expresss general design considerations in electrical machine design and incorporation of computer aided design, analysis and synthesis

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2										3	
CO 2	3	2	2										3	1
CO 3	3	2	2										3	
CO 4	3	2	2										3	1
CO 5	3	2	2										3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE22	SPECIAL ELECTRICAL MACHINES	L	T	P	C
		3	0	0	3

Pre-requisites: 22EET33 –DC machines and Transformers,22EET43-Induction and Synchronous Machines,22EET51-Power Electronics.

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.

UNIT 1 STEPPERMOTORS 9

Constructional features –Principle of operation –Types – Torque predictions – Linear and Non-linear analysis – Characteristics – Drive circuits – Closed loop control –Applications

UNIT 2 SWITCHED RELUCTANCE MOTORS **9**

Constructional features –Principle of operation- Torque prediction–Characteristics-Power controllers – Control of SRM drive- Speed control-current control-design procedures- Sensor less operation of SRM – Current sensing-rotor position measurement and estimation methods- sensor less rotor position estimation-inductance based estimation –applications.

UNIT 3 PERMANENT MAGNET BRUSHLESS DC MOTORS **9**

Fundamentals of Permanent Magnets- Types- Principle of operation- Magnetic circuit analysis EMF and Torque equations- Characteristics- Controller design-Transfer function –Machine, Load and Inverter-Current and Speed Controller.

UNIT 4 PERMANENT MAGNET SYNCHROUNOUS MOTORS **9**

Permanent Magnet ac Machines, Machine Configurations, PMSM - Principle of operation – EMF and Torque equations - Phasor diagram - Torque speed characteristics –evaluation of control characteristics- design of current and speed controllers- Constructional features, operating principle and characteristics of synchronous reluctance motor

UNIT 5 STUDY OF OTHER SPECIAL ELECTRICAL MACHINES **9**

Principle of operation and characteristics of Hysteresis motor – AC series motors – Linear motor – Applications.

Lecture : 45, Tutorial : 0, Total : 45

TEXT BOOKS:

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

REFERENCES:

1. Jacek F. Gieras, Dr. Rong-Jie Wang, Professor Maarten J. Kamper - Axial Flux Permanent Magnet Brushless Machines-Springer Netherlands 2008.
2. 2.Bilgin, BerkerEmadi, Ali Jiang, James Weisheng - Switched reluctance motor drives: fundamentals to applications-CRC 2019
3. 3.Ramu Krishnan - Permanent Magnet Synchronous and Brushless DC Motor Drives -CRC Press, Marcel Applications -CRC Press 2009

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

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

CO1	Able to select the different types of stepper motor by knowing the working of various types of stepper motor, their characteristics, closed loop control and applications
CO2	To describe the principle & features of variable reluctance and to select the various types of SRM based on their applications.
CO3	Able to describe the magnetic circuit analysis and the magnetic materials and working principles, EMF, Torque equation, Characteristics and applications of BLPMDC motor.
CO4	Able to describe the phasor diagram, volt-amp requirements, features, working principles, EMF, torque equation, characteristics and applications of Permanent Magnet Synchronous Motors
CO5	Able to analyze the working principles, applications and difference between various types of special electrical machines

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	1	1					1			2	1	
CO 2	3	3	1	1					1			2	1	
CO 3	3	3	1	1					1			2	1	
CO 4	3	3	1	1					1			2	1	
CO 5	3	3	1	1					1			2	1	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE23 **MODERN POWER CONVERTERS**

L	T	P	C
3	0	0	3

Pre-requisites: 22EET51-Power Electronics,22EET61- Solid State Drives

Preamble

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

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 examples on converter-closed loop performance.

UNIT 2 AC-DC CONVERTERS 9

Switched mode AC-DC converters. synchronous rectification - single and three phasetopologies-switchingtechniques-highinputpowerfactor-reducedinputcurrentharmonicdistortion-improved efficiency-with and without input-output isolation-performance in dicesdesignexamples

UNIT 3 DC-AC CONVERTERS 9

Multi-level Inverters–Basic concept, classification of multi-level inverters, Principle of operation, main features and analysis of Diode clamped, Flying capacitor and cascaded multi-level 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.

Lecture : 45, Total : 45

TEXT BOOKS:

1. PowerElectronicsHandbook,M. H. Rashid,Academicpress,NewYork,2000.
2. AdvancedDC/DCConverters,FangLin Luoand FangLinLuo, CRCPress, New York, 2004.

REFERENCES:

1. Control in Power Electronics- Selected Problem, Marian P. Kazmierkowski, R. Krishnan and FredeBlaabjerg,Academic Press(ElsevierScience), 2002
2. Power Electronics for Modern Wind Turbines, FredeBlaabjerg and Zhe Chen, Morgan & ClaypoolPublishersseries,United Statesof America, 2006.
3. KreinPhilipT,ElementsofPowerElectronics, OxfordUniversitypress, 2008

e-Resources:

1. http://www.nptelvideos.in/2012/11/industrial-drives-power-electronics.html, Industrial Drives - PowerElectronics,Prof.K

Gopakumar,CentreforElectronicsDesignandTechnology,IISC,Bangalore.

2. https://nptel.ac.in/courses/108104011/,―AdvancedElectricDrives‖,Prof.ShyamaPrasadDas,IITKanpur

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

CO1 Explain the working principle of single-phase thyristor-controlled converter with different types loads

CO2 Describe the operation, characteristics and performance parameters of three phase thyristor-controlled converter

CO3 Analyze the different types of dc-dc converters

CO4 Describe the operation of single-phase bi-directional controllers with R, L and R-L loads & 3-phasecontrollers

CO5 Explain the Principle of operation of single phase and three phase Cyclo converters

Mapping of COs with POs and PSOs

COs\POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 2	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 3	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 4	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO 5	3	2	2	-	-	-	-	-	-	-	-	1	3	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantal (High).

22EEE24 ARTIFICIAL INTELLIGENCE IN ELECTRICAL DRIVES

L	T	P	C
3	0	0	3

Pre-requisites : 22EET51-Power Electronics,22EET61- Solid State Drives

Preamble

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

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 operationof converter / chopper fed drive – closed loop control with current and speedfeedback– V/f control and self-control of electric motor drives– speed control of DC and AC Motors.

Lecture : 45, Total : 45

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 Intelligence‖, 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
3. https://freevideolectures.com/course/2272/artificial-intelligence

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

CO1 Understand feed forward neural networks, feedback neural networks and learning techniques.
CO2 Analyze fuzziness involved in various systems and fuzzy set theory.
CO3 Develop fuzzy logic control for applications in electrical engineering
CO4 Develop genetic algorithm for applications in electrical engineering.
CO5 Understand the various real time applications of AI Techniques.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2		3								3	2
CO 2	3	2	2		3								3	2
CO 3	3	2	2		3								3	2
CO 4	3	2	2		3								3	2
CO 5	3	2	2		3								3	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

		L	T	P	C
22EEE25	**POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS**	**3**	**0**	**0**	**3**

Pre-requisites : 22EET51-Power Electronics,22EET61- Solid State Drives

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.

UNIT 1 INTRODUCTION **9**

Classification of Energy Sources – Importance of Non-conventional energy sources – Advantages and disadvantages of conventional energy sources - Environmental aspects of energy - Impacts of Renewable energy generation on the environment - Qualitative study of renewable energy resources: Ocean energy, Biomass energy, Hydrogen energy, - Solar Photovoltaic (PV), Fuel cells: Operating principles and characteristics, Wind Energy: Nature of wind, Types, control strategy, operating area.

UNIT 2 ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION **9**

Construction, Principle of operation and analysis: Squirrel Cage Induction Generator (SCIG), Doubly Fed Induction Generator (DFIG) - Permanent Magnet Synchronous Generator (PMSG)

UNIT 3 POWER ELECTRONICS FOR SOLAR **9**

Power Converters: Line commutated converters (inversion-mode) - Boost and buck-boost converters-selection of inverter, battery sizing, array sizing. Simulation of line commutated converters, buck/boost converters. Analysis: Block diagram of the solar PV systems - Types of Solar PV systems: Stand-alone PV systems, Grid integrated solar PV Systems - Grid Connection Issues.

UNIT 4 POWER ELECTRONICS FOR WIND **9**

Power Converters: Three-phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid-Interactive Inverters - Matrix converter. Power Converters: Three-phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid-Interactive Inverters - Matrix converter.

UNIT 5 HYBRID RENEWABLE ENERGY SYSTEMS **9**

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Diesel-PV, Wind-PV, Micro hydel-PV, Biomass-Diesel systems - Maximum Power Point Tracking (MPPT).

Lecture : 45, Total : 45

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.

REFERENCES:

1. B.H. Khan Non-conventional Energy sources Tata McGraw-Hill Publishing Company, New Delhi, 2009
2. Mukund R. Patel, “Wind and Solar Power Systems: Design, Analysis, and Operation”, CRC Press, London, 2006.
3. Ned Mohan Tore. M. Undeland, William. P. Robbins, “Power Electronics converters, Applications and design”, 3rd Edition, John Wiley and Sons, 2006.

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.

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

CO1 Illustrate the renewable energy resources, describe the environmental aspects of energy conversion and explain the impact of renewable energy systems on environment.

CO2 Explain the basic concepts of solar energy conversion systems, and explore maximum power point tracking algorithm.

CO3 Explain the basic concepts of wind energy conversion systems, operation of synchronous, induction generators and select the suitable generator for wind energy conversion system

CO4 Analyze and comprehend the various operating modes of grid connected wind and solar energy conversion systems and describe the issues in grid integration.

CO5 Describe the need for hybrid renewable energy systems and expose in to Wind-PV, Wind-Diesel and Wind-Mini-hydro Systems.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	2				1						3	2
CO 2	3	2	2				1						3	2
CO 3	3	2	2				1						3	2
CO 4	3	2	2				1						3	2
CO 5	3	2	2				1						3	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE26	HVDC AND EHVAC TRANSMISSION	L	T	P	C
		3	0	0	3

Pre-requisites: 22EET44-Transmission & Distribution, 22EET51Power Electronics

Preamble

This course is to gain a fair knowledge on HVDC and EHVAC transmission systems

UNIT 1 INTRODUCTION **9**

Necessity of EHV AC transmission – advantages and problems–power handling capacity and line losses-mechanical considerations – resistance of conductors – properties of bundled conductors – bundle spacing and bundle radius- Examples. Line and Ground Reactive Parameters: Line inductance and capacitance – sequence inductances and capacitances – modes of propagation – ground return - Examples.

UNIT 2 CORONA EFFECTS **9**

Power loss and audible noise (AN) – corona loss formulae – charge voltage diagram – generation, characteristics - limits and measurements of AN – relation between single phase and three phase AN levels – Examples. Radio interference (RI) Electrostatic Field: Calculation of electrostatic field of EHV AC lines – effect on humans, animals and plants –electromagnetic interference-Examples.

UNIT 3 VOLTAGE CONTROL **9**

Power circle diagram and its use – voltage control using synchronous condensers – cascade connection of shunt and series compensation – sub synchronous resonance in series capacitor – compensated lines – static VAR compensating system.

UNIT 4 HVDC BASICS & CONVERTERS **9**

Necessity of HVDC Transmission. Economics & Terminal equipment of HVDC transmission systems: Types of HVDC Links -Apparatus required for HVDC Systems - Comparison of EHV AC &HVDC Transmission, Application of HVDC Transmission System. Choice of Converter configuration - analysis of Graetz - characteristics of six Pulse converters and twelve pulse converters.

UNIT 5 HARMONICS & FILTERS **9**

Harmonics: Generation of Harmonics Characteristics Harmonics, calculation of AC Harmonics, Non-Characteristic harmonics, adverse effects of harmonics – Calculation of voltage & Current harmonics – Effect of Pulse number on harmonics. Filters: Types of AC filters, Design of Single tuned filters –Design of High pass filters.

Lecture : 45, Total : 45

TEXT BOOKS:

1. EHVAC Transmission Engineering by R. D. Begamudre, New Age International (p) Ltd.
2. K. R. Padiyar (2005), HVDC Power Transmission Systems: Technology and system Interactions, 1st edition, New Age International (P) Ltd, New Delhi.

REFERENCES:

1. EHV AC and HVDC Transmission and Distribution Engineering by S. Rao, Khanna Publishers, 3rdedition
2. E. W. Kimbark (2006), Direct Current Transmission, 2nd edition, John Wiley &Sons, NewDelhi.
3. N. G. Hingorani, L. Guygi (2001), Understanding FACTS, 1st edition, IEEE Press, USA.

e-Resources:

1. https://archive.nptel.ac.in/courses/108/108/108108099/
2. https://nptel.ac.in/courses/108104013
3. https://eepower.com/technical-articles/an-in-depth-comparison-of-hvdc-and-hvac

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

CO1 Explain the basic concepts of extra high voltage AC and high voltage DC transmission
CO2 Analyze the behavior of the line parameters for extra high voltages
CO3 Illustrate the effect of corona, electrostatic field, voltage control for extra high voltages
CO4 Describe the basic concepts of HVDC, HVDC converters.
CO5 Discuss the effect of harmonics and suppression of harmonics by using filters

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	3										1	3	
CO 2	2	3										1	3	
CO 3	2	3										1	3	
CO 4	2	3										1	3	
CO 5	2	3										1	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE27 MULTILEVEL POWER CONVERTERS

L	T	P	C
3	0	0	3

Pre-requisites : 22EET51-Power Electronics,22EET61- Solid State Drives

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.

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.

Lecture : 45, Total : 45

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 Convertersfor 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

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

CO1 Examine the different topologies of multilevel inverters (MLIs) with and without DC link capacitor.

CO2 Examine the performance of MLIs with Bipolar Pulse Width Modulation (PWM) Unipolar PWM Carrier-Based PWM Schemes Phase Level Shifted Multicarrier Modulation

CO3 Demonstrate the working principles of diode clamped MLI and analyze the voltage balancing performance in Diode clamped MLI.

CO4 Describe the working principles of flying capacitor MLI .

CO5 Explain the working principles of flying capacitor MLI with reduced switch count.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	1	1								1	3	
CO 2	3	3	1	1								1	3	
CO 3	3	3	1	1								1	3	
CO 4	3	3	1	1								1	3	
CO 5	3	3	1	1								1	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE31 **EMBEDDED PROCESSORS**

L	T	P	C
3	0	0	3

Pre-requisites : 22EET53 - Microprocessors and Microcontrollers

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.

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.

Lecture : 45,Total : 45

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

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

CO1 Interpret the basics and functionality of processor functional blocks.
CO2 Observe the specialty of RISC processor Architecture.
CO3 Incorporate the I/O hardware interface of processor with peripherals.
CO4 Emphasis the communication features of the processor.
CO5 Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in commercial embedded processors.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	1	1	2	2									2	
CO 2	1	1	2	2									1	
CO 3	3	2	3	2									3	
CO 4	3	2	3	2									2	
CO 5	3	2	1	2									1	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE32 **EMBEDDED C PROGRAMMING**

L	T	P	C
3	0	0	3

Pre-requisites :22EET53**-** Microprocessor and Microcontroller

Preamble

Introducing the basics of Embedded system programming by exposing GNC C programming tool chain with the basics of 8051 programming.

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.

Lecture : 45, Tutorial : 15, Total : 45

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.

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

CO1 Deliver insight into embedded C programming and its salient features for embedded systems.

CO2 Illustrate the software and hardware architecture for distributed computing in embedded systems.

CO3 Develop a solution for problems by using the concept learned in programming using the embedded controllers.

CO4 Develop simple applications with 8051 by using its various features and interfacing with various external hardware.

CO5 Improved Employability and entrepreneurship capacity due to knowledge upgradation on recent trends in embedded programming skills.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	3	3	3				1				3	3
CO 2	3	2	3	3	3				1				3	3
CO 3	3	2	3	3	3				1				3	3
CO 4	3	2	3	3	3				1				3	3
CO 5	3	2	3	3	3				1				3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE33 **EMBEDDED PROCESSORS**

L	T	P	C
3	0	0	3

Pre-requisites : 22EET53 - Microprocessors and Microcontrollers

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.

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.

Lecture : 45, Total : 45

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

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

CO1 Interpret the basics and functionality of processor functional blocks.
CO2 Observe the specialty of RISC processor Architecture.
CO3 Incorporate the I/O hardware interface of processor with peripherals.
CO4 Emphasis the communication features of the processor.
CO5 Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in commercial embedded processors.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	1	1	2	2									2	
CO 2	1	1	2	2									1	
CO 3	3	2	3	2									3	
CO 4	3	2	3	2									2	
CO 5	3	2	1	2									1	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE34	EMBEDDED CONTROL FOR ELECTRIC DRIVES	L	T	P	C
		3	0	0	3

Pre-requisites : 22EET51- Power Electronics, 22EET61- Solid State Drives

Preamble

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

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.

Lecture : 45, Total : 45

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/
3. https://www.e3s-conferences.org/articles/e3sconf/pdf/2019/13/e3sconf_SeFet2019_01004.pdf

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

CO1 Interpret the significance of embedded control of electrical drives.
CO2 Deliver insight into various control strategies for electrical drives
CO3 Developing knowledge of Machine learning and optimization techniques for motor control.
CO4 Develop embedded system solutions for real-time application such as Electric vehicles and UAVs.
CO5 Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded system skills required for motor control strategy.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	1	1	2	2	1								2	
CO 2	2	1	3	2	1								2	
CO 3	3	2	3	3	3								1	
CO 4	3	2	3	3	3								3	
CO 5	3	2	1	2	1								2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE35 **SMART SYSTEM AUTOMATION**

L	T	P	C
3	0	0	3

Pre-requisites :22EET53 - Microprocessors and Microcontrollers

Preamble

This course helps the student to basic idea of role of Automation. Students are introduced to the basic design consideration of robots.

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.

Lecture : 45, Total : 45

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

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

CO1 Understand the concepts of smart system design and its present developments.

CO2 Illustrate different embedded open-source and cost-effective techniques for developing solution for real time applications.

CO3 Acquire knowledge on different platforms and Infrastructure for Smart system design.

CO4 Infer about smart appliances and energy management concepts.

CO5 Improve Employability and entrepreneurship capacity due to knowledge upgradation on embedded system technologies.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	1	3	1									1	
CO 2	3	1	2	2									1	
CO 3	2	2	3	2									2	
CO 4	2	2	2	1									1	
CO 5	3	2	2	2									2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE36 EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS

L	T	P	C
3	0	0	3

Pre-requisites :

Preamble

To provide 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.

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.

Lecture : 45, Total : 45

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. Uwe Kiencke, Lars Nielsen, "Automotive Control Systems: For Engine, Driveline, and Vehicle", Springer; 1 st Edition, 2005
6. Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 5 th Edition, 2014.
7. 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/
3) https://ackodrive.com/car-guide/different-types-of-car-sensors/
4) https://www.tomtom.com/blog/automated-driving/what-is-adaptive-cruise-control/
5) https://prodigytechno.com/difference-between-lin-can-and-flexray-protocols/
6) https://www.synopsys.com/automotive/what-is-autonomous-car.html

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

CO1	Insight into the significance of the role of embedded system for automotive applications.
CO2	Illustrate the need, selection of sensors and actuators and interfacing with ECU.
CO3	Develop the Embedded concepts for vehicle management and control systems.
CO4	Demonstrate the need of Electrical vehicle and able to apply the embedded system technology for various aspects of EVs
CO5	Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design and its application in automotive systems.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	2	3	-	3	-	1	-	-	-	-	1	1	-
CO 2	2	2	3	-	3	-	1	-	-	-	-	1	1	-
CO 3	2	2	3	-	3	-	1	-	-	-	-	1	1	-
CO 4	2	2	3	-	3	-	1	-	-	-	-	1	1	-
CO 5	2	2	3	-	3	-	1	-	-	-	-	1	1	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EET37	SOFT COMPUTING TECHNIQUES	L	T	P	C
		3	0	0	3

Pre-requisites :

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

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..

Lecture : 45, Total : 45

TEXT BOOKS:

1. Jyh-Shing Roger Jang, Chuen-Tsai Sun, EijiMizutani, ―Neuro-Fuzzyand Soft Computing‖, PrenticeHall of India, 2003.
2. S.Rajasekaran, G.A.VijayalakshmiPai, ―Neural Networks, Fuzzy Logic and Genetic Algorithm‖, PHI Learning

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

2. Kumar Pratihar, IIT - Kharagpur.
https://nptel.ac.in/courses/108/108/108108148/, ―Neural Networks for signal processing‖, Prof.ShayanSrinivasaGarani, IISc - Bengaluru.

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

CO1 Describe the role of artificial intelligence techniques in realworld
CO2 Apply different neural network controller for electricalengineering problem
CO3 Apply fuzzy logic controller for electrical engineeringproblem
CO4 Apply neural network -fuzzy logic controller for electrical engineering problem
CO5 Apply and compare performance of different optimizationtechniques for electrical engineering problem

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	1	3		3							1	1	1
CO 2	3	1	3		3							1	1	1
CO 3	3	1	3		3							1	1	1
CO 4	3	1	3		3							1	1	1
CO 5	3	1	3		3							1	1	1

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE41 BIOMEDICAL INSTRUMENTATION

L	T	P	C
3	0	0	3

Pre-requisites: 22EET31 - Electronic Devices and Circuits, 22EET34 **-** Measurement and Instrumentation Systems, 22EET41 - Digital Logic Circuits, 22EET42 - Linear Integrated Circuits and Applications, 22EET53 - Microprocessors and Microcontrollers.

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.

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 pCO2, pO2.

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.

Lecture : 45, Total : 45

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.

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

CO1 Categorize the sources of bio signals in human body and the electrodes and bio amplifiers used in biomedical instrumentation system.

CO2 Identify and explain ECG, EEG, EMG, PCG recording methods and discuss the electrical safety in medical environment.

CO3 Summarize the measuring procedures of heart rate, pulse rate, blood pressure, pulmonary function, pH, pO_2 and pCO_2.

CO4 Discuss the operations of X rays, Computer Tomography, Magnetic Resonance Imaging, and Ultrasonography imaging modalities.

CO5 Illustrate the role of cardiac pacemakers, DC defibrillator, hemodialysis machine, heart-lung machine, ventilators, and biotelemetry in medical field.

Mapping of COs with POs and PSOs

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	-	3	-	-	-	2	-	-	-	-	-	-	-	-
CO 2	-	3	-	-	-	2	-	-	-	-	-	-	-	-
CO 3	-	3	-	-	-	2	-	-	-	-	-	-	-	-
CO 4	-	3	-	-	-	2	-	-	-	-	-	-	-	-
CO 5	-	3	-	-	-	2	-	-	-	-	-	-	-	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE43	SENSORS AND TRANSDUCERS	L	T	P	C
		3	0	0	3

Pre-requisites : 22EET34-Measurement & Instrumentation

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.

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.

Lecture : 45, Total : 45

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

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

CO1 Understand the various calibration techniques and signal types for sensors.
CO2 Explain about the various sensors in the Automotive and Mechatronics applications
CO3 Study the basic principles of various smart sensors.
CO4 Understand the operation of various optical, pressure and temperature sensors.
CO5 Implement the DAQ systems with different sensors for real time applications.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	-	3	1	-	-	-	-	-	-	-	1	1	-
CO 2	2	-	3	1	-	-	-	-	-	-	-	1	1	-
CO 3	2	-	3	1	-	-	-	-	-	-	-	1	1	-
CO 4	2	-	3	1	-	-	-	-	-	-	-	1	1	-
CO 5	2	-	3	1	-	-	-	-	-	-	-	1	1	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE44	PLC AND AUTOMATION	L	T	P	C
		3	0	0	3

Pre-requisites :

Preamble

Provides the knowledge of factory and process automation components, PLC tools, PLC Programming and Networking, Human Interface Systems involved in industrial automation

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.

Lecture : 45, Total : 45

TEXT BOOKS:

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.

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

CO1 Discuss the evolution and need for PLC, and summarize the importance of control elements in Industrial automation and their selection criteria.

CO2 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.

CO3 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.

CO4 Discuss the need of Human-Machine Interface (HMI) in Industrial Automation and explain the configuration of HMI, HMI objects and Interfacing with PLC.

CO5 Describe the PLC networking, IEEE Standards and Protocols, and Design PLC configurations for Manufacturing automation and Process automation applications.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3							2			1	3	3
CO 2	3	3							2			1	3	3
CO 3	3	3							2			1	3	3
CO 4	3	3							2			1	3	3
CO 5	3	3							2			1	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE45	VIRTUAL INSTRUMENTATION	L	T	P	C
		3	0	0	3

Pre-requisites :

Preamble

The course deals with the study of basic concepts, Software, Programming Structures, Instrument Connectivity and applicationsof 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 Hardwareand Software - Introduction to IMAQ and IMAQ Vision. Motion Control: Components of a motion control system – Softwarefor configuration - Prototyping and Development - General Applications.

Lecture : 45, Total : 45

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 Hallof India Learning Private Limited, New Delhi, 2006.
4. Rick Bitter, TaqiMohiuddin, 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

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

CO1 Understand Graphical programming
CO2 Understand the LabVIEW environment
CO3 Understand the Programming Structures
CO4 Understand the Instrument Connectivity
CO5 Develop Virtual Instruments for the Real-Time applications

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3							2			1	3	3
CO 2	3	3							2			1	3	3
CO 3	3	3							2			1	3	3
CO 4	3	3							2			1	3	3
CO 5	3	3							2			1	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE46	ADVANCED CONTROL SYSTEM	L	T	P	C
		3	0	0	3

Pre-requisites : 22EET45-Control Systems

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 non linear systems are acquainted.

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.

Lecture : 45, Tutorial : 0, Total : 45

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.

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

CO1 Develop the state space model for linear continuous time systems.
CO2 Develop the solution of state equation for homogeneous and non-homogeneous systems.
CO3 Construct the phase portraits for linear and non linear systems.
CO4 Identify the stability of given system using Lyapunov and Krasovskii's method of stability.
CO5 Design the state feedback controller and observer.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2	-	-	-	-	-	-	1	-	1	2	-
CO 2	3	3	2	-	-	-	-	-	-	1	-	1	2	-
CO 3	3	3	2	-	-	-	-	-	-	1	-	1	2	-
CO 4	3	3	2	-	-	-	-	-	-	1	-	1	2	-
CO 5	3	3	2	-	-	-	-	-	-	1	-	1	2	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE47	DIGITAL IMAGE PROCESSING	L	T	P	C
		3	0	0	3

Pre-requisites : 22EET62-Digital Signal Processing

Preamble

Digital image processing has become inevitable in many fields such as signature recognition, iris recognition and face recognition, in forensics, in automobile detection and in military applications. Each of these applications has its basic requirements, which may be unique from the others. Everyone is concerned and demands a system as faster, more accurate, cheaper and more extensive computation. In order to understand the analysis of entire image in the frequency domain, it is essential to learn the various image transforms. Also, It is necessary to learn the concepts of image enhancement, segmentation and compression.

UNIT 1 DIGITAL IMAGE FUNDAMENTALS **9**

Elements of visual perception - Image sensing and acquisition - Image sampling and quantization - Color images - RGB model - Basic relationship between pixels – Histogram - Histogram equalization.

UNIT 2 IMAGE TRANSFORMS **9**

Basics of 1D and 2D image transforms - Separable Image Transforms - One dimensional Fourier Transform - DFT - Two dimensional Fourier Transform - Discrete Cosine Transform - Walsh - Hadamard Transform - Wavelet transform - Haar transform - Properties.

UNIT 3 IMAGE ENHANCEMENT AND RESTORATION **9**

Image Enhancement: Gray level transformations - Spatial Domain Methods - Image subtraction - Image averaging - Spatial filtering - Smoothing, Sharpening filters - First and Second Derivatives - Frequency Domain Methods - Filtering - Smoothing and Sharpening filters - Butterworth and Gaussian. Image Restoration: Model of Image Degradation/ Restoration process - Linear, position invariant degradation - Inverse filtering - Weiner filtering.

UNIT 4 IMAGE SEGMENTATION AND REPRESENTATION **9**

Detection of discontinuities - Point, Line and Edge detection - Gradient operators - Edge linking - Graph theoretic technique - Thresholding - global and adaptive - Region based segmentation - Boundary representation - chain codes - Polygonal approximation - Signatures - skeletons - Boundary segments.

UNIT 5 IMAGE COMPRESSION **9**

Introduction to Image compression : Lossy and Lossless compression - Sequential and Progressive Compression - Rate/Distortion optimization - Parameters of compression - Huffman coding - Run Length Coding - Predictive coding - DPCM - Transform coding - Vector quantization - Image compression standards: JPEG, JPEG2000.

Lecture : 45, Total : 45

TEXT BOOKS:

1. R. C. Gonzalez, R. E. Woods- “Digital Image Processing”, Prentice-Hall, 4th Edition, 2018.
2. Anil K- Jain- “Fundamentals of Digital Image Processing”, Pearson/Prentice Hall of India- 2002

REFERENCES:

1. David Salomon, ―Data Compression, Springer Verlag New York Inc., 4th Edition. 2006.
2. Dr. S. Jayaraman, ―Digital Image Processing, Tata McGraw - Hill, 2009.

e-Resources:

1. NPTEL video, http://nptel.ac.in/courses/117105135, "Digital Image Processing", Prof. P.K. Biswas, IIT, Kharagpur.
2. NPTEL video, https://nptel.ac.in/courses/117104069 , "Digital Image Processing", Prof. Sumana Gupta, IIT, Kanpur.

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

CO1	Infer the digital images using sampling and quantization techniques and obtain the histogram of the given image by equalization and specification.
CO2	Compute the frequency spectrum of one dimensional signals using Fourier transform and DFT and two dimensional images using DCT, Walsh, Hadamard, Wavelet and Haar transforms.
CO3	Analyze the enhanced image by spatial domain and frequency domain methods and restore the images using inverse and Weiner filtering.
CO4	Contrast the given image discontinuities by point, line and edge detection and segment the given image by thresholding and represent the boundary of images using chain codes, polygonal approximation, signatures and skeletons.
CO5	Illustrate the compression techniques for the images using Huffman coding, Run length coding, Predictive coding and Transform Coding.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	3	2	3	2		2			1			3	1
CO 2	2	3	1	3	2				1				3	
CO 3	2	3	2	3	2						2	2	3	
CO 4	2	3	2	3	2	1	2		1		2	2	3	
CO 5	1	3	2	3	1	1	2			1	2	2	3	1

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE51 **ELECTRIC VEHICLE ARCHITECTURE**

L	T	P	C
3	0	0	3

Pre-requisites: 22EET51-Power Electronics, 22EET45Control Systems

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.

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.

Lecture : 45, Total : 45

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. NPTEL courses/Materials (IITG, IITM,IITD) – Electric and Hybrid vehicles
   https://nptel.ac.in/courses/108/103/108103009/ (IIT Guwahati)
   https://nptel.ac.in/courses/108/102/108102121/ (IIT Delhi)
   https://nptel.ac.in/courses/108/106/108106170/ (IIT Madras)

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

CO1 Summarize the History and Evolution of EVs, Hybrid and Plug-In Hybrid EVs.
CO2 Analyse the details and Specifications for the various EVs developed.

CO3 Describe the various EV components.
CO4 Describe the hybrid vehicle control strategy.
CO5 Describe the concepts related in the Plug-In Hybrid Electric Vehicles.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3		2					1				2	3	
CO 2	3		2					1				2	3	
CO 3	3		2					1				2	2	2
CO 4	3		3	3	3			1				2	3	3
CO 5	3		2					1				2	3	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE52	DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLE	L	T	P	C
		3	0	0	3

Pre-requisites: 22EET51-Power Electronics

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.

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.

Lecture : 45, Total : 45

TEXTBOOKS:

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/

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

CO1 Understand the architecture and vehicle dynamics of electric vehicles.
CO2 Explain the working of motors used in Electric Vehicles.
CO3 Understand and learn the simulation basics of control systems.
CO4 Devise power electronics based control strategies for electric vehicles.
CO5 compute a power stage transfer functions for DC-DC converters

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	3									2	3	
CO 2	3	3	3									2	3	
CO 3	3	3	3	3	3							2	3	2
CO 4	3	3	3	3	3							2	3	2
CO 5	3	3	3	3	3							2	3	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE53	ELECTRIC VEHICLE DESIGN, MECHANICS AND CONTROL	L	T	P	C
		3	0	0	3

Pre-requisites: 22EET43-Induction and Synchronous Machines,22EET53-Control Systems

Preamble:
students will have a broad and fundamental understanding of Internal Combustion Engines with EV Design, Mechanism and Controlling preliminaries.

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.

Lecture : 45, Total : 45

TEXTBOOKS:

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

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

CO1 Understand various types of I.C. Engines, Cycles of operation and Identify fuel supply systems

for different types of engines.

CO2 Describe the concepts related with EV, HEV and to compare the same with internal combustion engine vehicles.

CO3 Explain the concepts related with batteries and parameters of battery.

CO4 Find gain margin & phase margin for various types of transfer functions of boost converter.

CO5 Demonstrate the Control of AC Machines.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3								1			2	3	2
CO 2	3								1			2	3	2
CO 3	3		3		3		3		1			2	3	2
CO 4	3								1			2	3	2
CO 5	3						3		1			2	3	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE54	DESIGN OF ELECTRIC VEHICLE CHARGING SYSTEM	L	T	P	C
		3	0	0	3

Pre-requisites :22EET51-Power Electronics

Preamble

This course is to gain a fair knowledge on charging scheme in renewable based EV charging and the wireless power transfer technique.

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

Lecture : 45, Total : 45

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 Publisher1st Edition 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
3. https://elearn.nptel.ac.in/shop/nptel/electric-vehicles-and-renewable-energy-part2/

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

CO1 To illustrate various charging techniques and to know charging standards and regulations.
CO2 To demonstrate the working o DC-DC converters used for charging systems and principles
CO3 To illustrate the advantages of renewable system based charging systems
CO4 To demonstrate the principles of wireless power transfer.
CO5 To analyze the standards for wireless charging

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	2										1	3	
CO 2	2	2										1	3	
CO 3	2	2										1	3	
CO 4	2	2										1	3	
CO 5	2	2										1	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE55	TESTING OF ELECTRIC VEHICLE	L	T	P	C
		3	0	0	3

Pre-requisites: 22EET43-Induction and Synchronous Machines, 22EET51-Power Electronics, 22EET61Solid State Drives

Preamble

This course is to gain a fair knowledge on functional safety and testing of electric motors.

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.

Lecture : 45, Total : 45

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
3. https://link.springer.com/book/10.1007/978-3-319-13656-1

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

CO1 Describe the status and other details of standardization of EVs
CO2 Illustrate the testing protocols for EVs and HEV components
CO3 Examine the safety cycle and need for functions safety for EVs
CO4 Analyze the problems related with EMC for EV components.
CO5 Evaluate the EMI in motor drive and DC-DC converter system.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2										1	3	
CO 2	3	2										1	3	
CO 3	3	2										1	3	
CO 4	3	2										1	3	
CO 5	3	2										1	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE56 GRID INTEGRATING TECHNIQUES AND CHALLENGES

L	T	P	C
3	0	0	3

Pre-requisites :22EET52**-** Power System Analysis, 22EET63- Power System Operation and Control

Preamble

This course is to gain a fair knowledge on EV & V2G on the smart grids renewable energy 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.

Lecture : 45, Total : 45

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", Springer, 1st Edition 2022.

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
3. https://dnv.com/services/wind-farm-control-and-grid-integration

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

CO1	Review the power sector scenario in India
CO2	Understand the basic concepts ofa microgrid system
CO3	Model a converter for power grid distributed system
CO4	Integrate wind energy system.
CO5	Describe the grid integration of WECS and PV systems

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3		2							2		1	3	3
CO 2	3	3	2							2		1	3	3
CO 3	3	3	2							2		1	3	3
CO 4	3	3	2							2		1	3	3
CO 5	3	3	2							2		1	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE57	INTELLIGENT CONTROL OF ELECTRIC VEHICLES	L	T	P	C
		3	0	0	3

Pre-requisites : 22EET61-Power Electronics and 22EET61- Solid State Drives

Preamble

This course is to gain a fair knowledge on different control schemes for BLDC motor and the basics FPGA & VHDL.

UNIT 1 MATHEMATICAL MODEL AND CHARACTERISTICS ANALYSIS OF THE BLDC MOTOR **9**

Structure and Drive Modes - Basic Structure, General Design Method, Drive Modes. Mathematical Model, Differential Equations, Transfer Functions, State-Space Equations. Characteristics Analysis, Starting Characteristics, Steady-State Operation, Dynamic Characteristics, Load Matching Commutation Transients.

UNIT 2 SPEED CONTROL FOR ELECTRIC DRIVES **9**

Introduction -PID Control Principle, Anti windup Controller, Intelligent Controller. Vector Control. Control applied to BLDC motor.

UNIT 3 FUZZY LOGIC **9**

Membership functions: features, fuzzification, methods of membership value assignments Defuzzification: lambda cuts - methods - fuzzy arithmetic and fuzzy measures: fuzzy arithmetic - extension principle - fuzzy measures - measures of fuzziness -fuzzy integrals - fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning-fuzzy inference systems, overview of fuzzy expert system-fuzzy decision making..

UNIT 4 FPGA AND VHDL BASICS **9**

Introduction – FPGA Architecture-Advantages-Review of FPGA family processors- Spartan 3, Spartan 6 and Spartan 7. VHDL Basics- Fundamentals-Instruction set-data type-conditional statements- programs like arithmetic, sorting, PWM generation, Speed detection.

UNIT 5 REAL TIME IMPLEMENTATION **9**

Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of 48 V BLDC motor using FPGA.

Lecture : 45, Total : 45

TEXT BOOKS:

1. M.N. Cirstea, A. Dinu, J.G. Khor,M. McCormick, Neural and Fuzzy Logic Control of Drives and Power Systems, Newnes publications, 1st Edition, 2002.
2. VHDL Primer, A (3rd Edition), Jayaram Bhasker, Prentice Hall, 1st Edition 2015.

REFERENCES:

1. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, Third Edition” CRC Press, Taylor & Francis Group, 2021, 1st Edition.
2. Electric and Plug-in Hybrid Vehicle Networks Optimization and Control, Emanuele Crisostomi •

Robert Shorten, Sonja Stüdli • Fabian Wirth, CRC Press, 1 st Edition. 2018.
3. Electric Power train Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, Wiley 1 st Edition 2018.

e-Resources:

1. https://www.ijstr.org/final-print/jan2017/Intelligent-Control-Of-An-Electric-Vehicle-icev.pdf
2. https://www.researchgate.net/publication/350478470_Intelligent_control_system_for_high_efficiency_Electric_Vehicles
3. https://nptel.ac.in/courses/108104049

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

CO1	To design the mathematical model of a BLDC motor and to discuss about its characteristics
CO2	To demonstrate the PID control, ant windup controller, Intelligent Controller and Vector Control. Control applied to BLDC motor.
CO3	To illustrate the basics of fuzzy logic system
CO4	To describe the basics of VHDL & FPGA applied to control of EVs.
CO5	To design and implement of fuzzy logic control scheme for BLDC motor using FPGA in real time.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	2										1	3	
CO 2	2	2										1	3	
CO 3	2	2										1	3	
CO 4	2	2										1	3	
CO 5	2	2										1	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE61	VLSI DESIGN	L	T	P	C
		3	0	0	3

Pre-requisites : 22EET31 - Electronic Devices and Circuits, 22EET41 - Digital Logic Circuits

Preamble

To impart the knowledge on MOS transistor characteristics, fabrication, programming in Verilog Hardware Description Language and testing of ICs.

UNIT 1	MOS TRANSISTOR THEORY	9

MOS Transistor Theory: NMOS enhancement transistor – PMOS enhancement transistor – Threshold voltage – Body effect. MOS transistor switches. Basic D.C. equations – Second order effects: Threshold voltage – Body effect – Sub threshold region –Channel length modulation – Mobility variation – Fowler-Nordheim tunneling – Drain punch through – Hot electron effect.

UNIT 2	CMOS LOGIC AND CIRCUIT DESIGN	9

CMOS Logic: Inverter – Combinational logic – NAND gate – NOR gate – Compound gates – Multiplexers – Memory – Latches and registers. Complementary CMOS inverter - DC characteristics – βn/βp ratio, Noise margin. Switching characteristics: Fall time – Rise time – Delay time. Power dissipation for CMOS logic: Static dissipation – Dynamic dissipation – Short circuit dissipation. Layout design rules and Stick diagram for inverter, NAND and NOR.

UNIT 3	CMOS FABRICATION TECHNOLOGY	9

Basic CMOS technology: N-Well CMOS process – P-Well process – Twin tub process – Silicon on Insulator. Latchup: Physical origin of latchup – Latchup triggering – Latchup prevention – Internal latchup prevention techniques –I/O latchup prevention. FPGA: Programmable Logic – Programmable Logic structures – Programmable Interconnect – Xilinx Programmable Gate Arrays – Design flow.

UNIT 4	VERILOG HDL	9

Typical design flow, Basic concepts: Lexical conventions – Data types, Modules and Ports, Gate level modeling, Dataflow modeling: Continuous assignment, Behavioral modeling: Structured procedure – Procedural assignments. Switch level modeling: MOS switches – CMOS switches – Bidirectional switches. Implementation of logic using Verilog HDL: Half Adder, Full Adder, Ripple Carry Adder, Multiplexer, D-Flip-Flop.

UNIT 5	CMOS TESTING AND VERIFICATION	9

Introduction: Logic Verification, Debugging, Manufacturing Test- Manufacturing test principles: Fault Models, Observability, Controllability, Repeatability, Survivability, Fault Coverage, Automatic Test Pattern Generation (ATPG). Design strategies for test: Built in Self-Test (BIST).

Lecture : 45, Total : 45

TEXT BOOKS:

1. Neil Weste, & David Harris, “CMOS VLSI Design-A circuits & System Perspective”, 4th Edition, Pearson education, New Delhi,2017 for Units 1,2,3 and 5.
2. Palnitkar Samir, " Verilog HDL: Guide to Digital Design and synthesis", 2nd Edition, Pearson Education, New Delhi, 2017 for Unit 4.

REFERENCES:	
1.	Pucknell, Douglas A.,& Eshragian K., "Basic VLSI Design", 3rd Edition, PHI Learning, New Delhi, 2012.
2.	Wayne wolf , "FPGA Based System Design", Prentice Hall of India, cdr Edition, New Delhi,2004
3.	Sung Mo Kang, Yousf Leblebici & Chulwoo Kim, "CMOS Digital Integrated circuits, Analysis and Design" 4th edition, McGraw Hill Education, New Delhi, 2019.

e-Resources:	
1.	http://www.nptelvideos.in/2012/12/digital-vlsi-system-design.html, "Combinational and Sequential circuit design", Prof.S.Srinivasan, IIT, Madras.
2.	http://nptel.ac.in/courses/117101058/26, "Leakage Power Dissipation", Prof. Ajit Pal, IIT Kharagpur.

Course Outcomes: Upon completion of this course, students will be able to:	
CO1	Examine the characteristics and the second order effects in designing MOSFET
CO2	Discuss the CMOS logics and its characteristic for different logics
CO3	Discuss the various fabrication techniques for chip development
CO4	Develop programming for VLSI systems using Verilog Hardware Description Language
CO5	Explain the Testing process involved in chip design.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	2	1	1	1					1			3	3
CO 2	3	2	1	1	1					1			3	3
CO 3	3	2	1	1	1					1			3	3
CO 4	3	2	1	1	1					1			3	3
CO 5	3	1	1	1	1					1			2	2

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE62	ENERGY STORAGE SYSTEMS	L	T	P	C
		3	0	0	3

Pre-requisites :

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.

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.

Lecture : 45, Total : 45

TEXT BOOKS:

1. Ibrahim Dincer and Mark A. Rosen, ‘Thermal Energy Storage Systems and Applications’,John Wiley & Sons, 3rd Edition, 2021.
2. Ru-shi Liu, Lei Zhang and Xueliang sun, ‘Electrochemical technologies for energy storageand conversion’, Wiley publications, 2nd Volume set, 2012.

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 byProf.

SubhasishBasuMajumder, IIT Kharagpur

2. https://archive.nptel.ac.in/courses/108/106/108106182/- ElectricVehicles and Renewable Energy by Prof.AshokJhunjhunwala ,IIT Madras

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

CO1 Explain different types storage technologies.
CO2 Design a thermal storage system.
CO3 Model battery storage system.
CO4 Analyze the thermodynamics of fuel cell.
CO5 Analyze the appropriate storage technologies for different applications.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	1	1								1	3	
CO 2	3	3	1	1	2							1	3	
CO 3	3	3	1	1								1	3	
CO 4	3	3	1	1								1	3	
CO 5	3	3	1	1								1	3	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE63	HYBRID ENERGY TECHNOLOGY	L	T	P	C
		3	0	0	3

Pre-requisites : 22EET43-Induction and Synchronous Machines,22EET51-Power Electronics**.**

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.

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.

Lecture : 45, Total : 45

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. VaibhavVasantGoud, 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

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

CO1 Analyze the impacts of hybrid energy technologies on the environment and demonstrate them to harness electrical power.
CO2 Select a suitable Electrical machine for Wind Energy Conversion Systems and simulate wind energy conversion system
CO3 Design the power converters such as AC-DC, DC-DC, and AC-AC converters for SPV systems.
CO4 Analyze the power converters such as AC-DC, DC-DC, and AC-AC converters for Hybrid energy systems.
CO5 Interpret the hybrid renewable energy systems

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	1	1								1	2	
CO 2	3	3	1	1								1	2	
CO 3	3	3	1	1								1	2	
CO 4	3	3	1	1								1	2	
CO 5	3	3	1	1								1	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE64	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.

Lecture : 45, Total : 45

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.
3. Nabil Derbel, Quanmin ZhuModeling, "Identification and Control Methods in Renewable Energy

Systems" , Springer, First Edition, 2019.

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.
4. Renewable Energy Devices and Systems with Simulations in MATLAB and ANSYS, Frede Blaabjerg, Dan M. Ionel, CRC press, 2017, 1st 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
3. https://www.sciencedirect.com/topics/engineering/three-phase-inverter
4. academia.edu/32704493/Wind_Power_Lecture_Notes
5. https://www.syscop.de/files/2018ss/WES/handouts/script.pdf
6. https://www.sciencedirect.com/topics/engineering/wound-rotor-induction-generator

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	1	1								1	2	
CO 2	3	3	1	1								1	2	
CO 3	3	3	1	1								1	2	
CO 4	3	3	1	1								1	2	
CO 5	3	3	1	1								1	2	

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE65 ELECTRICAL ENERGY MANAGEMENT AND AUDITING

L	T	P	C
3	0	0	3

Pre-requisites: 22EET34-DC Machines and Transformers, 22EET43-Induction and Synchronous Machines.

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.

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).

Lecture : 45, Tutorial :0 , Total : 45

TEXT BOOKS:

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. 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.

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

CO1	Explain the need of energy audit and energy management and identify the energy conservation schemes and its importance.
CO2	Suggest the management methods for energy systems.
CO3	Sequence the methods of improving efficiency of electric motor.
CO4	Identify the impact of power factor in electrical system for energy conservation and to design a good illumination system with energy conservation schemes.
CO5	Examine the economic evaluation of energy conservation solutions adopted.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3							2			1	3	3
CO 2	3	3							2			1	3	3
CO 3	3	3							2			1	3	3
CO 4	3	3							2			1	3	3
CO 5	3	3							2			1	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE66 GRID INTEGRATING TECHNIQUES AND CHALLENGES

L	T	P	C
3	0	0	3

Pre-requisites : 22EET51-Power Electronics,22EET52-Power System Analysis, 22EET63-Power System Operation and Control

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.

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 PowerDevices-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.

Lecture : 45, Tutorial :0 , Total : 45

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", Springer, 1st Edition 2022.

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
3. https://dnv.com/services/wind-farm-control-and-grid-integration

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

CO1 Review the power sector scenario in India
CO2 Understand the basic concepts of a micro-grid system
CO3 Model a converter for power grid distributed system
CO4 Integrate wind energy system.
CO5 Describe the grid integration of WECS and PV systems

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	3	3	2							2		1	3	3
CO 2	3	3	2							2		1	3	3
CO 3	3	3	2							2		1	3	3
CO 4	3	3	2							2		1	3	3
CO 5	3	3	2							2		1	3	3

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEE67	POWER PLANT INSTRUMENTATION AND CONTROL	L	T	P	C
		3	0	0	3

Pre-requisites : 22EE34-Measurement and Instrumentation

Preamble

Disseminate the student with the functions and instrumentation available in a modern power generation plant.

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.

Lecture : 45, Tutorial :0 , Total : 45

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

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

CO1 Explain about the various methods of power generation.
CO2 Understand about the electrical and non electrical parameters measurement in power plants.
CO3 Know about the various analyzers in power plant.
CO4 Explain about the various control methods of turbine boiler control.
CO5 Understand about the monitoring and control of various parameters in turbine.

Mapping of COs with POs and PSOs

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO 1	2	-	-	2	-	-	-	-	-	-	1	1	2	-
CO 2	2	-	-	2	-	-	-	-	-	-	1	1	2	-
CO 3	2	-	-	2	-	-	-	-	-	-	1	1	2	-
CO 4	2	-	-	2	-	-	-	-	-	-	1	1	2	-
CO 5	2	-	-	2	-	-	-	-	-	-	1	1	2	-

1 - Slight (Low), 2 - Moderate (Medium), 3 - Substantial (High).

22EEO02 **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.

22EEO03	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,
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,
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

22EEO04 **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