FACULTY OF ELECTRICAL ENGINEERING

REGULATIONS - 2022

(CURRICULUM & SYLLABUS)

B.E.- ELECTRICAL AND ELECTRONICS ENGINEERING

Choice Based Credit System (CBCS)

I - VIII Semesters

Vision of the department

To become a well renowned department in the field of Electrical and Electronics Engineering by imparting quality education and inculcating ethical values among students to serve the global society.

Mission of the department

The department strives
M1: To provide strong fundamental knowledge through effective teaching- learning process to make the students competent in the field of Electrical and Electronics Engineering

M2: To enable students with intellectual resources to conduct innovative research in order to meet the challenges faced by the industries and mankind

M3: To promote the skills on emerging technologies through industry-interactions to attain sustained placements and other career opportunities

M4: To inculcate ethically bound professional standards, skills of leadership and management for a successful career.

B.E Electrical and Electronics Engineering

Regulation R-2022

Choice Based Credit System (CBCS)

Curriculum & Syllabi

I-VIII Semester

Program Education Objectives (PEOs)

PEO1: To provide strong foundation in science and mathematics to formulate, solve and analyze the Electrical and Electronics problems.

PEO2: To enhance the designing skills for the evolution of new technology in the Electrical and Electronics domain.

PEO3: To equip the students to work in interdisciplinary groups for enhancing professional skills.

PEO4: To prepare the students for a successful career in the industry orhigher education.

PEO5: To create an awareness for lifelong learning and inculcate professional ethics.

Program Outcomes (POs):

a) Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

b) Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

c) Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

d) Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

e) Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

f) The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

g) Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

h) Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

i) Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

j) Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

k) Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

l) Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO1: Our graduates will be able to understand the basic concepts related to engineering and technology with enhanced problem solving skills.

PSO2: Our graduates, with high proficiency in Electrical and Electronics Engineering will be able to exhibit technical knowledge in industrial and entrepreneurial focus.

PSO3: Our graduates can translate the effects of professional values and ethics in accordance with Electrical and Electronics Engineering domain, to create sustained environment for social growth.

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES												PROGRAMME SPECIFIC OUTCOMES		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	3	3	3	3	2	2	-	2	3	-	3		3	2	2
II	-	-	-	-		3	1	2	1	2	2	-	3	1	-
III	3	1	1	2	1	-	-	-	-	3	3	2	2	2	1
IV	3	2	2	3	-	-	-	-	3	3	2	-	3	1	-
V	2	-		-	-	2	3	2	-	1	2	-	3	2	1

Correlation Level 1, 2 or 3 as defined below

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

SEMESTER I

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
1.	IP4151	Induction Programme	-	-	-	-	-	0
THEORY								
2.	HS4101	Communicative English	HSMC	3	0	0	3	3
3.	MA4102	Engineering Mathematics	BSC	3	1	0	4	4
4.	PH4103	Engineering Physics	BSC	3	0	0	3	3
5.	CY4104	Engineering Chemistry	BSC	3	0	0	3	3
6.	GE4105	Problem solving and Python Programming	ESC	3	0	0	3	3
7.	GE4106	Engineering Graphics	ESC	2	0	4	6	4
8.	GE4151	தமிழர் மரபு /Heritage of Tamils	HSMC	1	0	0	1	1
PRACTICALS								
9.	GE4107	Python Programming Laboratory	ESC	0	0	4	4	2
10.	BS4108	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
			TOTAL	**18**	**1**	**12**	**31**	**25**

SEMESTER II

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	HS4201	Professional English	HSMC	3	0	0	3	3
2.	MA4202	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	PH4252	Physics for Electronics Engineering	BSC	3	0	0	3	3
4.	GE4204	Environmental Science and Engineering	BSC	3	0	0	3	3
5.	BE4205	Basic Civil and Mechanical Engineering	ESC	3	0	0	3	3
6.	EE4201	Principles of Electrical, Electronics and Communication Engineering	PCC	3	0	0	3	3
7.	GE4251	தமிழரும் தொழில்நுட்பம் / Tamils and Technology	HSMC	1	0	0	1	1
PRACTICALS								
8.	GE4207	Engineering Practices Laboratory	ESC	0	0	4	4	2
9.	EE4211	Principles of Electrical and Electronic devices Laboratory	PCC	0	0	4	4	2
			TOTAL	**19**	**1**	**8**	**28**	**24**

SEMESTER III

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	MA4352	Transforms and Complex Functions	BSC	3	1	0	4	4
2.	EE4301	Electric Circuit Analysis	PCC	3	1	0	4	4
3.	EE4302	Electrical Machines – I	PCC	3	0	0	3	3
4.	EE4303	Analog Circuits	PCC	3	0	0	3	3
5.	EE4304	Digital Electronics	PCC	3	0	0	3	3
PRACTICALS								
6.	EE4311	Electrical and Electronic Circuits Laboratory	PCC	0	0	4	4	2
7.	EE4312	Electrical Machines Laboratory – I	PCC	0	0	4	4	2
8.	EE4313	Linear and Digital Circuits Laboratory	PCC	0	0	4	4	2
			TOTAL	**15**	**2**	**12**	**29**	**23**

SEMESTER IV

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	MA4401	Probability and Statistics	BSC	3	1	0	4	4
2.	EE4401	Electrical Machines –II	PCC	2	1	0	3	3
3.	EE4402	Control Systems	PCC	2	1	0	3	3
4.	EE4403	Measurements and Instrumentation	PCC	3	0	0	3	3
5.	EE4404	Microprocessors and Microcontrollers	PCC	3	0	0	3	3
6.	EE4405	Generation, Transmission and Distribution	PCC	3	0	0	3	3
PRACTICALS								
7.	EE4411	Electrical Machines Laboratory– II	PCC	0	0	4	4	2
8.	EE4412	Microprocessors and Microcontrollers Laboratory	PCC	0	0	4	4	2
9.	HS4310	Professional Skills Lab	EEC	0	0	2	2	1
			TOTAL	**16**	**3**	**10**	**29**	**24**

SEMESTER V

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	CS4505	Fundamentals of Data Structures using C	ESC	3	0	0	3	3
2.	EE4501	Power Electronics	PCC	3	0	0	3	3
3.	EE4502	Power System Analysis	PCC	2	1	0	3	3
4.		Professional Elective-I	PEC	3	0	0	3	3
5.		Open Elective–I*	OEC	3	0	0	3	3
6.		Mandatory Course – I **	MC	3	0	0	3	0
PRACTICALS								
7.	CS4561	Data structures using C Laboratory	ESC	0	0	4	4	2
8.	EE4511	Control and Instrumentation Laboratory	PCC	0	0	4	4	2
9.	EE4512	Power Electronics and Drives Laboratory	PCC	0	0	4	4	2
			TOTAL	**17**	**1**	**12**	**30**	**21**

SEMESTER VI

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	CS4651	Object Oriented Programming	ESC	3	0	0	3	3
2.	EE4601	Power Electronic Drives and Control	PCC	3	0	0	3	3
3.	EE4602	Power System Operation and Control	PCC	2	1	0	3	3
4.	EC4650	Embedded Systems and IoT System Design	PCC	3	0	0	3	3
5.		Professional Elective-II	PEC	3	0	0	3	3
6.		Mandatory Course – II **	MC	3	0	0	3	0
PRACTICALS								
7.	CS4661	Object Oriented Programming Laboratory	ESC	0	0	4	4	2
8.	EE4611	Mini Project	EEC	0	0	4	4	2
			TOTAL	**17**	**1**	**8**	**26**	**19**

* Open Elective – I Shall be chosen from the list of open electives offered by other Programmes

** Mandatory Course I and II is a Non-credit Course (Student shall select one course from the list given under Mandatory Courses I and II)

SEMESTER VII

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	EE4701	Protection and Switch Gear	PCC	3	0	0	3	3
2.	EE4702	Renewable Energy Systems	PCC	3	0	0	3	3
3.		Professional Elective-III	PEC	3	0	0	3	3
4.		Professional Elective-IV	PEC	3	0	0	3	3
5.		Open Elective–II*	OEC	3	0	0	3	3
PRACTICALS								
6.	EE4711	Power System Simulation Laboratory	PCC	0	0	4	4	2
7.	EE4712	Renewable Energy Systems Laboratory	PCC	0	0	4	4	2
			TOTAL	**15**	**0**	**8**	**23**	**19**

*Open Elective – II Shall be chosen from the list of open electives offered by other Programmes

SEMESTER VIII

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	GE4791	Human Values and Ethics	HSMC	3	0	0	3	2
2.		Professional Elective-V	PEC	3	0	0	3	3
PRACTICALS								
3.	EE4811	Project Work	EEC	0	0	20	20	10
			TOTAL	**6**	**0**	**20**	**26**	**15**

TOTAL CREDITS = 170

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Professional Elective	Vertical I Power Engineering	Vertical II Converters and Drives	Vertical III Embedded Systems	Vertical IV Advanced Control	Vertical V (Diversified Courses)
1.	Power Quality	Special Electrical Machines	Digital Signal Processing	Industrial Automation	Soft Computing Techniques
2.	High Voltage Direct Current Transmission	Design of Electrical Apparatus	MEMS and NEMS	System Identification and Adaptive Control	Power System Transients
3.	High Voltage Engineering	Multilevel Power Converters	Operating Systems	Principles of Robotics	Industry 4.0
4.	Electric Energy Utilization and Conservation	Electric Vehicle	Microcontroller Based System Design	Advanced Control System	EHVAC Transmission
5.	Flexible AC Transmission Systems	Line Commutated and Active Rectifiers	VLSI Design	Process Modelling and Simulation	Smart Energy Grid
6.	Power System Stability	Power Electronics for Renewable Energy Systems	Smart System Design	Optimal Control	Energy Storage Systems

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL I: POWER ENGINEERING

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
1.	EE4001	Power Quality	PEC	3	0	0	3	3
2.	EE4002	High Voltage Direct Current Transmission	PEC	3	0	0	3	3
3.	EE4003	High Voltage Engineering	PEC	3	0	0	3	3
4.	EE4004	Electric Energy Utilization and Conservation	PEC	3	0	0	3	3
5.	EE4005	Flexible AC Transmission Systems	PEC	3	0	0	3	3
6.	EE4006	Power System Stability	PEC	3	0	0	3	3

VERTICAL II: CONVERTERS AND DRIVES

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
1.	EE4007	Special Electrical Machines	PEC	3	0	0	3	3
2.	EE4008	Design of Electrical Apparatus	PEC	3	0	0	3	3
3.	EE4009	Multilevel Power Converters	PEC	2	0	2	4	3
4.	EE4010	Electric Vehicle	PEC	2	0	2	4	3
5.	EE4011	Line Commutated and Active Rectifiers	PEC	3	0	0	3	3
6.	EE4012	Power Electronics for Renewable Energy Systems	PEC	3	0	0	3	3

VERTICAL III: EMBEDDED SYSTEMS

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
1.	EE4013	Digital Signal Processing	PEC	3	0	0	3	3
2.	EE4014	MEMS and NEMS	PEC	3	0	0	3	3
3.	EE4015	Operating Systems	PEC	3	0	0	3	3
4.	EE4016	Microcontroller Based System Design	PEC	3	0	0	3	3
5.	EE4017	VLSI Design	PEC	3	0	0	3	3
6.	EE4018	Smart System Design	PEC	3	0	0	3	3

VERTICAL IV: ADVANCED CONTROL

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
1.	EE4019	Industrial Automation	PEC	3	0	0	3	3
2.	EE4020	System Identification and Adaptive Control	PEC	3	0	0	3	3
3.	EE4021	Principles of Robotics	PEC	3	0	0	3	3
4.	EE4022	Advanced Control System	PEC	3	0	0	3	3
5.	EE4023	Process Modelling and Simulation	PEC	3	0	0	3	3
6.	EE4024	Optimal Control	PEC	3	0	0	3	3

VERTICAL V: DIVERSIFIED COURSES

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
1.	EE4025	Soft Computing Techniques	PEC	3	0	0	3	3
2.	EE4026	Power System Transients	PEC	3	0	0	3	3
3.	EE4027	Industry 4.0	PEC	3	0	0	3	3
4.	EE4028	EHVAC Transmission	PEC	3	0	0	3	3
5.	EE4029	Smart Energy Grid	PEC	3	0	0	3	3
6.	EE4030	Energy Storage Systems	PEC	3	0	0	3	3

OPEN ELECTIVE–I (V SEMESTER)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
1.	OEC411	IoT Concepts and Applications	OEC	3	0	0	3	3
2.	OEC414	Biomedical Instrumentation	OEC	3	0	0	3	3
3.	OEC412	Foundations of Robotics	OEC	3	0	0	3	3
4.	OIT411	Fundamentals of Database Design	OEC	3	0	0	3	3
5.	OME416	Testing of Materials	OEC	3	0	0	3	3

OPEN ELECTIVE–II (VII SEMESTER)

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
1.	OAD421	Data Science Fundamentals	OEC	3	0	0	3	3
2.	OCS422	Machine Learning Techniques	OEC	3	0	0	3	3
3.	OCS423	Augmented and Virtual Reality	OEC	3	0	0	3	3
4.	OME421	Energy Conservation and Management	OEC	3	0	0	3	3
5.	OME422	Air Pollution and Control	OEC	3	0	0	3	3

MANDATORY COURSE–I

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
1.	MX4001	Introduction to Women and Gender Studies	MC	3	0	0	3	0
2.	MX4002	Elements of Literature	MC	3	0	0	3	0
3.	MX4003	Personality Development through Life Enlightment skills	MC	3	0	0	3	0
4.	MX4004	Disaster Management	MC	3	0	0	3	0

MANDATORY COURSE–II

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
1.	MX4005	Well Being with traditional practices (Yoga, Ayurveda and Siddha)	MC	3	0	0	3	0
2.	MX4006	History of Science and Technology in India	MC	3	0	0	3	0
3.	MX4007	Political and Economic Thought for a Humane Society	MC	3	0	0	3	0
4.	MX4008	Industrial Safety	MC	3	0	0	3	0

CATEGORIZATION OF COURSES

HUMANITIES AND SOCIAL SCIENCE INCLUDING MANAGEMENT COURSES (HSMC)

S.NO.	COURSE CODE	COURSE TITLE	Periods per week			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	HS4101	Communicative English	3	0	0	3	3
2.	GE4151	தமிழர் மரபு /Heritage of Tamils	1	0	0	1	1
3.	HS4201	Professional English	3	0	0	3	3
4.	GE4251	தமிழரும் தொழில்நுட்பம்/ Tamils and Technology	1	0	0	1	1
5.	GE4791	Human Values and Ethics	3	0	0	3	2

BASIC SCIENCE COURSE (BSC)

S.NO.	COURSE CODE	COURSE TITLE	Periods per week			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	MA4102	Engineering Mathematics	3	1	0	4	4
2.	PH4103	Engineering Physics	3	0	0	3	3
3.	CY4104	Engineering Chemistry	3	0	0	3	3
4.	BS4108	Physics and Chemistry Laboratory	0	0	4	4	2
5.	MA4202	Statistics and Numerical Methods	3	1	0	4	4
6.	PH4252	Physics for Electronics Engineering	3	0	0	3	3
7.	GE4204	Environmental Science and Engineering	3	0	0	3	3
8.	MA4352	Probability and Complex Functions	3	1	0	4	4
9.	MA4401	Probability and Statistics	3	1	0	4	4

ENGINEERING SCIENCE COURSE (ESC)

S.NO.	COURSE CODE	COURSE TITLE	Periods per week			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	GE4105	Problem solving and Python Programming	3	0	0	3	3
2.	GE4106	Engineering Graphics	2	0	4	6	4
3.	GE4107	Python Programming Laboratory	0	0	4	4	2
4.	BE4205	Basic Civil and Mechanical Engineering	3	0	0	3	3
5.	GE4207	Engineering Practices Laboratory	0	0	4	4	2
6.	CS4551	Fundamentals of Data Structures using C	3	0	0	3	3
7.	CS4561	Data structures using C Laboratory	0	0	4	4	2

8.	CS4651	Object Oriented Programming	3	0	0	3	3
9.	CS4661	Object Oriented Programming Laboratory	0	0	4	4	2

PROFESSIONAL CORE COURSES (PCC)

S.NO.	COURSE CODE	COURSE TITLE	Periods per week			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	EE4201	Principles of Electrical, Electronics and Communication Engineering	3	0	0	3	3
2.	EE4211	Principles of Electrical and Electronic devices Laboratory	0	0	4	4	2
3.	EE4301	Electric Circuit Analysis	3	1	0	4	4
4.	EE4302	Electrical Machines – I	3	0	0	3	3
5.	EE4303	Analog Circuits	3	0	0	3	3
6.	EE4304	Digital Electronics	3	0	0	3	3
7.	EE4311	Electrical and Electronic Circuits Laboratory	0	0	4	4	2
8.	EE4312	Electrical Machines Laboratory – I	0	0	4	4	2
9.	EE4313	Linear and Digital Circuits Laboratory	0	0	4	4	2
10.	EE4401	Electrical Machines –II	2	1	0	3	3
11.	EE4402	Control Systems	2	1	0	3	3
12.	EE4403	Measurements and Instrumentation	3	0	0	3	3
13.	EE4404	Microprocessors and Microcontrollers	3	0	0	3	3
14.	EE4405	Generation, Transmission and Distribution	3	0	0	3	3
15.	EE4411	Electrical Machines Laboratory– II	0	0	4	4	2
16.	EE4412	Microprocessors and Microcontrollers Laboratory	0	0	4	4	2
17.	EE4501	Power Electronics	3	0	0	3	3
18.	EE4502	Power System Analysis	2	1	0	3	3
19.	EE4511	Control and Instrumentation Laboratory	0	0	4	4	2
20.	EE4512	Power Electronics Laboratory	0	0	4	4	2
21.	EE4601	Power Electronic Drives and Control	3	0	0	3	3
22.	EE4602	Power System Operation and Control	2	1	0	3	3
23.	EC4650	Embedded Systems and IoT System Design	3	0	0	3	3
24.	EE4701	Protection and Switch Gear	3	0	0	3	3
25.	EE4702	Renewable Energy Systems	3	0	0	3	3
26.	EE4711	Power System Simulation Laboratory	0	0	4	4	2
27.	EE4712	Renewable Energy Systems	0	0	4	4	2

		Laboratory					

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.NO.	COURSE CODE	COURSE TITLE	Periods per week			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	EE4310	Professional Skills Lab	0	0	2	2	1
2.	EE4612	Mini Project	0	0	4	4	2
3.	EE4811	Project Work	0	0	20	20	10

OPEN ELECTIVE COURSES (OEC)

S.NO.	COURSE CODE	COURSE TITLE	Periods per week			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	OEC411	IoT Concepts and Applications	3	0	0	3	3
2.	OEC414	Biomedical Instrumentation	3	0	0	3	3
3.	OEC412	Foundations of Robotics	3	0	0	3	3
4.	OIT411	Fundamentals of Database Design	3	0	0	3	3
5.	OME416	Testing of Materials	3	0	0	3	3
6.	OAD421	Data Science Fundamentals	3	0	0	3	3
7.	OCS422	Machine Learning Techniques	3	0	0	3	3
8.	OCS423	Augmented and Virtual Reality	3	0	0	3	3
9.	OME421	Energy Conservation and Management	3	0	0	3	3
10.	OME422	Air Pollution and Control	3	0	0	3	3

PROFESSIONAL ELECTIVE COURSES (PEC)

S.NO.	COURSE CODE	COURSE TITLE	Periods per week			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	EE4001	Power Quality	3	0	0	3	3
2.	EE4002	High Voltage Direct Current Transmission	3	0	0	3	3
3.	EE4003	High Voltage Engineering	3	0	0	3	3
4.	EE4004	Electric Energy Utilization and Conservation	3	0	0	3	3
5.	EE4005	Flexible AC Transmission Systems	3	0	0	3	3
6.	EE4006	Power System Stability	3	0	0	3	3
7.	EE4007	Special Electrical Machines	3	0	0	3	3
8.	EE4008	Design of Electrical Apparatus	3	0	0	3	3
9.	EE4009	Multilevel Power Converters	2	0	2	4	3
10.	EE4010	Electric Vehicle	2	0	2	4	3
11.	EE4011	Line Commutated and Active Rectifiers	3	0	0	3	3
12.	EE4012	Power Electronics for	3	0	0	3	3

		Renewable Energy Systems					
13.	EE4013	Digital Signal Processing	3	0	0	3	3
14.	EE4014	MEMS and NEMS	3	0	0	3	3
15.	EE4015	Operating Systems	3	0	0	3	3
16.	EE4016	Microcontroller Based System Design	3	0	0	3	3
17.	EE4017	VLSI Design	3	0	0	3	3
18.	EE4018	Smart System Design	3	0	0	3	3
19.	EE4019	Industrial Automation	3	0	0	3	3
20.	EE4020	System Identification and Adaptive Control	3	0	0	3	3
21.	EE4021	Principles of Robotics	3	0	0	3	3
22.	EE4022	Advanced Control System	3	0	0	3	3
23.	EE4023	Process Modelling and Simulation	3	0	0	3	3
24.	EE4024	Optimal Control	3	0	0	3	3
25.	EE4025	Soft Computing Techniques	3	0	0	3	3
26.	EE4026	Power System Transients	3	0	0	3	3
27.	EE4027	Industry 4.0	3	0	0	3	3
28.	EE4028	EHVAC Transmission	3	0	0	3	3
29.	EE4029	Smart Energy Grid	3	0	0	3	3
30.	EE4030	Energy Storage Systems	3	0	0	3	3

SUMMARY

Name of the Programme - EEE											
S.No	**Subject Area**	**Credits per Semester**								**Credits Total**	**Percentage %**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
1.	**HSMC**	4	4	--	--	--	--	--	2	**10**	**5.88**
2.	**BSC**	12	10	4	4	--	--	--	--	**30**	**17.65**
3.	**ESC**	9	5	--	--	5	5	--	--	**24**	**14.12**
4.	**PCC**	--	5	19	19	10	9	10	--	**72**	**42.35**
5.	**PEC**	--	--	--	--	3	3	6	3	**15**	**8.82**
6.	**OEC**	--	--	--	--	3	--	3	--	**6**	**3.53**
7.	**EEC**	--	--	--	1	--	2	--	10	**13**	**7.65**
8.	**Non- Credit/ (Mandatory)**		√			√	√				
	TOTAL	25	24	23	24	21	19	19	15	**170**	**100**

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E./B.Tech. (Honours) 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 verticals also.

Vertical I **Fintech and Block Chain**	**Vertical II** **Entrepreneurship**	**Vertical III** **Public Administration**	**Vertical IV** **Business Data Analytics**	**Vertical V Environment and Sustainability**
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics for Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building and Leadership Management for Business	Constitution of India	Data mining for Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity and Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials
Introduction to Blockchain and its Applications	Principles of Marketing Management for Business	Administrative Theories	Marketing and Social Media Web Analytics	Materials for Energy Sustainability
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurship	Indian Administrative System	Operation and Supply Chain Analytics	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis
-	-	-	-	Integrated Energy Planning for Sustainable Development
--	-	-	-	Energy Efficiency for Sustainable Development

SEMESTER – I

IP4151	INDUCTION PROGRAMME	L	T	P	C
	(Common to all branches of B.E. / B. Tech. Programmes)	-	-	-	-

Objectives

- 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 a 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.

ACTIVITY I	PHYSICAL ACTIVITY
This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc	

ACTIVITY 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 everyday 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.	

ACTIVITY 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, make 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.	

ACTIVITY IV	LITERARY ACTIVITY
Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.	

ACTIVITY V	PROFICIENCY MODULES

Listening – Listening to technical talks, Presentations, Formal job interviews, (analysis of the interview performance); Speaking – Participating in a Role play, (interview/telephone interview), virtual interviews, Making presentations with visual aids; Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses Vocabulary – Easily confused words.	
ACTIVITY 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.	
ACTIVITY 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 underprivileged.	
ACTIVITY 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.	
ACTIVITY 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	

HS4101	**COMMUNICATIVE ENGLISH**	**L**	**T**	**P**	**C**
	(Common to all branches of B.E. / B. Tech Programmes)	**3**	**0**	**0**	**3**

Objectives

- To develop listening skills to comprehend lectures, ask questions and seek clarifications
- To improve speaking skills to speak fluently in real contexts
- To hone reading skills to comprehend different types of texts
- To enhance writing skills to convey their ideas effectively
- To strengthen the grammar and general vocabulary

UNIT - I	**LISTENING TO CONVERSATIONS AND SPEECHES**	**9**
Listening – short texts – short formal and informal conversations; Speaking – basics of speaking – introducing oneself – exchanging information – speaking on given topics &situations; Reading – critical reading – finding key information in a given text – sifting facts from opinions; Writing – autobiographical writing – developing hints; Language development – Parts of speech – articles – voices – Question types: wh- and yes/no; Vocabulary development – prefixes – suffixes – Polite Expressions.		**CO1**

UNIT II	**SHARING INFORMATION RELATED TO ONESELF/FAMILY& FRIENDS**	**9**
Listening **–** TED talks – extensive speech on current affairs and discussions; Speaking – describing a simple process – asking and answering questions; Reading – short narratives and descriptions from newspapers –Reading comprehension texts with varied question types – Writing – paragraph writing		**CO2**

– topic sentence – main ideas– free writing, short narrative descriptions using suggested vocabulary and structures – Language development – prepositions, clauses; Vocabulary development– guessing meanings of words in context – use of sequence words.		
UNIT– III	**READING FOR COMPREHENSION**	**9**
Listening – Listening to TED talks and long speeches for comprehension; Speaking – role play – asking about routine actions and expressing opinions; Reading– short texts and longer passages (cloze reading) & critical analysis of a text; Writing – types of paragraphs and writing essays – rearrangement of jumbled sentences; Language development – degrees of comparison – pronouns – Direct vs; Indirect Questions; Vocabulary development – idioms and phrases– cause & effect expressions, adverbs.		**CO3**
UNIT - IV	**FREE WRITING AND EXTENDED WRITING**	**9**
Listening – Listening comprehension for English proficiency tests; Speaking –describing friends/places/hobbies; Reading – comprehension – reading longer texts – reading different types of texts – magazines; Writing – informal letter writing – e–mails – conventions of personal email; Language development – Tenses – Simple present – simple past– present continuous and past continuous – conditionals; Vocabulary development– synonyms – antonyms – single word substitutes – Collocations.		**CO4**
UNIT - V	**GRAMMAR AND LANGUAGE DEVELOPMENT**	**9**
Listening – popular speeches and presentations; Speaking – impromptu speeches &debates; Reading –comparisons and contrast; Writing – brainstorming – writing short essays – developing an outline – identifying main and subordinate ideas – dialogue writing; Language development – modal verbs – present/ past perfect tense; Vocabulary development – Phrasal verbs– fixed and semi–fixed expressions.		**CO5**
Total Periods:		**45**

Text Books:

1. Sanjay Kumar & PushpLata Communication Skills Second Edition, Oxford University Press: 2015.
2. Board of Editors. Using English, A Course book for Undergraduate Engineers and Technologists. Orient Black Swan Limited, Hyderabad:2020
3. Richards, C. Jack. Interchange Students 'Book–2 New Delhi: CUP, 2015.

References:

1. Bailey, Stephen. Academic Writing: A Practical Guide for Students. New York: Rutledge, 2011.
2. Means, L. Thomas and Elaine Langlois. English & Communication for Colleges. Cengage Learning, USA:2007
3. Redston,Chris&GilliesCunninghamFace2Face(Pre–intermediateStudent'sBook &Workbook) Cambridge University Press, New Delhi:2005
4. Comfort, Jeremy, et al. Speaking Effectively: Developing Speaking Skills for Business English. Cambridge University Press, Cambridge: Reprint2011
5. Dutt P. Kiranmaiand Rajeevan Geeta Basic Communication Skills, Foundation Books:2013
6. John Eastwood et al: Be Grammar Ready: The Ultimate Guide to English Grammar, Oxford University Press: 2020..

Course Outcomes (CO) Upon completion of the course, students will be able to	
CO1	Listen and comprehend different spoken discourses/excerpts
CO2	Speak clearly and confidently with one or many listeners using appropriate communicative strategies
CO3	Read different genres of texts adopting various reading strategies
CO4	Write coherently and flawlessly on different topics
CO5	Communicate using a wide vocabulary without grammatical errors

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	–	–	–	–	–	–	–	–	2	3	–	–	1	1	2
CO2	–	1	–	2	–	–	–	–	–	3	–	–	1	1	2
CO3	–	2	–	3	–	–	–	–	–	2	–	–	1	1	2
CO4	–	–	–	–	–	–	–	–	2	2	–	–	1	1	2
CO5	–	2	1	1	2	–	2	–	–	3	–	–	2	1	2

MA4102	ENGINEERING MATHEMATICS	L	T	P	C
	(Common to all branches of B.E. / B. Tech Programmes)	3	1	0	4

Objectives

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.

To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

UNIT - I	MATRICES	9+3
Characteristic equation - Cayley-Hamilton theorem (without proof) - Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.		CO1

UNIT - II	DIFFERENTIAL CALCULUS	9+3

Limit of a function - Continuity - Derivatives - Differentiation rules – Interval of increasing and decreasing functions – Maxima and Minima - Intervals of concavity and convexity.	**CO2**

UNIT – III	**FUNCTIONS OF SEVERAL VARIABLES**	**9+3**
Partial differentiation – Homogeneous functions and Euler's theorem – Total derivatives – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Maxima and Minima of functions of two variables – Lagrange's method of undetermined multipliers.		**CO3**

UNIT - IV	**INTEGRAL CALCULUS**	**9+3**
Definite and Indefinite integrals – Substitution rule – Techniques of Integration – Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.		**CO4**

UNIT - V	**MULTIPLE INTEGRALS**	**9+3**
Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Change of variables from cartesian to polar co-ordinates in double integrals –Triple integrals – Volume of solids.		**CO5**

Total Periods:	**60**

Text Books:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. James Stewart, "Calculus: Early Transcendental", Cengage Learning, 7th Edition, New Delhi, 2015. [For Units I & III - Sections 2.2, 2.3, 2.5, 2.7(Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1(Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.2 - 7.4 and7.8].

References:

1. Anton, H, Bivens, I and Davis, S, "Calculus", Wiley, 10th Edition,2016.
2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
3. Narayanan, S. and Manicavachagom Pillai, T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2007.
4. Srimantha Pal and Bhunia, S.C, "Engineering Mathematics" Oxford University Press, 2015.
5. T. Veerarajan, "Engineering Mathematics – I", McGraw Hill Education; First edition 2017.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Understand the concepts of matrix algebra foranalysing practical problems.
CO2	Apply differential calculus tools in solving various application problems.
CO3	Use differential calculus ideas on several variable functions.
CO4	Apply different methods of integration in solving practical problems.
CO5	Evaluate area, volume and other practical problems by multiple integrals.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**

CO1	3	3	3	1	2	3	-	-	3	2	3	3	2	2	3
CO2	3	3	3	2	2	1	-	-	-	-	1	2	3	3	2
CO3	3	3	3	2	2	1	-	-	-	-	1	2	3	2	2
CO4	3	3	3	2	2	1	-	-	-	-	1	2	2	1	1
CO5	3	3	3	2	1	1	-	-	-	-	1	2	2	1	1

PH4103	**ENGINEERING PHYSICS**	**L**	**T**	**P**	**C**
	(Common to all branches of B.E. / B. Tech Programmes)	**3**	**0**	**0**	**3**

Objectives

- To make the students to understand about the elastic property and stress strain diagram.
- To educate the students about principle of laser and its role in optical fibers and its applications as sensors and communication.
- To teach the students about the heat transfer through solids and liquids.
- To educate the students about the quantum concepts and its use to explain black body radiation, Compton effect, tunnelling electron microscopy and its applications.
- To make the students to understand the importance of various crystal structures and various growth techniques.

UNIT - I	**PROPERTIES OF MATTER**	**9**
Elasticity – Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – torsional stress and deformations–twisting couple-torsion pendulum: theory and experiment - bending of beams - bending moment – cantilever: theory and experiment –uniform and non-uniform bending: theory and experiment – Practical applications of modulus of elasticity-I-shaped girders-stress due to bending in beams.		**CO1**

UNIT II	**LASER AND FIBER OPTICS**	**9**
Lasers : population of energy levels, Einstein‘s A and B coefficients derivation — resonant cavity, optical amplification (qualitative) – Nd-YAG Laser-Semiconductor lasers: homojunction and heterojunction— Industrial and medical applications of Laser– Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, mode) — losses associated with optical fibers — Fabrication of Optical fiber-Double crucible method-fibre optic sensors: pressure and displacement - Industrial and medical applications of optical fiber-Endoscopy- Fiber optic communication system.		**CO2**

UNIT– III	**THERMAL PHYSICS**	**9**
Transfer of heat energy – thermal expansion of solids and liquids – expansion joints – bimetallic strips - thermal conduction, convection and radiation – heat conductions in solids – thermal conductivity–Rectilinear flow of heat- Lee‘s disc method: theory and experiment-conduction through compound media(series and parallel)-Radial flow of heat–thermal insulation– applications: heat exchangers, refrigerators, oven, Induction furnace and solar water heaters.		**CO3**

UNIT - IV	**QUANTUM PHYSICS**	**9**

Black body radiation – Planck's theory(derivation) Compton effect: theory and experimental verification – wave particle duality – electron diffraction – concept of wave function and its physical significance Schrödinger's wave equation time independent and time dependent equations–particle in a one-dimensional rigid box– Electron microscope-tunnelling (qualitative)-scanning tunnelling microscope-Applications of electron microscopy.	**CO4**

UNIT - V	**CRYSTAL PHYSICS**	**9**
Single crystalline, polycrystalline and amorphous materials — single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices — inter-planar distances coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures — Graphite structure-crystal imperfections: point defects, line defects — Burger vectors, stacking faults–growth of single crystals: solution and melt growth techniques - Epitaxial growth-Applications of Single crystal(Qualitative). Crystal structure determination – Laue and powder diffraction method.		**CO5**

Total Periods:	**45**

Text Books:

1. Bhattacharya. D.K.& Poonam,T."Engineering Physics".Oxford University Press, 2019.
2. Gaur. R.K.&Gupta,S.L."Engineering Physics".Dhanpat Rai Publishers, 2017.
3. Halliday. D., Resnick. R.& Walker, J."Principles of Physics".Wiley, 2015.

References:

1. Tipler. P.A.& Mosca.G."Physics for Scientists and Engineers with Modern Physics'. W.H. Freeman, 2007.
2. Serway.R.A.& Jewett,J.W."Physics for Scientists and Engineers" Cengage Learning, 2019.
3. Pandey.B.K.& Chaturvedi.S."Engineering Physics".Cengage Learning India,2019.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Gain knowledge on the basics of properties of matter and its applications,
CO2	Acquire knowledge on the concepts of waves and optical devices and their applications in fibre optics.
CO3	Have adequate knowledge on the concepts of thermal properties of materials and their applications in expansion joints and heat exchangers.
CO4	Get knowledge on advanced physics concepts of quantum theory and its applications in tunneling microscopes, and
CO5	Understand the basics of crystals, their structures and different crystal growth techniques.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	3	3	3	3	2	2	1	3	2	1	2	2	2	2
CO2	3	3	3	2	3	2	2	1	2	2	2	1	2	2	3
CO3	3	3	2	2	2	1	2	1	2	1	1	2	2	2	2

CO4	3	3	2	2	2	1	1	1	1	1	1	3	3	3	2	
CO5	3	3	3	3	2	1	2	1	3	1	1	3	3	2	3	

CY4104	**ENGINEERING CHEMISTRY**	**L**	**T**	**P**	**C**
	(Common to all branches of B.E. / B. Tech Programmes)	**3**	**0**	**0**	**3**

Objectives

- To Study the principles of water characterization and treatment for industrial purposes.
- To apply the principles and applications of surface chemistry and catalysis.
- To learn about Phase rule and various types of alloys.
- To analyze Various types of fuels, applications and combustion.
- To understand Conventional and non–conventional energy sources and energy storage device.

UNIT - I	**WATER AND ITS TREATMENT**	**9**
Hardness of water– Types – Expression of hardness–Units–Estimation of hardness by EDTA method – Numerical problems on EDTA method – Boiler troubles (scale and sludge, caustic embrittlement, boiler corrosion, priming and foaming)–Treatment of boiler feed water– Internal treatment (carbonate, phosphate, colloidal, sodium aluminate and calgon conditioning)–External treatment–Ion exchange process, Zeolite process–Desalination of brackish water by reverse Osmosis.		**CO1**

UNIT II	**SURFACE CHEMISTRY AND CATALYSIS**	**9**
Surface chemistry: Types of adsorption – Adsorption of gases on solids – Adsorption of solute from solutions– Adsorption isotherms – Freundlich's adsorption isotherm–Langmuir's adsorption isotherm ― Kinetics of uni-molecular surface reactions ―Adsorption in chromatography – Applications of adsorption in pollution abatement using PAC. **Catalysis**: Catalyst – Types of catalysis – Criteria – Contact theory – Catalytic poisoning and Catalytic promoters – Industrial applications of catalysts – Catalytic convertor – Auto catalysis – Enzyme catalysis – Michaelis – Menten equation.		**CO2**

UNIT– III	**PHASE RULE AND ALLOYS**	**9**
Phase rule: Introduction – Definition of terms with examples – One component system–Water system – Reduced phase rule – Thermal analysis and cooling curves – Two component systems–Lead- silver system – Pattinson process. **Alloys**: Introduction– Definition – Properties of alloys – Significance of alloying – Functions and effect of alloying elements – Nichrome , Alnico , Stainless steel (18/8) Heat treatment of steel – Non-ferrous alloys – Brass and bronze.		**CO3**

UNIT - IV	**FUELS AND COMBUSTION**	**9**
Fuels : Introduction – classification of fuels – Comparison of solid, liquid, gaseous fuels – Coal– Analysis of coal (proximate and ultimate). – Carbonization – Manufacture of metallurgical coke (Otto Hoffmann method) – Petroleum – Cracking – Manufacture of synthetic petrol (Bergius process, Fischer Tropsch Process) – Knocking – Octane number – Diesel oil– Cetane number– Compressed natural gas (CNG) – Liquefied petroleum gases (LPG) – Power alcohol and biodiesel. **Combustion of fuels**: Introduction – Calorific value – Higher and lower calorific values –Theoretical calculation of calorific value – Ignition temperature – Spontaneous ignition		**CO4**

temperature – Explosive range – Flue gas analysis by Orsat Method.		
UNIT - V	**NON – CONVENTIONAL ENERGY SOURCES AND STORAGE DEVICES**	**9**
Nuclear energy – Fission and fusion reactions – Differences – Chain reactions – Nuclear reactors – Classification of reactors – Light water nuclear reactor for power generation –Breeder reactor — Solar energy conversion — Solar cells — Wind energy — Fuel cells — Hydrogen - oxygen fuel cell. Batteries – Types of batteries – Alkaline batteries – Lead - acid, Nickel – cadmium and Lithium batteries.		**CO5**
Total Periods:		**45**

Text Books:

1. P.C.Jain, Monica Jain, Engineering Chemistry ‖17thEd.Dhanpat Rai Pub. Co., New Delhi,(2015).
2. S.S. Dara, S.S. Umare, A text book of Engineering Chemistry ‖ S. Chand & Co. Ltd., New Delhi (2020).
3. P. Kannan, A. Ravi Krishnan, Engineering Chemistry ‖,Sri Krishna Hi-tech Publishing Company (P) Ltd. Chennai, (2009).

References:

1. B.K. Sharma – Engineering chemistry ‖ Krishna Prakasan Media (P) Ltd., Meerut (2001).
2. B. Sivasankar – Engineering Chemistry ‖ Tata Mc Graw – Hill Pub. Co. Ltd, New Delhi(2008).
3. Prasanta Rath- Engineering Chemistry ‖ Cengage Learning India (P) Ltd., Delhi, (2015).
4. Shikha Agarwal – Engineering Chemistry– Fundamentals and Applications ‖, Cambridge University Press , Delhi, (2015).
5. A. Pahari, B. Chauhan- Engineering Chemistry ‖,Fire wall Media., New Delhi., (2010). Sheik Mideen , Engineering Chemistry, Airwalk Publications ,Chennai (2018).

Course Outcomes (CO)
Upon completion of the course, students will be

CO1	Able to understand impurities in industrial water, boiler troubles , internal and external treatment methods of purifying water.
CO2	Able to understand concepts of absorption, adsorption, adsorption isotherms, application of adsorption for pollution abatement , catalysis and enzyme kinetics.
CO3	Able to recognize significance of alloying , functions of alloying elements and types of alloys ,uses of alloys .They should be acquainted with phase rule and reduced phase and its Applications in alloying.
CO4	Able to identify various types of fuels , properties ,uses and analysis of fuels. They should be able to understand combustion of fuels, method of preparation of bio-diesel, synthetic petrol.
CO5	Able to understand conventional , non–conventional energy sources , nuclear fission and fusion, power generation by nuclear reactor, wind, solar energy and preparation, uses of various batteries.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	3	3	3	3	2	3	2	2	2	2	2	2	2	1

CO2	3	3	2	2	2	2	2	1	1	1	1	2	2	1	1
CO3	3	3	3	3	3	2	2	1	2	2	2	2	2	2	2
CO4	3	3	3	2	2	3	3	2	2	3	2	2	3	1	2
CO5	3	2	3	3	3	3	3	2	2	2	2	2	3	2	3

GE4105	**PROBLEM SOLVING AND PYTHON PROGRAMMING**	**L**	**T**	**P**	**C**
	(Common to all branches of B.E. / B. Tech Programmes)	**3**	**0**	**0**	**3**

Objectives

- To know the basics of algorithmic problem solving
- To write simple python programs
- To develop python program by using control structures and functions
- To use python pre defined data structures
- To write file-based program

UNIT - I	**ALGORITHMIC PROBLEM SOLVING**	**9**
Algorithms, Building blocks of algorithms: statements, state, control flow, functions, Notation: pseudo code, flowchart, programming language, Algorithmic problem solving: Basic algorithms, flowcharts and pseudo code for sequential, decision processing and iterative processing strategies, Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.		**CO1**

UNIT II	**INTRODUCTION TO PYTHON**	**9**
Python Introduction, Technical Strength of Python, Python interpreter and interactive mode, Introduction to colab, pycharm and jupyter idle(s) ,Values and types: int, float, boolean, string,and list; Built-in data types, variables, Literals, Constants, statements, Operators: Assignment, Arithmetic, Relational, Logical, Bitwise operators and their precedence, Expressions, tuple ssignment, Accepting input from Console, printing statements, Simple Python programs.		**CO2**

UNIT– III	**CONTROL FLOW, FUNCTIONS AND STRINGS**	**9**
Conditionals: Boolean values and operators, conditional(if), alternative(if-else), chained conditional (if-elif-else); Iteration: while, for; Loop manipulation using pass, break, continue and else; Modules and Functions: function definition and use, flow of execution, parameters and arguments, local and global scope, return values, function composition, recursion. Strings: string slices, immutability, string functions and methods, string module; Illustrative programs: square root, gcd, exponentiation, sum and array of numbers, linear search, binary search.		**CO3**

UNIT - IV	**LISTS, TUPLES, DICTIONARIES**	**9**
Lists: Defining list and list slicing, list operations, list slices, list methods, list loop, list Manipulation, mutability, aliasing, cloning lists, list parameters, lists as arrays. Tuples: tuple assignment, tuple as return value, tuple Manipulation; Dictionaries: operations and methods; advanced list processing—list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.		**CO4**

UNIT - V	**FILES, MODULES, PACKAGES**	**9**
Files and exception: Concept of Files, Text Files; File opening in various modes and closing		**CO5**

of a file, Format Operators, Reading from a file, Writing onto a file, File functions- open(), close(),read(),readline(), readlines(), write(), writelines(), tell(),seek(), Command Line arguments; Errors and exceptions: handling exceptions; modules, packages; introduction to numpy, matplotlib. Illustrative programs: word count, copy a file.	
Total Periods:	**45**

Text Books:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist ", 2nd edition, Updated for Python3,Shroff/O_Reilly Publishers,2016 (http://greenteapress.com/wp/thinkpython/)
2. Guidovan Rossum and Fred L.DrakeJr,-An Introduction to Python Revised and nupdated for Python3.2, Network Theory Ltd.,2011.
3. Reema Thareja, Python Programming: Using Problem Solving Approach, Oxford University Press, 2019.

References:

1. John V Guttag, ―Introduction to Computation and Programming Using Python‖, Revised and expanded Edition, MIT Press ,2013
2. Robert Sedgewick, Kevin Wayne, Robert Dondero,―Introduction to Programming in Python:An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd.,2016.
3. Timothy A.Budd,―Exploring Python‖, Mc-Graw Hill Education(India)PrivateLtd.,,2015.
4. Kenneth A.Lambert,―Fundamentals of Python: First Programs, CENGAGE Learning,2012.
5. Charles Dierbach,―Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Edition, 2013.
6. Paul Gries, Jennifer Campbell and Jason Montojo,―Practical Programming: An Introduction.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Develop algorithmic solutions to simple computational problems
CO2	Develop simple console application in python
CO3	Develop python program by applying control structure and decompose program into functions.
CO4	Represent compound data using python lists, tuples and dictionaries.
CO5	Read and write data from/to files in Python.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	2	2	1	2	1	2	1	-	-	1	-	2	2	1	1
CO2	2	1	2	2	1	1	1	2	2	2	1	2	2	1	1

CO3	2	2	2	2	2	2	2	2	-	1	1	2	2	1	1
CO4	2	2	2	2	1	2	1	-	2	1	1	2	2	1	1
CO5	2	2	2	2	2	1	1	-	-	2	1	2	2	1	1

GE4106	**ENGINEERING GRAPHICS**	**L**	**T**	**P**	**C**
	(Common to all branches of B.E. / B. Tech Programmes)	**2**	**0**	**4**	**4**

Objectives

- To develop graphic skills for communication of concepts, ideas and design of engineering products.
- To inculcate drawing practice in standardized form whenever technical drawing is needed.
- To expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (Not for Examination)

Importance of graphics in engineering applications - Use of drafting instruments - BIS conventions and specifications - Size, layout and folding of drawing sheets - Lettering and one dimensioning.

UNIT - I	**PLANE CURVES AND FREEHAND SKETCHING**	**7+12**
Basic Geometrical constructions, Curves used in engineering practices: Conics - Construction of ellipse, parabola and hyperbola by eccentricity method - Construction of cycloidal curves - construction of involutes of square and circle - Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles -Representation of Three-Dimensional objects - Layout of views- Freehand sketching of multiple views from pictorial views of objects (Draw without using drawing instruments)		**CO1**

UNIT II	**PROJECTION OF POINTS, LINES AND PLANE SURFACE**	**7+12**
Orthographic projection - principles-Principal planes - First angle projection-projection of points. 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 traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.		**CO2**

UNIT– III	**PROJECTION OF SOLIDS**	**7+12**
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes when the solid is simply suspended by rotating object method.		**CO3**

UNIT - IV	**PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES**	**7+12**
Sectioning of simple solids like prisms, pyramids, cylinder, and cone in a simple vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other - obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids - Prisms, pyramids cylinders and cones - Graphically finding the shortest distance connecting two points.		**CO4**

UNIT - V	**ISOMETRIC AND PERSPECTIVE PROJECTIONS**	**7+12**
Principles of isometric projection - isometric scale -Isometric projections and isometric views of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two		**CO5**

solid objects in simple vertical positions. Perspective projection of simple solids - Prisms, pyramids and cylinders by visual ray method.	
Total Periods:	**90**

Text Books:

1. Natarajan K.V., "A text book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, Twenty ninth edition 2017
2. Venugopal K. and Prabhu Raja V., "Engineering Graphics", New Age International (P) Limited, 2011.
3. S. Ramachandran and K. Pandian, "Engineering Graphics" Airwalk Publications; 8th edition 2014

References:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2019.
2. Basant Agarwal and Agarwal C.M., "Engineering Drawing", Tata McGraw Hill Publishing Company Limited, New Delhi, 2018.
3. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Stores, Bangalore 2018
4. Luzzader, Warren.J and Duff,John 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.
5. N S Parthasarathy and Vela Murali, "Engineering Graphics", Oxford University, Press, New Delhi, 2015.
6. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson, 2nd Edition, 2009.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Understand the fundamentals and standards of engineering graphics.
CO2	Perform freehand sketching of basic geometrical constructions and multiple views of objects.
CO3	Understand the concept of orthographic projections of lines and plane surfaces.
CO4	Draw projections of the section of solids and development of surfaces.
CO5	Visualize and to project isometric and perspective sections of simple solids.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	-	3	3	3	-	-	-	-	3	3	3	-	2	-	2
CO2	-	3	3	3	-	-	-	-	3	3	3	-	2	-	2
CO3	-	3	3	3	-	-	-	-	3	3	3	-	2	-	2
CO4	-	3	3	3	-	-	-	-	3	3	3	-	2	-	2
CO5	-	3	3	3	-	-	-	-	3	3	3	-	2	-	2

GE4151	**HERITAGE OF TAMILS**	**L**	**T**	**P**	**C**
	(Common to all branches of B.E. / B. Tech Programmes)	**1**	**0**	**0**	**1**

UNIT - I	**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.		**CO1**
UNIT II	**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.		**CO2**
UNIT– III	**FOLK AND MARTIAL ARTS**	**3**
Therukoothu, Karagattam, VilluPattu, KaniyanKoothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.		**CO3**
UNIT - IV	**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.		**CO4**
UNIT - V	**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.		**CO5**
Total Periods:		**15**

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 (விகடன்பிரசுரம்)
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,TamilNadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by:RMRL)– Reference Book.

GE4151	தமிழர் மரபு	L	T	P	C
	(Common to all branches of B.E. / B. Tech Programmes)	1	0	0	1

அலகு I	மொழி மற்றும் இலக்கியம்	3
இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள்- சங்க இலக்கியத்தின் சமயச்சார்பற்ற தன்மை - சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.		CO1

அலகு II	மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை- சிற்பக்கலை	3
நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்- பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் - தேர் செய்யும் கலை - சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள்- குமரி முனையில் திருவள்ளுவர் சிலை – இசை கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம்-தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.		CO2

அலகு III	நாட்டுப் புறக்கலைகள் மற்றும் வீர விளையாட்டுகள்	3
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம் - தமிழர்களின் விளையாட்டுகள்.		CO3

அலகு IV	தமிழர்களின் திணைக் கோட்பாடுகள்	3
தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறைமுகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.		CO4

அலகு V	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு	3
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப் பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் –		CO5

இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள்- தமிழ் புத்தகங்களின் அச்சுவரலாறு.	
Total Periods:	**15**

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 (விகடன்பிரசுரம்)
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,TamilNadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by:RMRL)– Reference Book.

PRACTICALS

GE4107	PYTHON PROGRAMMING LABORATORY	L	T	P	C
	Common for all branches of B.E./B.Tech Programmes	0	0	4	2

Objectives

- To write, test and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.

- ❖ Represent compound data using Python lists, tuples and dictionaries.
- ❖ Read and write data from/to files in Python.

LIST OF EXPERIMENTS

1. Write an algorithm and draw flow chart illustrating mail merge concept. 2. Write an algorithm, draw flowchart and write pseudo code for a real life or scientific or technical problems. 3. Scientific problem-solving using decision making and looping. • Armstrong number, palindrome of a number, Perfect number. 4. Simple programming for one dimensional and two-dimensional arrays. • Transpose, addition, multiplication, scalar, determinant of a matrix	**CO1**
5. Program to explore string functions and recursive functions. 6. Utilizing Functions in Python a. Find mean, median, mode for the given set of numbers in a list. b. Write a function dups to find all duplicates in the list. c. Write a function unique to find all the unique elements of a list. d. Write function to compute gcd, lcm of two numbers. 7. Demonstrate the use of Dictionaries and tuples with sample programs. 8. Implement Searching Operations: Linear and Binary Search. 9. To sort the 'n' numbers using: Selection, Merge sort and Insertion Sort.	**CO2**
10. Find the most frequent words in a text of file using command line arguments. 11. Demonstrate Exceptions in Python. 12. Applications**:** Implementing GUI using turtle, pygame.	**CO3**

Total Periods:	**60**

References

1. Reema Thareja, Python Programming: Using Problem Solving Approach, Oxford University Press, 2019
2. Allen B.Downey,―Think Python: How to Think Like a Computer Scientist‖, Second Edition, Updated for Python 3, Shroff/ O'Reilly Publishers, 2016.
3. Shroff―Learning Python: Powerful Object-Oriented Programming; Fifth edition, 2013.
4. David M.Baezly―Python Essential Reference‖. Addison-Wesley Professional; Fourth edition,2009.
5. David M.Baezly―Python Cookbook‖ O'Reilly Media; Third edition (June1, 2013)
6. http://www.edx.org

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Develop simple console applications through python with control structure and functions
CO2	Use python built in data structures like lists, tuples, and dictionaries for representing compound data.
CO3	Read and write data from/to files in Python and applications of python.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	1	1	1	1	1	-	-	-	2	-	2	2	2	2	1
CO2	1	1	1	1	1	-	-	-	2	-	1	2	2	2	1

CO3	1	1	1	1	1	-	-	-	2	-	1	2	2	2	1	

BS4108	**PHYSICS AND CHEMISTRY LABORATORY**	**L**	**T**	**P**	**C**
	Common for all branches of B.E./B.Tech Programmes	**0**	**0**	**4**	**2**

Objectives

The students will be trained to perform experiments to study the following.

- ❖ The Properties of Matter
- ❖ The Optical properties, Characteristics of Lasers & Optical Fibre
- ❖ Electrical & Thermal properties of Materials
- ❖ Enable the students to enhance accuracy in experimental measurements.
- ❖ To make the student to acquire practical skills in the determination of water quality parameters through volumetric analysis
- ❖ Instrumental method of analysis such as potentiometry, conductometry and pHmetry

LIST OF EXPERIMENTS – PHYSICS (A minimum of 5 experiments to be performed from the given list)	
1. Determination of Young's modulus of the material of the given beam by Non-uniform Bending method. 2. Determination of Young's modulus of the material of the given beam by uniform Bending method. 3. Determination of rigidity modulus of the material of the given wire using torsion pendulum.	**CO1**
4. Determination of wavelength of mercury spectra using Spectrometer and grating. 5. Determination of dispersive power of prism using Spectrometer. 6. (a) Determination of wavelength and particle size using a laser. (b) Determination of Numerical and acceptance angle of an optical fibre. 7. Determination of energy band gap of the semiconductor. 8. Determination of coefficient of thermal conductivity of the given bad conductor using Lee's disc. 9. Determination of Hysteresis loss in ferromagnetic materials.	**CO2**
DEMONSTRATION EXPERIMENT	
1. Determination of thickness of a thin sheet/wire–Air wedge method	**CO1**
LIST OF EXPERIMENTS – CHEMISTRY (A minimum of 6 experiments to be performed from the given list)	
1. Determination of chloride content of water sample by argentometric method. 2. Estimation of copper content of the given solution by Iodometry. 3. Determination of strength of given hydrochloric acid using pH meter.	**CO3**
4. Determination of strength of acids in a mixture of acids using conductivity meter. 5. Estimation of iron content of the given solution using potentiometer. 6. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer. 7. Conductometric titration of strong acid vs strong base.	**CO4**
8. Estimation of HCl using Na_2CO_3 as primary standard and determination of alkalinity in Water sample. 9. Determination of total, temporary & permanent hardness of water by EDTA method. 10. Determination of DO content of water sample by Winkler'smethod.	**CO5**
DEMONSTRATION EXPERIMENTS	
1. Estimation of iron content of the water sample using spectro photometer (1,10-Phenanthroline/thiocyanate method).	**CO3**
2. Estimation of sodium and potassium present in water using flame photometer.	**CO5**

Total Periods:	**60**

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Understand the concept about the basic properties of matter like stress, strain and types of moduli. Understand the concept of optics like reflection, refraction, diffraction by using Spectrometer grating.
CO2	Understand the thermal properties of solids, specific heat and some models for specific heat calculation. Understand the working principle of laser components and working of different laser system. Understand the phenomenon of light, applications of fibre optics.
CO3	Understand the concept of determining the pH value by using pH meter. Understand the concept about the amount of chloride present in the given sample of water.
CO4	Understand the concept of determining the emf values by using potentiometer Understand the concept about the measurement of conductance of strong acid and strong base by using conductivity meter.
CO5	Understand the amount of dissolved oxygen present in the water. Understand the concept of estimation of hardness of water by EDTA method. Understand the concept of estimation of alkalinity in water sample.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	1	2	2	2	1	1	1	3	2	2	3	2	2	2
CO2	3	1	2	1	1	1	1	1	2	1	1	2	2	2	2
CO3	3	1	2	1	2	2	2	1	2	1	1	1	2	1	1
CO4	3	2	1	1	2	1	1	1	2	1	1	2	2	1	2
CO5	3	2	1	1	1	2	2	1	2	1	2	1	2	2	1

SEMESTER – II

HS4201	**PROFESSIONAL ENGLISH**	**L**	**T**	**P**	**C**
	(Common to all branches of B.E. / B. Tech Programmes)	**3**	**0**	**0**	**3**

Objectives

- To engage learners in meaningful language activities to improve their LSRW skills
- To enhance learners' awareness of general rules of writing for a specific purpose
- To develop analytical thinking skills for problem solving in communicative contexts
- To help learners understand the purpose, audience, contexts of different types of writing

- To demonstrate an understanding of job applications and interviews for internship and placements

UNIT - I	**MAKING COMPARISONS**	**9**
Listening – Evaluative Listening: Advertisements, Product Descriptions – Audio / video – Listening and filling a Graphic Organiser – Choosing a product or service by comparison; Speaking – Marketing a product, Persuasive Speech Techniques; Reading – Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette – Compare and Contrast Essay - Writing definitions; Grammar – Prepositional phrases; Vocabulary – Contextual meaning of words.		**CO1**
UNIT II	**EXPRESSING CASUAL RELATIONS IN SPEAKING AND WRITING**	**9**
Listening – Listening to longer technical talks and completing gap filling exercises – Listening to technical information from podcasts – Listening to process/event descriptions to identify cause & effects – Speaking – Describing and discussing the reasons of accidents or disasters based on news reports; Reading – Reading longer technical texts – Cause and Effect Essays – Letters/ emails of complaint; Writing – Purpose statements – Writing responses to complaints; Grammar – Impersonal passive, Infinitive and Gerunds; Vocabulary – Word Formation (Noun-Verb-Adj-Adv).		**CO2**
UNIT– III	**PROBLEM SOLVING**	**9**
Listening – Listening to / Watching movie scenes/ documentaries depicting a technical problem and suggesting solutions; Speaking – Group Discussion (based on case studies) – techniques and strategies, Reading – Case Studies, excerpts from literary texts, news reports etc; Writing – Letter to the Editor, Checklists, Problem solution essay – Argumentative Essay; Grammar – Error correction – If conditional sentences; Vocabulary - Compound Words, Sentence Completion.		**CO3**
UNIT - IV	**REPORTING OF EVENTS AND RESEARCH**	**9**
Listening – Listening comprehension based on news reports and documentaries – paraphrasing and summarising; Speaking – Interviewing, presenting an oral report, Mini presentations on select topics; Reading – Newspaper articles; Writing – Recommendations, Transcoding charts and graphs Transcoding Accident Report, Survey Report Grammar – Reported Speech, Subject-verb agreement, Vocabulary – Conjunctions – use of prepositions.		**CO4**
UNIT - V	**PRESENTING IDEAS OR INFORMATION COGENTLY**	**9**
Listening – Listening to technical talks, Presentations, Formal job interviews, analysis of the interview performance; Speaking – Participating in a Role play, (interview/telephone interview), virtual interviews, making presentations with visual aids; Reading – Company profiles, Statement of Purpose (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses; Vocabulary – Easily confused words.		**CO5**
Total Periods:		**45**

Text Books:

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
3. Raman. Meenakshi, Sharma. Sangeeta (2022). Technical Communication. Oxford University Press. New Delhi.

References:

1. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, New Delhi.
2. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
3. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
4. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.
5. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford University Press. New Delhi.

Course Outcomes (CO)
Upon completion of the course, students will be able

CO1	To compare and contrast products and ideas in technical texts.
CO2	To identify cause and effects in events, industrial processes through technical texts.
CO3	To analyse problems in order to arrive at feasible solutions and communicate them orally and in the written format.
CO4	To report events and the processes of technical and industrial nature.
CO5	To present opinions in a planned and logical manner, and draft effective resumes in context of job search.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	-	-	1	1	-	1	1	-	1	2	2	2	1	2	-
CO2	-	-	1	1	-	1	1	-	1	2	2	2	2	2	-
CO3	-	-	2	1	-	-	1	-	1	3	2	2	2	2	2
CO4	-	-	2	1	-	2	2	1	2	3	2	3	3	2	2
CO5	-	-	1	2	-	2	2	1	1	3	2	3	1	1	1

MA4202	STATISTICS AND NUMERICAL METHODS	L	T	P	C
	(Common to all branches of B.E. / B. Tech Programmes)	3	1	0	4

Objectives

- This course aims at providing the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT - I	TESTING OF HYPOTHESIS	9+3
Sampling distributions – Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi-square test for goodness of fit – Independence of attributes.		**CO1**

UNIT II	DESIGN OF EXPERIMENTS	9+3
One-way and two-way classifications – Completely randomized design – Randomized block design – Latin square design – 2^2 factorial design.		**CO2**

UNIT– III	SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS	9+3
Solution of algebraic and transcendental equations by Newton Raphson method –Solution of linear system of equations – Gauss elimination method – Pivoting – Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel – Eigen value of a matrix by Power method.		**CO3**

UNIT - IV	INTERPOLATION AND NUMERICAL CALCULUS	9+3
Interpolations – Lagrange's, Newton's forward and backward Interpolations –Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.		**CO4**

UNIT - V	NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS	9+3
Single step methods: Taylor's series method – Euler's method - Modified Euler's method – Fourth order Runge-Kutta method for solving first order differential equations - Multi step method: Adams- Bash forth predictor corrector method for solving first order differential equations.		**CO5**

Total Periods:	**60**

Text Books:

1. Grewal. B.S. and Grewal. J.S., "Numerical Methods in Engineering and Science" , 10th Edition, Khanna Publishers, New Delhi, 2015.
2. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
3. Kandasamy P., ThilagavathiK and Gunavathi K., "Statistical and numerical methods", S. Chand & Company Ltd. Sultan Chand & Company, 2001.

References:

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 2006.
4. Gupta S.C. and Kapoor V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
5. Spiegel. M.R., Schiller. J. and Srinivasan. R.A.,"Schaum's Outlines on Probability and Statistics", Tata McGraw Hill Edition, 4th Edition, 2012.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", 9th Edition, Pearson Education, Asia, 2010.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Apply the concept of testing of hypothesis for small and large samples in real life problems.
CO2	Apply the basic concepts of classifications of design of experiments in the field of agriculture.

CO3	Appreciate the numerical techniques of interpolation in various intervals and apply the numerical techniques of differentiation and integration for engineering problems.
CO4	Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
CO5	Solve the ordinary differential equations with initial conditions by using certain techniques with engineering applications.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	2	3	3	3	2	3	2	-	2	-	2	2	3	2	1
CO2	2	3	3	3	3	2	2	-	2	-	2	2	2	1	1
CO3	2	3	2	2	1	-	-	-	-	-	-	2	3	1	2
CO4	3	3	3	2	2	1	-	-	-	-	-	2	2	1	2
CO5	3	3	2	1	2	1	-	-	-	-	-	2	3	2	1

PH4252	PHYSICS FOR ELECTRONICS ENGINEERING	L	T	P	C
	(Common to ECE and EEE)	3	0	0	3

Objectives

- Understand the transport properties of conducting materials and their modelling using classical and quantum theories,
- Acquire knowledge in semiconductors and their applications in various devices
- Grasp the principles of magnetic and dielectric materials and their applications
- Understand the functioning of optical materials for optoelectronics
- Understand the basics of quantum structures, properties of nano materials and their applications.

UNIT - I	CONDUCTING MATERIALS	9
Classical free electron theory - Expression for electrical conductivity -Thermal conductivity, expression - Wiedemann-Franz law - Success and failures - electrons in metals - Particle in a three-dimensional box - degenerate states - Fermi-Dirac statistics - Density of energy states - Electron in periodic potential: Bloch theorem - metals and insulators - Energy bands in solids - tight binding approximation – Electron effective mass - concept of hole.		CO1

UNIT II	PHYSICS OF SEMICONDUCTOR DEVICES	9
Intrinsic Semiconductors - Energy band diagram - direct and indirect band gap semiconductors - Carrier concentration in intrinsic semiconductors - extrinsic semiconductors - carrier concentration in n- type & p-type semiconductors - carrier transport: velocity-electric field relations - drift and diffusion transport - Einstein's relation - Hall effect and devices - Zener and avalanche breakdown in p-n junction diode - Zener diode as voltage regulator - Ohmic contacts - tunnel diode - Schottky diode - MOS Capacitor.		CO2

UNIT– III	MAGNETIC AND DIELECTRIC MATERIALS	9
Origin of magnetic moment - Bohr magneton - Microscopic and macroscopic classification of magnetic materials: diamagnetic, paramagnetic and ferromagnetic materials - Domain theory - Hysteresis (based on domain theory) - soft and hard magnetic materials - Ferrites - applications.		CO3

Dielectric materials: Polarization processes - internal field - Clausius-Mosotti relation - dielectric loss - dielectric breakdown.		
UNIT - IV	**OPTICAL MATERIALS**	**9**
Classification of optical materials - carrier generation and recombination processes - Absorption, emission and scattering of light in metals, insulators and semiconductors (concepts only) - photo current in p-n junction diode - solar cell - photo detectors - LED - Organic LED - excitons - quantum confined Stark effect - quantum dot laser, quantum well laser.		**CO4**
UNIT - V	**NANO ELECTRONIC DEVICES**	**9**
Introduction - electron density in bulk material - size dependence of Fermi energy - quantum confinement - quantum structures - Density of states in quantum well, quantum wire and quantum dot structures - resonant tunneling - quantum interference effects - mesoscopic structures - Coulomb blockade effects - Single electron phenomena and Single electron Transistor - magnetic semiconductors - spintronics, Spintronic Devices: Spin Valve, Spin FET- Carbon nanotubes: Types ,Preparation-CVD, Properties and applications.		**CO5**
Total Periods:		**45**

Text Books:

1. Donald Neaman, Dhrubes Biswas , Semiconductor Physics and Devices (SIE) 4th Edition, 2017
2. Umesh K Mishra &Jasprit Singh, "Semiconductor Device Physics and Design", Springer, 2008
3. Adaptation by Balasubramanian. R, Callister "Material Science and Engineering", Wiley India Pvt. Ltd., 2nd Edition, 2014.

References:

1. Traugott Fischer , "Materials Science for Engineering Students" , I Edition, Elsevier , 2009
2. Budinski. K.G. & Budinski, M.K. "Engineering Materials Properties and Selection", Prentice Hall, 2009.
3. Rogers. B., Adams. J & Pennathur. S "Nanotechnology: Understanding Small Systems". CRC Press, 2014

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Gain knowledge on classical and quantum free electron theories and formation of energy band structures.
CO2	Gain knowledge on semiconducting devices and its applications.
CO3	Acquire knowledge on magnetic and dielectric materials and their applications.
CO4	Understand the relationship of optoelectronic materials and their applications.
CO5	Acquire knowledge about the nano structures and its applications.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	3	3	3	3	2	2	1	3	2	1	2	2	2	2
CO2	3	3	3	2	3	2	2	1	2	2	1	2	3	3	2
CO3	3	3	2	2	2	1	2	1	2	1	1	2	3	3	2
CO4	3	3	2	2	2	1	1	1	1	1	1	3	3	3	2

	CO5	3	3	3	3	2	1	2	1	3	1	1	3	3	3	3	

GE4204	**ENVIRONMENTAL SCIENCE AND ENGINEERING**	**L**	**T**	**P**	**C**
	(Common to all branches of B.E. / B. Tech Programmes)	**3**	**0**	**0**	**3**

Objectives

- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To find and implement scientific, technological, economic and political solutions to environmental problems.
- To learn the integrated themes and biodiversity, natural resources, pollution control and waste management.
- To apply the dynamic processes and understand the features of the earth‘s interior and surface

UNIT - I	**ENVIRONMENT, ECOSYSTEM AND BIODIVERSITY**	**9**
Definition, scope and importance of environment – Need for public awareness – Role of Individual in Environmental protection – Concept of an ecosystem – Structure and function of and ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Foodchains, food webs and ecological pyramids – Ecological succession – Types, characteristic features, structure and function of forest, grassland, desert and aquatic (ponds, lakes, rivers, oceans, estuaries) ecosystem. Biodiversity – Definition – Genetic, species and ecosystem diversity – Value of biodiversity – Consumptive use, productive use, social, ethical, aesthetic and option values– Biodiversity at global, national and local levels–India as a mega diversity nation–Hotspots of biodiversity– Threats to biodiversity– Habitat loss, poaching of wild life, human-wildlife conflicts – Wildlife protection act and forest conservation act–Endangered and endemic species– Conservation of biodiversity–In-situ and ex-situ conservation of biodiversity.		**CO1**

UNIT II	**ENVIRONMENTAL POLLUTION**	**9**
Definition – Causes, effects and control measures of: (a)Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – Solid waste management : causes, effects and control measures of municipal solid wastes – Problems of e-waste – Role of an individual in prevention of pollution – Pollution case studies – Disaster management – Floods, earthquake, cyclone, tsunami and landslides – Field Study of local polluted site–Urban/Rural/Industrial/Agricultural.		**CO2**

UNIT– III	**NATURAL RESOURCES**	**9**
Forest resources: Uses and over-exploitation – Deforestation – Timber extraction, mining, dams and their effects on forests and tribal people – Water resources – Use and overutilization of surface and groundwater, floods, drought, conflicts over water–Dams: benefits and problems – Mineral resources: Uses and exploitation – Environmental effects of extracting and using mineral resources – Food resources: World food problems – Changes caused by agriculture and overgrazing – Effects of modern agriculture: fertilizer– pesticide problems, water logging, salinity — Energy resources: Growing energy needs – Renewable and non renewable energy sources – Use of alternate energy sources – Land resources: Land as a resource – Land degradation, man induced landslides, soil erosion and desertification – Role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles–Field study of local area to document		**CO3**

environmental assets – River/Forest/Grassland/Hill/Mountain- Case studies.		
UNIT - IV	**SOCIAL ISSUES AND THE ENVIRONMENT**	**9**
From unsustainable to sustainable development – Urban problems related to energy–Water conservation, rain water harvesting, watershed management– Resettlement and rehabilitation of people; its problems and concerns–Role of non-governmental organization– Environmental ethics – Issues and possible solutions – Climate change – Global warming – Acid rain, Ozone layer depletion –Nuclear accidents and holocaust — Wasteland reclamation – Consumerism and waste products – Principles of Green Chemistry– Environment protection act– Air(Prevention and Control of Pollution) Act–Water(Prevention and control of Pollution) Act – Wildlife protection Act–Forest conservation Act –Enforcement machinery involved in environmental legislation–Central and state pollution control boards–National Green Tribunal – Public awareness- Case studies.		**CO4**
UNIT - V	**HUMAN POPULATION AND THE ENVIRONMENT**	**9**
Population growth – Variation among nations – Population explosion – Family welfare programme – Environment and human health–Human rights–Value education –HIV/AIDS – COVID19–Women and child welfare – Role of information technology in environment and Human health–Case studies		**CO5**
Total Periods:		**45**

Text Books:

1. Benny Joseph, Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, (2014).
2. Gilbert M. Masters, Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education,(2004).
3. Dr. A. Sheik Mideen and S.Izzat Fathima, Environmental Science and Engineering, Airwalk Publications, Chennai, (2018).

References:

1. Dharmendra S.Sengar, 'Environmental law', Prentice hall of India Pvt Ltd, New Delhi,(2007).
2. Erach Bharucha, Textbook of Environmental Studies, Universities Press(I) Pvt, Ltd, Hydrabad,(2015).
3. G.Tyler Miller, Scott E. Spoolman, Environmental Science, Cengage Learning India Pvt. Ltd, Delhi,(2014).
4. R.Rajagopalan, Environmental Studies-From Crisisto Cure',Oxford University Press,(2005).
5. Anubha Kaushik, C.P. Kaushik, Perspectives in Environmental Studies, New Age International Pvt. Ltd, New Delhi,(2004).
6. Frank R. Spellman, Handbook of Environmental Engineering, CRC Press,(2015).

Course Outcomes (CO)
Upon completion of the course, students will be able

CO1	To obtain knowledge about environment, ecosystems and biodiversity.
CO2	To take measures to control environmental pollution.
CO3	To gain knowledge about natural resources and energy sources.
CO4	To find and implement scientific, technological, economic and political solutions to environmental problems.
CO5	To understand the impact of environment on human population.

Course Outcomes	**Program Outcomes**	**Program Specific Outcomes**

	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	2	3	3	3	3	3	2	2	2	3	2	1	2
CO2	3	2	3	3	2	3	3	3	3	2	2	3	2	2	2
CO3	3	3	2	2	3	3	2	2	1	2	1	3	2	2	2
CO4	3	3	3	3	1	2	3	3	2	2	2	2	2	1	2
CO5	3	2	3	2	3	3	3	2	2	2	2	3	3	2	3

BE4205	**BASIC CIVIL AND MECHANICAL ENGINEERING**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Objectives

- The objective of this course is to introduce basic knowledge on Civil Engineering Materials, Surveying, Foundations, Civil Engineering Structures, IC Engine, Working Principle of Power Plant, Accessories of Power Plant, Refrigeration and Air Conditioning System

UNIT - I	**SCOPE OF CIVIL AND MECHANICAL ENGINEERING**	**6**
Overview of Civil Engineering - Civil Engineering contributions to the welfare of Society – Specialized subdisciplines in Civil Engineering – Structural, Construction, Geotechnical, Environmental, Transportation and Water Resources Engineering **Overview of Mechanical Engineering** – Mechanical Engineering contributions to the welfare of Society –Specialized subdisciplines in Mechanical Engineering Production, Automobile, Energy Engineering – Inter disciplinary concepts in Civil and Mechanical Engineering.		**CO1**

UNIT II	**SURVEYING AND CIVIL ENGINEERING MATERIALS**	**9**
Surveying: Objects–classification–principles–measurementsofdistances–angles–levelling determination of areas–contours- examples. **Civil Engineering Materials:**Bricks–stones–sand–cement–concrete–steel-timber-modern materials		**CO2**

UNIT– III	**BUILDING COMPONENTS AND STRUCTURES**	**12**
Foundations: Types of foundations-Bearing capacity and settlement–Requirement of good foundations. **Civil Engineering Structures:** Brick masonry – stonemasonry – beams – columns – lintels – roofing flooring – plastering – floor area, carpet area and floor space index - Types of Bridges and Dams – water supply- sources and quality of water-Rain water harvesting- Introduction to highway and railway.		**CO3**

UNIT - IV	**INTERNAL COMBUSTION ENGINES AND POWER PLANTS**	**12**
Classification of Power Plants – Internal combustion engines as automobile power plant – Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines – Working principle of steam, Gas, Diesel, Hydro - electric and Nuclear Power plants –- working principle of Boilers, Turbines, Reciprocating Pumps (single acting and double acting)and Centrifugal Pumps		**CO4**

UNIT - V	**REFRIGERATION AND AIR CONDITIONING SYSTEM**	**6**
Terminology of Refrigeration and Air Conditioning. Principle of vapour compression and absorption system – Layout of typical domestic refrigerator –Window and Split type room Air conditioner.		**CO5**

Total Periods:	**45**

Text Books:

1. Shanmugam G and Palanichamy M S, "Basic Civil and Mechanical Engineering", Tata McGraw Hill Publishing Co., New Delhi,1996.

References:

1. Palanikumar.K. Basic Mechanical Engineering, ARS Publications, 2010.
2. Ramamrutham.S, "Basic Civil Engineering",Dhanpat Rai Publishing Co.(P)Ltd,1999.
3. SeetharamanS.,"Basic Civil Engineering", Anuradha Agencies,2005.
4. Shantha Kumar SRJ.,"Basic Mechanical Engineering",Hi-tech Publications, Mayiladuthurai,2000
5. Venugopal K and Prahu Raja V,"Basic Mechanical Engineering", Anuradha Publishers, Kumbakonam,2000.

Course Outcomes (CO)
Upon completion of the course, students will be able

CO1	To impart basic knowledge on Civil and Mechanical Engineering.
CO2	To familiarize the materials and measurements used in Civil Engineering.
CO3	To provide the exposure on the fundamental elements of civil engineering structures.
CO4	To enable the students to distinguish the components and working principle of power plant, IC engines
CO5	To provide the exposure on the fundamental elements of R & AC system.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	2	3	3	3	-	3	2	2	3	3	-	3
CO2	3	2	3	3	3	3	2	-	2	1	1	3	3	-	3
CO3	3	2	3	3	2	3	2	-	3	2	1	3	3	-	3
CO4	3	2	3	2	2	3	2	-	3	2	2	3	3	-	3
CO5	3	2	3	2	2	3	2	-	2	2	1	3	3	-	3

EE4201	PRINCIPLES OF ELECTRICAL, ELECTRONICS AND COMMUNICATION ENGINEERING	L	T	P	C
		3	0	0	3

Objectives

- To understand the basic concepts of electric circuits and wiring practices.
- To study about the three phase system and magnetic circuits
- To understand the working principle of electronic devices.
- To study the working of current controlled and voltage controlled devices.
- To understand the basic concepts of communication systems.

UNIT - I	BASIC ELECTRIC CIRCUITS AND DOMESTIC WIRING	9
Electrical circuit elements (R, L and C)-Dependent and independent sources - Ohm's Law, Kirchhoff's laws –Mesh and Nodal Analysis with independent sources - Single phase AC circuits:		CO1

Phasor – RMS and Average values- Types of wiring- Domestic wiring - Electrical Safety - Protective devices and Earthing.		
UNIT II	**THREE PHASE CIRCUITS AND MAGNETIC CIRCUITS**	**9**
Evolution of Three phase circuits from single phase circuits – Star connection – Delta connection –Balanced and Unbalanced Loads- Power in three-phase circuits -Magnetic circuits- Definitions- MMF, Flux, Reluctance, Magnetic field intensity, Flux density, Fringing, self and mutual inductances-simple problems.		**CO2**
UNIT– III	**BASICS OF ELECTRONICS**	**9**
P-N junction diode - VI Characteristics, static and dynamic resistance, Diffusion and drift current densities, transition & diffusion capacitance - Zener diode - VI Characteristics, Zener and avanlache Breakdown, Zener Voltage Regulator. Diode Rectifier & Filter circuits – LC Filters		**CO3**
UNIT - IV	**CURRENT CONTROLLED AND VOLTAGE CONTROLLED DEVICES**	**9**
Current controlled devices: Construction, operation and characteristics of BJT, UJT, SCR. Voltage controlled devices: Construction, operation and characteristics of JFET and MOSFET.		**CO4**
UNIT - V	**FUNDAMENTAL OF COMMUNICATION ENGINEERING**	**9**
Introduction – Elements of communication systems – Modulation and Demodulation : principle of amplitude and frequency modulation. Digital communication - Nyquist Sampling Theorem, Pulse Code Modulation, Delta Modulation, BPSK, QPSK(Qualitative Approach)- Communication systems: Radio Antenna, TV, Satellite and optical fibre(Block diagram approach only)		**CO5**
Total Periods:		**45**

Text Books:

1. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", McGraw Hill Education, 2014.
2. Del Toro, "Electrical Engineering Fundamentals", Second Edition, Pearson Education, New Delhi, 2015.
3. John Bird, "Electrical Circuit theory and technology", Routledge; 5th Edition, 2013.

References:

1. Thomas L. Floyd, 'Electronic Devices', 10th Edition, Pearson Education, 2018.
2. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th Edition, 2017.
3. Kothari DP and I.J Nagrath, "Basic Electrical Engineering", McGraw Hill, 2010.
4. Muhammad H.Rashid, "Spice for Circuits and electronics", 4th Edition, Cengage 2019.
5. V.K. Mehta and Rohit Mehta, 'Principles of Power System', S.Chand Publishers, Reprint Edition 2019.
6. Taub & Schiling "Principles of Communication Systems" Tata McGraw Hill 4th Edition 2017

Course Outcomes (CO)
Upon completion of the course, students will be able

CO1	To understand the concepts related with electrical circuits and wiring practices.
CO2	To study the different three phase connections and the concepts of magnetic circuits.
CO3	To understand the working principle of electronic devices such as diode and zener diode.
CO4	To understand the characteristics and working of current controlled and voltage controlled devices.
CO5	To understand the basic concepts of communication systems.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	2	3	3	2	1	3	2	2	3	3	2	1
CO2	3	3	3	2	2	1	3	1	1	2	2	2	3	2	1
CO3	3	3	3	2	2	1	2	1	1	1	2	3	3	2	1
CO4	3	3	3	2	1	2	2	1	1	1	1	2	3	2	1
CO5	3	2	1	2	1	1	2	1	1	1	1	2	3	2	1

GE4251	TAMILS AND TECHNOLOGY	L	T	P	C
	(Common to all branches of B.E. / B. Tech Programmes)	1	0	0	1

UNIT - I	WEAVING AND CERAMIC TECHNOLOGY	3
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.		CO1

UNIT II	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.		CO2

UNIT– III	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.		CO3

UNIT - IV	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.		CO4

UNIT - V	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.		CO5

Total Periods:	15

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 (விகடன்பிரசுரம்)
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,TamilNadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by:RMRL)– Reference Book.

GE4251	தமிழரும் தொழிநுட்பமும்	L	T	P	C
	(Common to all branches of B.E. / B. Tech Programmes)	1	0	0	1

அலகு I	நெசவு மற்றும் பானைத் தொழில்நுட்பம்	3
சங்ககாலத்தில் நெசவுத் தொழில் - பானைத் தொழிநுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.		CO1

அலகு II	வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்	3
சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்ககாலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு - சங்ககாலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றியவிவரங்கள்–மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர்காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழி பாட்டுத்தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் - செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.		CO2

அலகு III	உற்பத்தித்தொழில்நுட்பம்	3
கப்பல் கட்டும் கலை - உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்று சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள்- கல்மணிகள், கண்ணாடி மணிகள்- சுடுமண்		CO3

மணிகள் – சங்கு மணிகள்- எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.		
அலகு IV	**வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில்நுட்பம்**	**3**
அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமிழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மையைச் சார்த்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.		**CO4**
அலகு V	**அறிவியல் தமிழ் மற்றும் கணித்தமிழ்**	**3**
அறிவியல் தமிழின் வளர்ச்சி – கணித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின் பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் –இணையத்தில் தமிழ் அகராதிகள் –சொற்குவைத் திட்டம்.		**CO5**
Total Periods:		**15**

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 (விகடன்பிரசுரம்)
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,TamilNadu)
12. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by:RMRL)– Reference Book.

PRACTICALS

GE4207	ENGINEERING PRACTICES LABORATORY	L	P	T	C
	(Common for all branches of B.E. / B. Tech Programmes)	0	0	4	2

OBJECTIVES

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering

LIST OF EXPERIMENTS

GROUP A (CIVIL & MECHANICAL)

I	**CIVIL ENGINEERING PRACTICE** **13** **Buildings:** (a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects. **Plumbing Works:** (a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings. (b) Study of pipe connections requirements for pumps and turbines. **(c)** Preparation of plumbing line sketches for water supply and sewage works. (d)**Hands-on-exercise:** Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components. (e) Demonstration of plumbing requirements of high-rise buildings. **Carpentry using Power Tools only:** (a) Study of the joints in roofs, doors, windows and furniture. (b)Hands-on-exercise: Wood work, joints by sawing, planning and cutting.	**CO1**
II	**MECHANICAL ENGINEERING PRACTICE** **18** **Welding:** (a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding. (b)Gas welding practice **Basic Machining:** (a) Simple Turning and Taper turning (b)Drilling Practice **Sheet Metal Work:** (a) Forming & Bending: (b) Model making – Trays and funnels. (c) Different type of joints. **Machine assembly practice:** (a) Study of centrifugal pump (b) Study of air conditioner **Demonstration on:** (a) Smithy operations, upsetting, swaging, setting down and bending. Example –Exercise – Production of hexagonal headed bolt. (b) Foundry operations like mould preparation for gear and step cone pulley. (c) Fitting – Exercises – Preparation of square fitting and V – fitting models.	**CO2**
	GROUP B (ELECTRICAL & ELECTRONICS)	
III	**ELECTRICAL ENGINEERING PRACTICE** **13** 1. Residential house wiring using switches, fuse, indicator, lamp and energy meter. 2. Fluorescent lamp wiring. 3. Stair case wiring 4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.	**CO3**
	5. Measurement of energy using single phase energy meter. 6. Measurement of resistance to earth of an electrical equipment.	**CO4**

IV ELECTRONICS ENGINEERING PRACTICE **16** 1. Study of electronic components and equipment's – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR. 2. Study of logic gates AND, OR, EX-OR and NOT. 3. Generation of Clock Signal. 4. Soldering practice – Components Devices and Circuits – Using general purpose PCB. Measurement of ripple factor of HWR and FWR.	**CO5**
TOTAL: 60 PERIODS	

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	Description of Equipment	Quantity required
	CIVIL	
1.	Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings.	**15 sets**
2.	Carpentry vice (fitted to work bench)	**15 Nos**
3.	Standard woodworking tools 15 Sets.	**15 Sets.**
4.	Models of industrial trusses, door joints, furniture joints	**5 each**
5.	**Power Tools:** (a) Rotary Hammer (b) Demolition Hammer (c) Circular Saw (d) Planer (e) Hand Drilling Machine (f) Jigsaw	**2 Nos**
	MECHANICAL	
1.	Arc welding transformer with cables and holders.	**5 Nos**
2.	Welding booth with exhaust facility.	**5 Nos**
3.	Welding accessories like welding shield, chipping hammer, wire brush, etc.	**5 Sets**
4.	Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	**2 Nos**
5.	Centre lathe.	**2 Nos**
6.	Hearth furnace, anvil and smithy tools.	**2 Sets**
7.	Moulding table, foundry tools.	**2 Sets**
8.	Power Tool: Angle Grinder.	**2 Nos**
9.	**Study-purpose items:** centrifugal pump, air-conditioner.	**1 each**
	ELECTRICAL	
1.	Assorted electrical components for house wiring.	**15 Sets**
2.	Electrical measuring instruments.	**10 Sets**
3.	**Study purpose items:** Iron box, fan and regulator, emergency lamp.	**1 each**
4.	Megger (250V/500V).	**1 No.**

5.	**Power Tools:** (a) Range Finder (b) Digital Live-wire detector	**2 Nos**
ELECTRONICS		
1.	Soldering guns 10 Nos.	**10 Nos.**
2.	Assorted electronic components for making circuits 50 Nos.	**50 Nos.**
3.	Small PCBs.	**10 Nos.**
4.	Multimeters	**10 Nos.**
5.	**Study purpose items:** Telephone, FM radio, low-voltage power supply	**1 each**

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Fabricate carpentry components and pipe connections including plumbing works.Use welding equipment's to join the structures.
CO2	Carry out the basic machining operations Make the models using sheet metal works
CO3	Carry out basic home electrical works and appliances.
CO4	Measure the electrical quantities
CO5	Elaborate on the components, gates, soldering practices

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	1	3	-	-	3	-	-	-	-	-	3	3	2	1
CO2	3	2	3	-	-	3	-	-	-	-	-	3	3	2	1
CO3	3	1	2	-	-	2	-	-	-	-	-	3	3	2	1
CO4	3	2	3	3	1	3	1	1	1	1	2	3	3	3	1
CO5	3	2	3	3	1	2	1	1	1	1	2	3	3	3	1

EE4211	PRINCIPLES OF ELECTRICAL AND ELECTRONIC DEVICES LABORATORY	L	T	P	C
		0	0	4	2

Objectives

- To provide practical knowledge of fundamental concepts of electrical and electronics engineering through relevant experiments.
- To impart hands on experience in measurement of electric and magnetic circuit parameters.
- To train the students in performing the verification of ohm's law and Kirchhoff's laws.
- To analyse various connections of balanced and unbalanced loads.
- To study the characteristics of electronic semiconductor devices.

LIST OF EXPERIMENTS

1. Measurement of equivalent Resistance in an electric circuit

2. Verification of ohm's law.	
3. Verification of Kirchhoff's laws.	
4. Measurement of magnetic flux in magnetic circuits.	
5. Star and delta connections with balanced and unbalanced loads.	
6. V-I characteristics of PN junction and Zener Diode.	
7. V-I characteristics of BJT (CE, CB, CC Configuration).	
8. V-I characteristics of FET.	
9. V-I characteristics of UJT and its application.	
Total Periods	**60**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Dual,(0-30V) variability Power Supply- 10 Nos
2. CRO-10 Nos-30MHz
3. Function Generator – 10 Nos- 1 MHz
4. Digital Multimeter -10 Nos
5. Bread board – 10 Nos
6. Digital Trainer Kit
7. Watt meter-2Nos.
8. Ammeter (0-10A)-10 Nos
9. Voltmeter (0-300V)-10Nos
10. Fluxmeter-2 Nos
11. Load Resistor Box-1Nos.

Consumables Sufficient Quantity

1. Resistor
2. BJT
3. UJT
4. Diodes
5. Zener Diode.

COURSE OUTCOMES

Upon completion of the course, students will be able to

CO1	Manipulate simple electric and magnetic circuits.
CO2	Understand the basic ohm's and kirchhoff's law realization.
CO3	Design and Analyse the basic circuit components and connect them to make a real electrical circuit.
CO4	Design and construct basic load connections of electrical networks
CO5	Study and analyse the characteristics of various electronic semiconductor devices.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	3	1	1	1	2	1	2	2	3	2	1
CO2	3	3	3	3	3	2	1	1	2	1	1	3	3	2	1
CO3	3	3	3	3	3	1	2	1	2	1	2	2	3	2	1
CO4	3	3	3	3	3	1	1	1	2	1	2	2	3	2	1
CO5	3	3	3	3	3	2	1	1	2	1	1	3	3	2	1

SEMESTER – III

MA4352	TRANSFORMS AND COMPLEX FUNCTIONS	L	T	P	C
	(Common to MECH, EEE & ECE)	3	1	0	4

Objectives

- This course is designed to cover topics such as Complex Analysis, Ordinary Differential Equations, Z- Transforms and Laplace Transform.

- To develop an understanding of the standard techniques analytic function and its mapping property.
- To familiarize the students with complex integration and contour integration techniques which can be used in real integrals.
- To acquaint the students with differential equations which are significantly used in engineering problems.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z-transform techniques for discrete time systems
- To apply Laplace transforms for solving the problems that occur in various branches of engineering disciplines.

UNIT - I	**ANALYTIC FUNCTIONS**	**9+3**
Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function – Conformal mapping – Mapping by functions w = Z + C, CZ, 1/Z - Bilinear transformation		**CO1**
UNIT - II	**COMPLEX INTEGRATION**	**9+3**
Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semi-circular contour(excluding poles on the real line)		**CO2**
UNIT – III	**ORDINARY DIFFERENTIAL EQUATIONS**	**9+3**
Higher order linear differential equations with constant coefficients - Method of variation of parameters–Homogenous equation of Euler's and Legendre's type–System of simultaneous linear differential equations with constant coefficients.		**CO3**
UNIT - IV	**Z – TRANSFORMS AND DIFFERENCE EQUATIONS**	**9+3**
Z-transforms – Elementary properties – Inverse Z-transform (using partial fraction and residues) –Initial and final value theorems – Convolution theorem – Formation of difference equations – Solution of difference equations using Z – transform.		**CO4**
UNIT - V	**LAPLACE TRANSFORMS**	**9+3**
Existence conditions – Transforms of elementary functions –Basic properties - Shifting theorems - transforms of derivatives and integrals— Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.		**CO5**
Total Periods:		**60**

Text Books:

1. Grewal B.S., Higher Engineering Mathematics, Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Kreyszig Erwin,"Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016. Strang G, Linear algebra for everyone,Wellesley Cambridge press, first edition, 2020

Reference Books:

1. G Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
2. Jain R.K. and Iyengar S.R.K., — Advanced Engineering Mathematics, Narosa Publications, New Delhi, 3rd Edition, 2007.
3. O_Neil,P.V.—Advanced Engineering Mathematics, Cengage Learning India Pvt.,Ltd, New Delhi,2007.
4. Sastry,S.S,"EngineeringMathematics",Vol.I&II,PHILearningPvt.Ltd,4thEdition, New Delhi, 2014
5. Wylie, R.C. and Barrett, L.C., "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Understand Analytic functions, conformal mapping &Bilinear transformation.
CO2	Evaluate real integration by Complex integration techniques.
CO3	Apply various techniques in solving ordinary differential equations.
CO4	Use the effective mathematical tools for the solutions of partial differential equations by using Z-transform techniques for discrete time systems.
CO5	Apply Laplace transform and inverse transform of simple functions, properties, various related theorems in solving differential equations with constant coefficients.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	2	2	2	1	1	-	-	-	-	1	2	2	3
CO2	3	3	3	2	2	2	1	-	-	-	-	1	3	3	2
CO3	3	3	3	2	3	3	2	-	-	1	1	3	3	2	2
CO4	3	1	1	1	2	1	1	1	2	2	1	-	2	1	1
CO5	3	3	3	2	2	2	1	-	-	-	-	1	2	1	1

EE4301	ELECTRIC CIRCUIT ANALYSIS	L	T	P	C
		3	1	0	4

Objectives

- To determine the response of electric circuits using basic analysis methods.
- To impart knowledge on solving circuit equations using network theorems.
- To analyse the transient behaviour of electric circuits with different types of source.
- To understand the concepts of resonance and coupled circuits.
- To compute and analyse the two-port network and its parameters.

UNIT - I	ANALYSIS OF ELECTRIC CIRCUITS	12
Mesh Analysis - Analysis with independent and dependent voltage sources, Super mesh Analysis. Node Analysis - Analysis with independent and dependent current sources, Super nodal Analysis.		CO1

UNIT - II	**NETWORK THEOREMS FOR DC AND AC CIRCUITS**	**12**
Network reduction: voltage and current division, source transformation, star delta conversion. Applications of: Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem, Reciprocity theorem.		**CO2**
UNIT - III	**TRANSIENT RESPONSE ANALYSIS**	**12**
Transient response: Natural response & Forced response of RL, RC and RLC circuits using Laplace transform for DC input and AC sinusoidal input.		**CO3**
UNIT - IV	**RESONANCE AND COUPLED CIRCUITS**	**12**
Series and parallel resonance: Variation of impedance with frequency - Variation in current through and voltage across L and C with frequency – Bandwidth - Q factor - Selectivity. Mutual coupled circuits: Self and mutual inductance – Coefficient of coupling – Dot Convention in coupled circuits.		**CO4**
UNIT - V	**TWO PORT NETWORK AND NETWORK FUNCTIONS**	**12**
Two Port Networks, terminal pairs, relationship of two port variables, impedance(Z) parameters, admittance(Y) parameters, transmission parameters (ABCD) and hybrid parameters(H), interconnections of two port networks.		**CO5**
Total Periods:		**60**

Text Books:

1. William H. Hayt Jr, Jack E. Kemmerly, Jamie D. Phillips and Steven M. Durbin, "Engineering Circuits Analysis", 9th Edition, McGraw Hill Education (India) Private Limited, 2020.
2. Charles K. Alexander, Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", Fifth Edition, McGraw Hill, 2020.

References:

1. Sudhakar. A, Shyammohan. S.P "Circuits and Networks-Analysis and Synthesis". Tata McGraw Hill publishers, 2018.
2. M. E. Van Valkenburg, "Network Analysis", Prentice Hall, 2020.
3. D. Roy Choudhury, "Networks and Systems", New Age International Publications, 2018.
4. M Nahvi I J A Edminster "Electric Circuits"; Schaum's Outline series , Tata Mcgraw Hill companies, 4th Edition, 2019.
5. David A Bell, "Electric Circuits", Oxford University Press, 2019.
6. NPTEL Video Lecture Notes on "Basic Electrical Circuits" by Prof. Nagendra Krishnapura, IIT Madras.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Able to determine the response of electric circuits using basic analysis methods and network topology
CO2	Able to compute the response of electric circuits using network theorem in real time applications.
CO3	Able to apply laplace transform techniques for solving problems and discuss the complete response of circuits.
CO4	Able to design and analyse resonance and coupled circuits.
CO5	Able to evaluate and analyse two port networks and its parameters.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	3	1	1	1	1	1	1	1	3	3	2
CO2	3	3	3	3	3	1	1	1	1	1	1	1	3	3	2
CO3	3	3	3	3	3	1	1	1	1	1	1	1	3	3	2
CO4	3	3	3	3	3	1	1	1	1	1	1	1	3	3	2
CO5	3	3	3	3	3	1	1	1	1	1	1	1	3	3	2

EE4302	ELECTRICAL MACHINES - I	L	T	P	C
		3	0	0	3

Objectives

- Working principles of electrical machines using the concepts of electro mechanical energy conversion principles and derive expressions for generated voltage and torque developed in all Electrical Machines.
- Working principles of DC machines as Generator types, determination of their no-load/load characteristics, starting methods of speed control of motors.
- Various losses taking place in D.C. Motor and to study the different testing methods to arrive at their performance.
- Constructional details, the principle of operation, prediction of performance, the methods of testing the transformers and three phase transformer connections.

UNIT – I	ELECTROMECHANICAL ENERGY CONVERSION	9
Principle of electromechanical energy conversion forces and torque in magnetic field systems- energy balance in magnetic circuits- magnetic force- co-energy in singly excited and multi excited magnetic field system -mmf of distributed windings – Winding Inductances- magnetic fields in rotating machines- magnetic saturation and leakage fluxes.		CO1

UNIT – II	DC GENERATORS	9
Principle of operation, constructional details, armature windings and its types, EMF equation, waveshape of induced emf, armature reaction, demagnetizing and cross magnetizing Ampere turns, compensating winding, commutation, methods of improving commutation, interpoles, OCC and load characteristics of different types of DC Generators. Parallel operation of DC Generators, equalizing connections- applications of DC Generators.		CO2

UNIT – III	DC MOTORS	9
Principle of operation, significance of back emf, torque equations and power developed by armature, speed control of DC motors, starting methods of DC motors, load characteristics of DC motors, losses and efficiency in DC machine, condition for maximum efficiency. Testing of DC Machines: Brake test, Swinburne's test, Hopkinson's test, Field test, Retardation test, Separation of core losses-applications of DC motors.		CO3

UNIT – IV	SINGLE PHASE TRANSFORMER	9
Construction and principle of operation, equivalent circuit, phasor diagrams, testing - polarity test, open circuit and short circuit tests, voltage regulation, losses and efficiency, all day efficiency, back-to back test, separation of core losses, parallel operation of single-phase transformers, applications of single-phase transformer.		CO4

UNIT – V	AUTO TRANSFORMER AND THREE PHASE TRANSFORMER	9
Construction and working of auto transformer, comparison with two winding transformers, applications of autotransformer. Three Phase Transformer- Construction, types of connections and their comparative features, Scott connection, applications of Scott connection.		CO5
Total Periods:		45

Text Books:

1. Fitzgerald.A.E., Charles Kingsely Jr, Stephen D. Umans, 'Electric Machinery', Sixth edition, McGraw Hill Books Company, 2003.
2. Stephen J. Chapman, 'Electric Machinery Fundamentals' 4th edition, McGraw Hill Education Pvt. Ltd, 2010.

References:

1. B.R.Gupta, 'Fundamental of Electric Machines' New age International Publishers, 3rd Edition, Reprint 2015.
2. S.K. Bhattacharya, 'Electrical Machines' McGraw - Hill Education, New Delhi, 3rd Edition, 2009.
3. Vincent Del Toro, 'Basic Electric Machines' Pearson India Education,2016.
4. Surinder Pal Bali, 'Electrical Technology Machines & Measurements, Vol.II, Pearson, 2013.
5. Nagrath.I.J. and Kothari.D.P., Electric Machines', McGraw-Hill Education, 5th Edition, 2017.
6. NPTEL Video Lecture Notes on "Electrical Machines-I" by Prof. Tapas Kumar Bhattacharya, IIT Kharagpur

Course Outcomes (CO)
Upon completion of the course, students will be

CO1	Able to understand the basics of energy conversion in electromagnetic fields.
CO2	Able to understand the construction, operating principle and performance analysis of DC generators.
CO3	Able to understand the construction and winding structure of the DC motors.
CO4	Able to understand the construction, operating principle and performance analysis of single phase transformers
CO5	Able to understand the operation and performance analysis of autotransformer, three phase transformers.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	2	2	1	1	1	1	1	1	1	2	1	1	3	2	1
CO2	3	2	1	1	1	1	1	1	1	2	1	2	3	2	1
CO3	2	2	1	1	1	1	1	1	1	1	1	2	3	2	1
CO4	2	1	1	1	1	1	1	1	1	1	1	2	3	2	1
CO5	2	2	1	1	1	1	1	1	1	1	1	2	3	2	1

EE4303	ANALOG CIRCUITS	L	T	P	C
		3	0	0	3

Objectives

- To familiarize the operation and applications of amplifiers using BJT.
- To learn the required functionality of oscillators, positive and negative feedback systems
- To understand signal analysis using Op-amp based circuits.
- To impart knowledge on applications of Op-amp
- To know about special ICs and applications.

UNIT - I	**AMPLIFIERS**	**9**
BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response- Differential amplifier – Common mode and Difference mode analysis.		**CO1**
UNIT - II	**FEEDBACK AMPLIFIERS AND OSCILLATORS**	**9**
Advantages of negative feedback – voltage / current, series, Shunt feedback –positive feedback –Condition for oscillations, phase shift – Wien bridge, Hartley, and Colpitts oscillator.		**CO2**
UNIT - III	**CHARACTERISTICS OF OPAMP**	**9**
Ideal OP-AMP characteristics, DC characteristics, AC characteristics, differential amplifier; frequency response of OP-AMP; Voltage-shunt feedback and inverting amplifier - Voltage series feedback: and Non-Inverting Amplifier - Basic applications of op-amp –, summer, differentiator and Integrator-V/I & I/V converters.		**CO3**
UNIT - IV	**APPLICATIONS OF OPAMP**	**9**
Instrumentation amplifier and its applications for transducer Bridge, Log and Antilog Amplifiers - Analog multiplier & Divider, first and second order active filters, comparators, multi vibrators, waveform generators, clippers, clampers, peak detector, S/H circuit, D/A converter (R- 2R ladder and weighted resistor types), A/D converters using OP-AMPs.		**CO4**
UNIT - V	**SPECIAL ICs AND APPLICATIONS**	**9**
Functional block, characteristics of 555 Timer and its PWM application - IC-566 voltage controlled oscillator IC - IC voltage regulators –LM78XX, LM79XX; Fixed voltage regulators its application as Linear power supply - LM317, 723 Variability voltage regulators		**CO5**
Total Periods:		**45**

Text Books:

1. David A. Bell , ”Electronic devices and circuits”, Oxford University higher education, 5th edition 2008.
2. D. Roy Choudhary, Sheil B. Jani, ‘Linear Integrated Circuits’, New Age, Fourth Edition, 2018.

References:

1. David A. Bell, ‘Op-amp & Linear ICs’, Oxford, Third Edition, 2011
2. Donald A Neamen, “Electronic Circuit Analysis and Design” Tata McGraw Hill, 3rd Edition, 2003.
3. Robert L. Boylestad, “Electronic devices and circuit theory”, 11th edition, Pearson prentice Hall 2013.
4. Fiore, “Opamps & Linear Integrated Circuits Concepts & applications”, Cengage, 2010.
5. Floyd, Buchla, “Fundamentals of Analog Circuits, Pearson, 2013.
6. NPTEL Video Lecture Notes on “Analog Electronic Circuits” by Prof. Pradip Mandal, IIT Kharagpur.

Course Outcomes (CO) Upon completion of the Course, the students will be able to	
CO1	Analyze the performance of various configurations of BJT based amplifier
CO2	Explain the operation of various feedback amplifiers and oscillators
CO3	Analyze the characteristics and basic applications (inverting/non-inverting amplifier, summer, differentiator, integrator, V/I and I/V converter) of Op-Amp
CO4	Explain circuit and applications of op-amp based instrumentation amplifier, log/antilog amplifier, analog multiplier /divider, active filters, comparators, waveform generators, A/D and D/A converters
CO5	Explain functional blocks, characteristics and applications of timer, fixed and variable voltage regulator.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	3	2	2	1	1	1	1	2	2	3	1
CO2	3	3	3	3	3	2	2	1	1	1	1	2	2	3	1
CO3	3	3	3	3	3	2	2	1	1	1	1	2	2	3	1
CO4	3	3	3	3	3	2	2	1	1	1	1	2	2	3	1
CO5	3	3	3	3	3	3	2	1	1	1	1	2	2	3	1

EE4304	DIGITAL ELECTRONICS	L	T	P	C
		3	0	0	3

Objectives

- To introduce the fundamentals of combinational and sequential digital circuits.
- To study various number systems and to simplify the mathematical expressions using Boolean functions word problems.
- To study implementation of combinational circuits using Gates` and MSI Devices.
- To study the design of various synchronous and asynchronous circuits
- To introduce digital simulation techniques for development of application oriented logic circuit.

UNIT - I	NUMBER SYSTEMS AND BOOLEAN ALGEBRA	9
Fundamentals of Number systems, error detection, corrections & codes conversions, Boolean algebra: De Morgan's theorem, switching functions and minimization using K-maps & Quine McCluskey method.		CO1

UNIT - II	COMBINATIONAL CIRCUITS	9
Combinational logic - representation of logic functions-SOP and POS forms, K-map representations- minimization using K maps - simplification and implementation of combinational logic - multiplexers and demultiplexers - code converters, adders, subtractors. Encoders and Decoders.		CO2

UNIT - III	SYNCHRONOUS SEQUENTIAL CIRCUITS	9
Sequential logic- SR, JK, D and T flip flops - level triggering and edge triggering - counters - asynchronous and synchronous type - Modulo counters - Shift registers - design of synchronous sequential circuits – Moore and Melay models- Counters, state diagram; state		CO3

reduction; state assignment.		
UNIT - IV	**ASYNCHRONOUS SEQUENTIAL CIRCUITS AND PROGRAMMABLE LOGIC DEVICES**	**9**
Asynchronous sequential logic circuits-Transition table, flow table-race conditions, hazards &errors in digital circuits; analysis of asynchronous sequential logic circuits-introduction to Programmable Logic Devices: PROM – PLA –PAL,CPLD-FPGA		**CO4**
UNIT - V	**VHDL**	**9**
RTL Design – combinational logic – Sequential circuit – Operators – Introduction to Packages –Subprograms – Test bench. (Simulation /Tutorial Examples: adders, counters, flipflops, FSM, Multiplexers /Demultiplexers).		**CO5**
Total Periods:		**45**

Text Books:

1. Morris Mano.M, 'Digital Logic and Computer Design', Prentice Hall of India, 3rdEdition, 2005.
2. Donald D. Givone, 'Digital Principles and Design', Tata McGraw Hill,1st Edition, 2003

References:

1. Thomas L Floyd, 'Digital fundamentals', Pearson Education Limited, 11th Edition, 2018
2. Tocci R.J., Neal S. Widmer, 'Digital Systems: Principles and Applications', Pearson Education Asia, 12th Edition, 2017.
3. Donald P Leach, Albert Paul Malvino, Goutam Sha, 'Digital Principles and Applications', Tata McGraw Hill, 7th Edition, 2010.
4. NPTEL Video Lecture Notes on "Digital Circuits and Systems" by Prof. S. Srinivasan, IIT Madras.

Course Outcomes (CO)
Upon completion of the Course, the students will be able to

CO1	Explain various number systems and Apply K-maps and Quine McCluskey methods to simplify the given Boolean expressions
CO2	Explain the implementation of combinational circuit such as multiplexers and de multiplexers - code converters, adders, subtractors, Encoders and Decoders
CO3	Design various synchronous and asynchronous circuits using Flip Flops
CO4	Explain asynchronous sequential circuits and programmable logic devices
CO5	Use VHDL for simulating and testing RTL, combinatorial and sequential circuits

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	3	3	3	3	2	2	1	1	1	1	2	2	3	1
CO2	3	3	3	3	3	2	2	1	1	1	1	2	2	3	1
CO3	3	3	3	3	3	2	2	1	1	1	1	2	2	3	1
CO4	3	3	3	3	3	2	2	1	1	1	1	2	2	3	1
CO5	3	3	3	3	3	3	2	1	1	1	1	2	2	3	1

PRACTICALS

EE4311	ELECTRICAL AND ELECTRONIC CIRCUITS LABORATORY	L	T	P	C
		0	0	4	2

Objectives

- To gain practical experience on verification of theorems in an electric circuit.
- To simulate various electric circuits using MATLAB for verification of theorems.
- To simulate frequency response of RLC electric circuit.
- To understand the operation and application of rectifier circuits.
- To construct application circuits like amplifiers and oscillators.

LIST OF EXPERIMENTS

1. Simulation and experimental verification of electrical circuit problems using Thevenin's theorem.
2. Simulation and experimental verification of electrical circuit problems using Norton's theorem.
3. Simulation and experimental verification of electrical circuit problems using Superposition theorem.
4. Simulation and experimental verification of Maximum Power transfer Theorem.
5. Simulation and Experimental validation of frequency response of RLC electric circuit.
6. Characteristics of Single phase half wave and full wave rectifiers with inductive and capacitive filters.
7. Frequency response of CE Amplifier.
8. Design of Oscillator - RC and LC oscillators.
9. Design of Differential amplifiers using FET
10. Measurement of frequency and phase angle using CRO.

Total Periods:	**60**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Regulated Power Supply: 0 – 15 V D.C - 8 Nos / Distributed Power Source.
2. Function Generator (1 MHz) - 8 Nos.
3. Oscilloscope (20 MHz) - 8 Nos.
4. Digital Storage Oscilloscope (20 MHz) – 1 No.
5. 10 Nos. of PC with Circuit Simulation Software (min 10 Users) (e-Sim /Scilab/ Pspice / MATLAB /other Equivalent software Package) and Printer (1 No.)
6. AC/DC - Voltmeters (10 Nos.), Ammeters (10 Nos.) and Multi-meters (10 Nos.)
7. Decade Resistance Box, Decade Inductance Box, Decade Capacitance Box - 3 Nos each.
8. Circuit Connection Boards - 10 Nos. Necessary Quantities of Resistors, Inductors, Capacitors of various capacities (Quarter Watt to 10 Watt)

Course Outcomes (CO)
Upon completion of the course, students will be

CO1	Able to identify network theorems and their application to network reduction techniques.
CO2	Able to simulate electric circuits by applying network theorems using MATLAB.
CO3	Able to measure frequency and phase angle using CRO.
CO4	Able to understand the operation and application of rectifier circuits.
CO5	Able to understand the operation of amplifier, oscillator and differential amplifier.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	2	2	2	1	1	1	1	3	1	1	1	1	3	2	1
CO2	3	2	2	1	1	1	1	3	1	2	1	2	3	2	1
CO3	2	2	1	1	1	1	1	3	1	1	1	2	3	2	1
CO4	2	1	2	2	1	1	1	3	1	1	1	2	3	2	1
CO5	2	2	2	1	1	1	1	3	1	1	1	2	3	2	1

EE4312	**ELECTRICAL MACHINES LABORATORY - I**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

Objectives

- To expose the students to determine the characteristics of DC machines and transformers by performing experiments on these machines.
- To provide hands on experience to evaluate the performance parameters of DC machines and transformer by conducting suitable tests

LIST OF EXPERIMENTS

1. Open circuit and load characteristics of DC shunt generator- calculation of critical resistance and critical speed.
2. Load characteristics of DC compound generator with differential and cumulative connections.
3. Load test on DC shunt motor.
4. Load test on DC compound motor.
5. Load test on DC series motor.
6. Swinburne's test and speed control of DC shunt motor.
7. Hopkinson's test on DC motor – generator set.
8. Load test on single-phase transformer and three phase transformers.
9. Open circuit and short circuit tests on single phase transformer.
10. Sumpner's test on single phase transformers.
11. Separation of no-load losses in single phase transformer.
12. Study of starters and 3-phase transformers connections.

Total Periods:	**60**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. DC Shunt Motor with Loading Arrangement – 3 nos
2. DC Shunt Motor Coupled with Three phase Alternator – 1 No.
3. Single Phase Transformer – 4 nos
4. DC Series Motor with Loading Arrangement – 1 No.
5. DC compound Motor with Loading Arrangement – 1 No.
6. DC Shunt Motor Coupled With DC Compound Generator – 2 nos
7. DC Shunt Motor Coupled With DC Shunt Motor – 1 No.
8. Tachometer -Digital/Analog – 8 nos
9. Single Phase Auto Transformer – 2 nos
10. Three Phase Auto Transformer – 1 No.
11. Single Phase Resistive Loading Bank – 2 nos
12. Three Phase Resistive Loading Bank – 2 Nos.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Understand the procedure to conduct direct test on DC machines and able to find its performance characteristics.
CO2	Understand the procedure to conduct indirect test on DC machines and able to find its performance characteristics.
CO3	Understand the procedure to conduct direct test on transformer and to find its performance characteristics.
CO4	Understand the procedure to conduct indirect test on transformer and able to find its performance characteristics.
CO5	Understand the procedure to conduct speed control of a DC motor and able to find its performance characteristics.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	2	2	1	1	1	1	1	3	1	1	1	1	3	2	1
CO2	3	2	1	1	1	1	1	3	1	2	1	2	3	2	1
CO3	2	2	1	1	1	1	1	3	1	1	1	2	3	2	1
CO4	2	1	1	1	1	1	1	3	1	1	1	2	3	2	1
CO5	2	2	1	1	1	1	1	3	1	1	1	2	3	2	1

EE4313	LINEAR AND DIGITAL CIRCUITS LABORATORY	L	T	P	C
		0	0	4	2

Objectives

- To learn design, testing and characterizing of circuit behavior with combinational logic gate ICs.
- To learn design, testing and characterizing of circuit behavior with register/ counter and sequential logic ICs.
- To learn design, testing and characterizing of circuit behavior with OP AMP ICs.
- To learn design, testing and characterizing of circuit behavior with analog Ics like 555 timer VCO and regulators.
- To learn design, testing and characterizing of circuit behavior with digital Ics like decoders, multiplexers.

LIST OF EXPERIMENTS

1. Implementation of Boolean Functions, Adder/ Subtractor circuits.
2. Code converters: Excess-3 to BCD and Binary to Gray code converter and vice-versa
3. Encoders and Decoders
4. Counters: Design and implementation of 3-bit modulo counters as synchronous and Asynchronous types using FF IC's and specific counter IC.
5. Shift Registers: Design and implementation of 4-bit shift registers in SISO, SIPO, PISO, PIPO modes using suitable IC's
6. Implementation of multiplexer and demultiplexer.
7. Applications of Op-Amp: Inverting, non-inverting amplifier.
8. IC 555 Timer applications – Astable and Monostable operation.
9. Design of Linear Voltage regulator.
10. Design of Integrator, Differentiator, Clipper and Clamper.

Total Periods:	**60**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Dual (0-30V) variability Power Supply- 10 Nos
2. CRO-10 Nos-30MHz
3. Function Generator – 10 Nos- 1 MHz
4. Digital Multimeter -10 Nos
5. IC Tester (Analog)- 2 Nos
6. Bread board – 10 Nos
7. Digital Trainer Kit

Consumables Sufficient Quantity

1. IC 741/ IC NE555

2. Digital IC types
3. LM317
4. Diodes - IN4001, BY126
5. DIB, DCB
6. Capacitor
7. Resistors 1/4 Watt Assorted
8. Single Strand Wire
9. Potentiometer 10K
10. Step Down Transformer - 230V to 12V

Course Outcomes (CO)
At the end of the course, the student should have the:

CO1	Ability to understand and implement Boolean Functions.
CO2	Ability to understand the importance of code conversion.
CO3	Ability to Design and implement circuits with digital ICs like decoders, multiplexers, register.
CO4	Ability to acquire knowledge on Application of Op-Amp.
CO5	Ability to Design and implement counters using analog ICs like timers, VCOs and digital ICs like Flip-flops and counters.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	-	-	-	3	-	-	-	-	-	-	3	-	2	1	1
CO2	-	-	3	3	-	-	-	-	-	-	3	-	2	1	1
CO3	-	3	2	3	3	-	-	-	-	-	3	-	2	1	1
CO4	-	3	3	3	3	-	-	-	-	-	3	-	2	1	1
CO5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

SEMESTER – IV

MA4401	PROBABILITY AND STATISTICS	L	P	T	C
		3	1	0	4

Objectives

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two dimensional random variables.
- To provide necessary basic concepts of probability and random processes for applications in engineering.
- To introduce the basic concepts and important roles in the statistical quality control.

UNIT – I	**PROBABILITY AND RANDOM VARIABLES**	**9+3**
Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.		**CO1**
UNIT – II	**TWO - DIMENSIONAL RANDOM VARIABLES**	**9+3**
Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables.		**CO2**
UNIT – III	**RANDOM PROCESSES**	**9+3**
Classification – Stationary process – Markov process – Poisson process – Discrete parameter Markov chain – Chapman Kolmogorov equations (Statement only) – Limiting distributions.		**CO3**
UNIT – IV	**NON-PARAMETRIC TESTS**	**9+3**
Introduction – The Sign test – The Signed – Rank test – Rank – sum tests – The U test – The H test – Tests based on Runs – Test of randomness – The Kolmogorov Test.		**CO4**
UNIT – V	**STATISTICAL QUALITY CONTROL**	**9+3**
Control charts for measurements (X and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.		**CO5**
Total Periods:		**60**

Text Books:

1. Johnson, R.A., Miller, I and Freund J., "Miller and Freund‘s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata McGraw Hill, 4th Edition, 2007.
3. Ibe, O.C., “Fundamentals of Applied Probability and Random Processes", Elsevier,1st Indian Reprint, 2007

Reference Books:

1. Devore. J.L., "Probability and Statistics for Engineering and the Sciences‖, Cengage Learning, New Delhi, 8th Edition, 2014.
2. Hsu, "Schaum’s Outline of Theory and Problems of Probability, Random Variables and Random Processes", Tata McGraw Hill Edition, New Delhi, 2004.
3. Papoulis, A. and Unnikrishnapillai, S., "Probability, Random Variables and Stochastic Processes", McGraw Hill Education India, 4th Edition, New Delhi, 2010.
4. Ross, S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 3rd Edition, Elsevier, 2004.
5. Spiegel. M.R., Schiller. J. and Srinivasan, R.A., "Schaum‘s Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 2004.
6. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th Edition, 2007.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.

CO2	Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
CO3	Apply the concept of random processes in engineering disciplines
CO4	Apply the basic concepts of statistical quality control.
CO5	Have the notion of sampling distributions and statistical techniques used in engineering and management problems.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	-	-	-	-	-	2	3	-	1	3	1	1
CO2	3	2	2	-	-	-	-	-	1	2	-	1	3	2	1
CO3	3	3	3	-	-	-	-	-	2	2	-	1	3	2	2
CO4	3	2	2	-	-	-	-	-	2	1	-	2	2	2	1
CO5	3	3	2	-	-	-	-	-	2	2	-	2	3	1	2

EE4401	ELECTRICAL MACHINES - II	L	T	P	C
		2	1	0	3

Objectives

To impart knowledge on the following topics

- Construction and performance of salient and non–salient type synchronous generators.
- Principle of operation and performance of synchronous motor.
- Construction, principle of operation and performance of induction machines.
- Starting and speed control of three-phase induction motors.
- Construction, principle of operation and Performance of single phase induction motors and special machines.

UNIT – I	SYNCHRONOUS GENERATOR	9
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 methods. Steady state power - angle characteristics. Two reaction theory – slip test- short circuit transients –Capability Curves		CO1

UNIT – II	SYNCHRONOUS MOTOR	9
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.		CO2

UNIT – III	THREE PHASE INDUCTION MOTOR	9
Constructional details: Types of rotors-Principle of operation - Slip–cogging and crawling - Equivalent circuit - Torque-Slip characteristics - Condition for maximum torque. Losses and		CO3

efficiency. Load test - No load and blocked rotor tests - Circle diagram –Separation of losses. Double cage induction motors. Induction generators. Synchronous induction motor.		
UNIT – IV	**STARTING AND SPEED CONTROL OF THREE PHASE INDUCTION MOTOR**	**9**
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.		**CO4**
UNIT – V	**SINGLE PHASE INDUCTION MOTORS**	**9**
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.		**CO5**
Total Periods:		**45**

Text Books:

1. Fitzgerald. A.E., Charles KingselyJr, Stephen D.Umans, 'Electric Machinery', Sixth edition, McGraw Hill Books Company, 2003.
2. Nagrath, I.J. and Kothari.D.P., Electric Machines', McGraw-Hill Education, 2004

References:

1. Stephen J. Chapman, 'Electric Machinery Fundamentals'4th edition, McGraw Hill Education Pvt. Ltd, 2010.
2. B.L.Theraja and A.K.Theraja, 'A Textbook of Electrical Technology Vol II AC and DC Machines.
3. B.R. Gupta, 'Fundamental of Electric Machines' New Age International Publishers,3rdEdition, Reprint 2015.
4. S.K. Bhattacharya, 'Electrical Machines' McGraw - Hill Education, New Delhi, 3rd Edition, 2009
5. Bimbhra P S, "Electrical Machinery", Khanna Publishers, New Delhi, 2011
6. NPTEL Video Lecture Notes on "Electrical Machines" by Prof. Tapas Kumar Bhattacharya, IIT Kharagpur.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Draw the constructional details and explain the performance of salient and non – salient type synchronous generators.
CO2	Draw and explain the Principle of operation and performance of synchronous motor.
CO3	Draw and describe the construction, principle of operation and performance of three phase induction machines.
CO4	Describe the starting and speed control of three-phase induction motors.
CO5	Explain the construction, principle of operation and performance of single phase induction motors and special machines.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**

CO1	2	2	1	1	1	1	1	1	1	2	1	1	3	2	2
CO2	3	2	1	1	1	1	1	1	1	2	1	2	3	2	2
CO3	2	2	1	1	1	1	1	1	1	1	1	2	3	2	2
CO4	2	1	1	1	1	1	1	1	1	1	1	2	3	2	2
CO5	2	2	1	1	1	1	1	1	1	1	1	2	3	2	2

EE4402	**CONTROL SYSTEMS**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

Objectives

- To understand the use of transfer function models for analysis physical systems and introduce the control system components.
- To provide adequate knowledge in the time response of systems and steady state error analysis.
- To accord basic knowledge in obtaining the open loop and closed–loop frequency responses of systems.
- To introduce stability analysis and design of compensators
- To introduce state variable representation of physical systems

UNIT – I	**SYSTEMS AND REPRESENTATION**	**9**
Basic elements in control systems: Open and closed loop systems – Electrical analogy of mechanical and thermal systems – Transfer function – AC and DC servomotors – Block diagram reduction techniques – Signal flow graphs.		**CO1**

UNIT – II	**TIME RESPONSE**	**9**
Time response: Time domain specifications – Types of test input – I and II order system response – Error coefficients – Generalized error series – Steady state error – Root locus construction- Effects of P, PI, PID modes of feedback control –Time response analysis.		**CO2**

UNIT – III	**FREQUENCY RESPONSE**	**9**
Frequency response: Bode plot – Polar plot – Determination of closed loop response from open loop response - Correlation between frequency domain and time domain specifications		**CO3**

UNIT – IV	**STABILITY AND COMPENSATOR DESIGN**	**9**
Characteristics equation – Routh Hurwitz criterion – Nyquist stability criterion - Performance criteria – Effect of Lag, lead and lag-lead compensation on frequency response - Design of Lag, lead and lag- lead compensator using bode plots.		**CO4**

UNIT – V	**STATE VARIABLE ANALYSIS**	**9**
Concept of state variables – State models for linear and time invariant systems – Solution of state and output equation in controllable canonical form – Concepts of controllability and observability.		**CO5**

Total Periods:	**45**

Text Books:

1. Nagarath, I.J. and Gopal, M., "Control Systems Engineering", New Age International Publishers, 2017.
2. Katsuhiko Ogata, "Modern Control Engineering", Pearson, 2015.

References:

1. Richard C. Dorf and Bishop, R.H., "Modern Control Systems", Pearson Education,2009.
2. John J.D., Azzo Constantine, H. and Houpis Sttuart, N Sheldon, "Linear Control System Analysis and Design with MATLAB", CRC Taylor& Francis Reprint2009.
3. Benjamin C. Kuo, "Automatic Control Systems", Wiley,2014.
4. M.Gopal, "Control System: Principle and design", McGraw Hill Education,2012.
5. NPTEL Video Lecture Notes on "Control Engineering "by Prof. S. D. Agashe, IIT Bombay.

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Ability to develop various representations of system and to reduce the complex systems into simpler system in transfer function.
CO2	Ability to do time domain analysis of various models of linear system and understand the use of controllers in closed loop system
CO3	Ability to do frequency domain analysis of various models of linear system
CO4	Infer the stability of systems and ability to design appropriate compensator for the given specifications
CO5	Ability to represent the system in state variable forms.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	3	2	2	1	2	2	3	2	3	3	1
CO2	3	3	3	3	3	2	2	1	2	2	3	2	3	3	1
CO3	3	3	3	3	3	2	2	1	2	2	3	2	3	3	1
CO4	3	3	3	3	3	2	2	1	2	2	3	2	3	3	1
CO5	3	3	3	3	3	2	2	1	2	2	3	2	3	3	1

EE4403	MEASUREMENTS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES

- To educate the fundamental concepts and characteristics of measurement and errors.
- To impart the knowledge on the functional aspects of measuring instruments.
- To infer the importance of various bridge circuits used with measuring instruments.
- To educate the fundamental working of sensors and transducers and their applications.
- To impart the knowledge on fundamentals of digital instrumentation.

UNIT - I	CONCEPTS OF MEASUREMENTS	9
Instruments: classification, applications – Elements of a generalized measurement system - Static and dynamic characteristics - Errors in measurement -Statistical evaluation of measurement data - Instrument standards.		CO1
UNIT - II	**MEASUREMENT OF PARAMETERS IN ELECTRICAL SYSTEMS**	**9**
Classification of instruments – moving coil and moving iron meters – Induction type, dynamometer type watt meters – Energy meter – Megger – Instrument transformers (CT & PT) – Frequency Meter (Resonance Type)		CO2
UNIT - III	**AC/DC BRIDGES AND INSTRUMENTATION AMPLIFIERS**	**9**

Wheatstone bridge, Kelvin double bridge - Maxwell, Hay, Wien and Schering bridges – Errors and compensation in A.C. bridges - Instrumentation Amplifiers.		**CO3**
UNIT - IV	**TRANSDUCERS FOR MEASUREMENT OF NON - ELECTRICAL PARAMETERS**	**9**
Classification of transducers – Measurement of pressure, temperature, displacement, flow, angular velocity – Digital transducers – Smart Sensors.		**CO4**
UNIT - V	**DIGITAL INSTRUMENTATION**	**9**
A/D converters: types and characteristics – Digital multimeter – Digital Frequency - D/A converters: types and characteristics- DSO- Data Loggers		**CO5**
Total Periods:		**45**

Text Books:

1. A.K. Sawhney, 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.
2. Doebelin E.O. and Manik D.N., Measurement Systems – Applications and Design, Special Indian Edition, McGraw Hill Education Pvt. Ltd., Reprint 2019.

References:

1. H.S. Kalsi, 'Electronic Instrumentation', McGraw Hill, III Edition 2017.
2. D.V.S. Murthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2015.
3. David Bell, 'Electronic Instrumentation & Measurements', Oxford University Press,2013.
4. J. B. Gupta, 'A Course in Electronic and Electrical Measurements', S. K. Kataria& Sons, Delhi, 2013.
5. NPTEL Video Lecture Notes on "Electrical Measurement and Electronic Instruments" by Prof. Avishek Chatterjee, IIT Kharagpur.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Acquire knowledge about measurement and basic functional elements of instrumentation.
CO2	Understand the concepts of fundamentals of electrical and electronic measuring instruments.
CO3	Understand the concept of measurement by comparison or balance of parameters.
CO4	Acquire knowledge on various storage and display devices to represent measured data.
CO5	Understand the concepts various transducers and the data acquisition systems.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	2	2	3	3	2	1	1	1	1	1	1	1	2	2	1
CO2	2	2	3	3	2	1	2	1	1	1	1	1	2	2	2
CO3	2	2	2	3	2	1	2	1	1	1	1	1	2	2	2
CO4	2	2	2	3	2	1	1	1	1	1	1	1	2	2	2
CO5	2	2	2	3	2	1	1	1	1	1	1	1	2	2	2

EE4404	MICROPROCESSORS AND MICROCONTROLLERS	L	T	P	C
		3	0	0	3

Objectives

- To study the addressing modes & instruction set of 8085.
- To develop skills in simple program writing in assembly languages
- To introduce commonly used peripheral/interfacing ICs.

- To study and understand typical applications of micro-processors.
- To study and understand the typical applications of micro-controllers.

UNIT - I	**INTRODUCTION TO 8085 ARCHITECTURE**	**9**
Functional block diagram – Memory interfacing–I/O ports and data transfer concepts – Timing Diagram – Interrupt structure		**CO1**
UNIT - II	**8085 INSTRUCTION SET AND PROGRAMMING**	**9**
Instruction format and addressing modes – Assembly language format – Data transfer, data manipulation & control instructions – Programming: Loop structure with counting & Indexing - Look up table - Subroutine instructions, stack.		**CO2**
UNIT – III	**INTERFACING BASICS AND ICS**	**9**
Study of Architecture and programming of ICs: 8255 PPI, 8259PIC, 8251USART, 8279 Keyboard display controller and 8254 Timer/Counter – Interfacing with 8085 -A/D and D/A converter interfacing.		**CO3**
UNIT - IV	**INTRODUCTION TO ARM PROCESSOR**	**9**
Architecture – ARM programmer's model –ARM Development tools- Memory Hierarchy – ARM Assembly Language Programming–Simple Examples–Architectural Support for Operating systems.		**CO4**
UNIT - V	**INTRODUCTION TO RISC BASED ARCHITECTURE**	**9**
PIC 16/18 architecture, Memory organization – Addressing modes – Instruction set - Programming techniques – Timers – I/O ports – Interrupts.		**CO5**
Total Periods:		**45**

Text Books:

1. Ramesh S. Gaonkar, 'Microprocessor Architecture Programming and Application', Penram International (P) ltd., Mumbai, 6th Education, 2013
2. Muhammad Ali Mazidi & Janice Gilli Mazidi, 'The PIC Micro Controller and Embedded Systems', 2010
3. Furber,S., "ARM System on Chip Architecture" Addison Wesley trade Computer Publication, 2000.

References:

1. Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition, Prentice Hall of India, New Delhi, 2nd edition, 2013.
2. Soumitra Kumar Mandal, Microprocessor & Microcontroller Architecture, Programming & Interfacing using 8085,8086,8051,McGraw Hill Edu,2013.
3. Douglas V. Hall, 'Microprocessor and Interfacing', McGraw Hill Edu, 2016.
4. NPTEL Video Lecture Notes on "Microprocessors and Microcontrollers "by Prof. Santanu Chattopadhyay, IIT Kharagpur

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Ability to explain the architecture of Microprocessor, Ability to need & use of Interrupt structure 8085
CO2	Ability to acquire knowledge in Addressing modes & instruction set of 8085, Ability to write the assembly language program.
CO3	Ability to understand the importance of Interfacing
CO4	Ability to explain the architecture of ARM processor.

CO5	Ability to understand and appreciate advanced architecture evolving microprocessor field

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	2	1	1	1	1	2	1	1	1	1	3	2	1
CO2	3	3	2	1	3	3	1	2	1	1	3	1	3	3	1
CO3	3	2	2	1	1	1	1	2	1	1	1	1	3	3	1
CO4	3	2	2	1	1	2	1	2	1	1	1	1	3	3	1
CO5	3	3	3	3	3	3	1	2	1	1	3	1	3	2	1

EE4405	GENERATION, TRANSMISSION AND DISTRIBUTION	L	T	P	C
		3	0	0	3

Objectives

- To impart knowledge about the different energy sources of power and Generation
- To study the line parameters and interference with neighbouring circuits
- To analyze and model different components of power system
- To learn different insulators and underground cables
- To compute sag and conductor length for different weather conditions.
- To study the distribution systems and grounding

UNIT - I	ELECTRICAL POWER GENERATION	9
Conventional and nonconventional energy sources – comparison - Generation of electrical energy - Selection of sight – hydroelectric – thermal and nuclear power plants - Detailed layout - explanation and comparison of hydro electric ,thermal and nuclear power plants		CO1
UNIT - II	**TRANSMISSION LINE PARAMETERS**	**9**
Structure of electric power system - Parameters of single and three phase transmission lines with single and double circuits -Resistance, inductance, and capacitance of solid, stranded, and bundled conductors - Typical configuration, conductor types - Symmetrical and unsymmetrical spacing and transposition – application of self and mutual GMD; skin and proximity effects - Effects of earth on the capacitance of the transmission line		CO2
UNIT - III	**MODELLING AND PERFORMANCE OF TRANSMISSION LINES**	**9**
Performance of Transmission lines – short line, medium line and long line – equivalent circuits, phasor diagram, attenuation constant, phase constant, surge impedance – transmission efficiency and voltage regulation, real and reactive power flow in lines – Ferranti effect – Formation of Corona – Critical Voltages		CO3
UNIT - IV	**MECHANICAL DESIGN OF OH LINES, UNDER GROUND CABLES**	**9**
Mechanical design of overhead lines – Line Supports – Tension and Sag Calculation – Insulators: Types, voltage distribution in insulator string - Underground cables – Types of cables – Construction of single core cable – Insulation Resistance –Capacitance –Dielectric stress of Single-core cable – Grading of cables(Qualitative treatment only).		CO4
UNIT - V	**DISTRIBUTION SYSTEMS**	**9**

Distribution Systems – General Aspects – Kelvin's Law – AC and DC distributions – Concentrated and Distributed loading - Methods of grounding -Techniques of Voltage Control and Power factor improvement	**CO5**
Total Periods:	**45**

Text Books:

1. D.P.Kothari, I.J. Nagarath, 'Power System Engineering', McGraw-Hill Publishing Company limited, New Delhi, Third Edition, 2019.
2. S.N. Singh, 'Electric Power Generation, Transmission and Distribution', Prentice Hall of India Pvt. Ltd, New Delhi, Second Edition, 2008.

References:

1. B.R.Gupta, 'Power System Analysis and Design' S. Chand, New Delhi, Sixth Edition, 2011.
2. Luces M.Fualken berry, Walter Coffer, 'Electrical Power Distribution and Transmission', Pearson Education, 2007.
3. Arun Ingole, "Power transmission and distribution" Pearson Education, first edition, 2018
4. C.L.Wadhwa, 'Electrical Power Systems', New Academic Science Ltd, seventh edition 2018.
5. V.K.Mehta, Rohit Mehta, 'Principles of power system', S. Chand & Company Ltd, New Delhi, 2013
6. NPTEL Video Lecture Notes on "Power System Generation, Transmission and Distribution" by Prof. D.P. Kothari, IIT Delhi.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Explore the different types of energy sources and its generation layout
CO2	Understand the structure of electric power system and to solve the expressions for transmission line parameters.
CO3	Obtain the equivalent circuit based on distance and operating voltage for determining voltage regulation and efficiency and also to know the methods of improvement of voltage profile along with real and reactive power flow in transmission lines with the help of power circle diagrams.
CO4	Develop the mechanical design of transmission lines with sag and tension calculation for different weather conditions. Know the types of insulator and cables and to analyze the voltage distribution and grading of cables.
CO5	Explore about distribution systems, Grounding

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	2	2	1	1	1	1	1	1	1	1	1	3	1	2
CO2	3	2	2	2	1	1	1	1	1	1	1	1	3	1	2
CO3	3	2	3	2	1	1	1	1	1	1	1	1	3	1	2
CO4	3	2	3	2	1	1	1	1	1	1	1	1	3	1	2
CO5	3	2	3	2	1	1	1	1	2	2	1	1	3	1	3

PRACTICALS

EE4411	ELECTRICAL MACHINES LABORATORY - II	L	T	P	C
		0	0	4	2

Objectives

- To expose the students to the operation of synchronous machines and induction motors and give them experimental skill.

LIST OF EXPERIMENTS

1. Regulation of three phase alternator by EMF and MMF methods.
2. Regulation of three phase alternator by ZPF and ASA methods.
3. Regulation of three phase salient pole alternator by slip test.
4. Measurements of negative sequence and zero sequence impedance of alternators.
5. V and Inverted V curves of Three Phase Synchronous Motor.
6. Load test on three-phase induction motor.
7. No load and blocked rotor tests on three-phase induction motor (Determination of equivalent circuit parameters).
8. Separation of No-load losses of three-phase induction motor.
9. Load test on single-phase induction motor.
10. No load and blocked rotor test on single-phase induction motor.
11. Study of Induction Motor Starters

Total Periods:	**60**

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

1. Synchronous motor 3HP – 1 No.
2. DC Shunt motor Coupled with Three phase Alternator – 4 Nos.
3. DC Shunt motor Coupled with Three phase Slip Ring Induction motor – 1 No.
4. Three phase Induction motor with Loading arrangement – 2 Nos.
5. Single phase Induction motor with Loading arrangement – 2 Nos.
6. Tachometer – Digital/Analog – 8 Nos.
7. Single Phase Auto Transformer – 2 Nos.
8. Three Phase Auto Transformer – 2 Nos.
9. Single Phase Resistive Loading bank - 2 Nos.
10. Three Phase Resistive Loading bank - 2 Nos.
11. Capacitor Bank – 1 No.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Understand the procedure to conduct EMF, MMF, ZPF and ASA test on AC generator and able to find its performance characteristics.
CO2	Understand the procedure to conduct direct test on AC generator and able to find its performance characteristics.
CO3	Understand the procedure to conduct direct test on induction machines and able to find its performance characteristics.
CO4	Understand the procedure to conduct indirect test on induction machines and able to find its performance characteristics.
CO5	Understand the procedure to conduct no load test on synchronous motor and able to plot its excitation characteristics.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	2	2	1	1	1	1	1	3	1	1	1	1	3	2	1
CO2	3	2	1	1	1	1	1	3	1	2	1	2	3	2	1
CO3	2	2	1	1	1	1	1	3	1	1	1	2	3	2	1
CO4	2	1	1	1	1	1	1	3	1	1	1	2	3	2	1

CO5	2	2	1	1	1	1	1	3	1	1	1	2	3	2	1	

EE4412	**MICROPROCESSORS AND MICROCONTROLLERS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

Objectives

- To perform simple arithmetic operations using assembly language program and study the addressing modes & instruction set of 8085
- To develop skills in simple program writing in assembly languages
- To write an assembly language program to convert Analog input to Digital output and Digital input to Analog output.
- To perform interfacing experiments with µP8085

LIST OF EXPERIMENTS

PROGRAMMING EXERCISES / EXPERIMENTS WITH µP8085:

1. Simple arithmetic operations: addition / subtraction / multiplication / division.
2. Programming with control instructions:
   (i) Ascending / Descending order, Maximum / Minimum of numbers
   (ii) Programs using Rotate instructions
   (iii) Hex / ASCII / BCD code conversions.
3. Interfacing using A/D converter
4. Interfacing using D/A converter
5. Traffic light controller.
6. I/O Port / Serial communication
7. Programming Practices with Simulators/Emulators/open source
8. Read a key, interface display
9. Application hardware development with processors
10. Study of ARM processor.

Total Periods:	**60**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No	Description of Equipment	Quantity required
1	8085 Microprocessor Trainer with Power Supply	15
2	8251 Interface boards	5
3	8279 Keyboard / Display Interface boards	5
4	ADC and DAC cards	5
5	Traffic Light Control Systems	5

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Ability to perform basic programming using 8085
CO2	Ability to perform interfacing of various peripheral ICs using 8085
CO3	Ability to program basic interfacing applications.
CO4	Ability to use basic Simulators/Emulators/open source related to 8085.
CO5	Ability to design and develop a simple application using ARM processor.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	2	1	1	1	1	1	1	1	1	1	3	2	2	1

CO2	3	2	2	2	2	2	2	1	1	1	1	3	2	3	1
CO3	3	2	3	2	2	1	2	1	1	1	1	3	2	3	1
CO4	3	2	2	2	3	2	1	1	1	1	1	3	2	3	1
CO5	3	2	3	3	3	3	3	3	3	3	3	3	3	3	1

HS4310	**PROFESSIONAL SKILLS LAB**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

Objectives

- Enhance the employability and career skills of students
- Orient the students towards grooming as a professional
- Make them employable graduates
- Develop their confidence and help them attend interviews successfully

LIST OF EXPERIMENTS

UNIT 1

Introduction to soft skills-Hard skills & Soft skills-employability and career skills-grooming as a professional with values-making an oral presentation-planning and preparing a model presentation – organizing the presentation to suit the audience and context; connecting with the audience with the presentation; projecting a positive image while speaking; emphasis on effective body language – general awareness of current affairs.

UNIT 2

Self-Introduction – organizing the material – introducing oneself to the audience introducing the topic answering questions individual presentation practice – making a power point presentation – structure and format; covering elements of an effective presentation; body language dynamics–making an oral presentation-planning and preparing a model presentation – organizing the presentation to suit the audience and context; connecting with the audience with the presentation; projecting a positive image while speaking;emphasis on effective body language

UNIT 3

Introduction to group discussion – participating in group discussions – understanding group dynamics – brain storming the topic – questioning and clarifying – GD strategies – structure and dynamics of a GD; techniques of effective presentation in group discussion; preparing for group discussion; accepting others views /ideas; arguing against others views or ideas etc.

UNIT 4

Basics of public speaking; preparing for a speech;features of a good speech;speaking with a microphone.(Famous speeches maybe played as model speeches for learning the art of public speaking). Interview etiquette-dress code-body language-attending interviews-telephone/skype interview-one to

one & a panel interview job interviews purpose and process;how to prepare for an interview;language and style to be used in an interview types of interview questions and how to answer them.

UNIT 5

Recognizing differences between groups and teams- managing time- managing stress- networking professionally- respecting social protocols- understanding career management- developing a long-term career plan making career change.

Total Periods:	**30**

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

One Server

30 Desktop Computers

One Hand Mike

One LCD Projector

TEXT BOOKS

1. Butterfield, Jeff Soft Skills for Everyone. Cengage Learning: New Delhi,2015
2. E. Suresh Kumar et al, Communication for Professional Success. Orient Blackswan: Hyderabad, 2015
3. Raman, Meenakshi and Sangeetha Sharma. Professional Communication. Oxford University Press: Oxford 2014
4. S. Hariharan et al. Soft Skills. MJP Publishers: Chennai, 2010
5. Interact English Lab Manual for Undergraduate Students, Orient BlackSwan: Hyderabad, 2016.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Develop adequate Soft Skills required for the workplace,
CO2	Make effective presentations
CO3	Participate confidently in Group discussions
CO4	Attend job interviews and be successful in them
CO5	Hone their communications skills for their career

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	-	2	-	2	1	-	-	-	2	3	-	-	1	2	2
CO2	-	2	-	2	-	-	-	-	2	3	-	-	1	2	2
CO3	-	-	-	-	-	-	-	-	2	2	-	-	1	1	2
CO4	-	-	-	-	-	-	-	-	2	2	-	2	3	3	3

	CO5	-	2	1	1	2	-	2	-	2	3	-	2	3	3	3	

SEMESTER – V

CS4505	**FUNDAMENTALS OF DATA STRUCTURES USING C**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Objectives					

- To learn the basics of C programming language.
- To learn the concepts of advanced features of C Programming language.
- To explore the applications of linear and non-linear data structures.
- To learn to represent data using graph data structure.
- To learn the basic sorting and searching algorithms.

UNIT - I	**C PROGRAMMING BASICS**	**9**
Structure of a C program – Constants, Variables – Data Types – Expressions using operators in C – Managing Input and Output operations – Looping statements. Arrays – Initialization – Declaration –Single and Multi-Dimensional arrays. Strings- String operations.		**CO1**
UNIT - II	**FUNCTIONS, POINTERS, STRUCTURES AND UNIONS**	**9**
Functions – Pass by value – Pass by reference – Recursion – Pointers - Definition – Initialization – Pointers arithmetic. Structures and unions - definition – Structure within a structure - Union - File Handling, Pre-processor directives.		**CO2**
UNIT - III	**LINEAR DATA STRUCTURES**	**9**
Abstract Data Types (ADTs) – List ADT - Stacks and Queues – Linked lists – Linked list-based implementation of Stacks and Queue – Applications of Stack and Queue.		**CO3**
UNIT - IV	**NON-LINEAR DATA STRUCTURES**	**9**
Trees – Binary Trees – Binary tree representation and traversals –Binary Search Trees – Application of Trees.		**CO4**
UNIT - V	**SEARCHING AND SORTING ALGORITHMS**	**9**
Linear Search – Binary Search. Bubble Sort, Insertion sort – Merge sort – Quick sort – Calculating Complexity. Hash tables – Overflow handling.		**CO5**
Total Periods:		**45**

Text Books:

1. Reema Thareja,"Programming in C",Second Edition,Oxford University Press,2016.
2. Mark Allen Weiss, ―Data Structures and Algorithm Analysis in C, Second Edition, Pearson Education, 1997.

References:

1. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, ―Data Structures and Algorithms, Pearson Education, 1983.
2. Robert Kruse, C.L.Tondo, Bruce Leung, Shashi Mogalla , ― Data Structures and Program Design in C, Second Edition, Pearson Education, 2007.
3. Jean-Paul Tremblay and Paul G. Sorenson, ―An Introduction to Data Structures with Applications, Second Edition, Tata McGraw-Hill, 1991.

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	To learn the basics of C programming language.
CO2	To learn the concepts of advanced features of C Programming language.
CO3	To explore the applications of linear and non-linear data structures.
CO4	To learn to represent data using graph data structure.
CO5	To learn the basic sorting and searching algorithms

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	C	d	e	f	g	h	i	j	k	l	1	2	3
CO1	2	2	1	1	0	1	0	0	2	1	1	2	2	2	1
CO2	3	3	3	1	0	0	0	1	1	1	1	2	2	2	1
CO3	2	3	3	2	1	1	1	0	2	1	2	2	2	2	2
CO4	2	3	3	3	0	1	0	1	1	1	2	2	2	2	2
CO5	3	3	3	2	1	1	1	0	2	1	2	2	3	2	2

EE4501	POWER ELECTRONICS	L	T	P	C
		3	0	0	3

Objectives

- To impart knowledge on different types of power semiconductor devices and their switching characteristics.
- To understand the operation, characteristics and performance parameters of uncontrolled and controlled rectifiers.
- To learn the Operation, switching techniques and basics topologies of DC-DC switching regulators.
- To Compute and analyse the different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
- To understand the operation of AC to AC converter.

UNIT - I	POWER SEMI-CONDUCTOR DEVICES	9
Study of switching devices - SCR, TRIAC, GTO, BJT, MOSFET, IGBT and IGCT. Static characteristics: SCR, MOSFET and IGBT. Triggering and commutation circuit for SCR. Introduction to Driver and snubber circuits.		CO1

UNIT - II	PHASE-CONTROLLED CONVERTERS	9
Controlled converters: 2-pulse, 3-pulse and 6-pulse converters – performance parameters. Effect of source inductance. Dual converters. Applications-light dimmer, Excitation system.		CO2

UNIT - III	DC TO DC CONVERTERS	9
Step-down and step-up chopper: control strategy. Introduction to types of choppers: A, B, C, D and E -Switched mode regulators- Buck, Boost, Buck- Boost regulator. Introduction to Resonant Converters. Applications-Battery operated vehicles and Solar PV systems.		CO3

UNIT - IV	INVERTERS	9
Single phase and three phase voltage source inverters (both120^0 mode and 180^0 mode): Voltage& harmonic control- PWM techniques: Multiple PWM, Sinusoidal PWM, modified sinusoidal PWM. Introduction to space vector modulation. Current source inverter - Applications-Induction heating, UPS.		CO4

UNIT - V	AC TO AC CONVERTERS	9
Single phase and Three phase AC voltage controllers: Control strategy- Power Factor Control – Multistage sequence control. -single phase and three phase cyclo-converters. Introduction to Matrix converters. Applications – Welding.		CO5

Total Periods:	**45**

Text Books:

1. M.H. Rashid, 'Power Electronics: Circuits, Devices and Applications', Pearson Education, third Edition, New Delhi, 2019.
2. Ned Mohan, Tore M. Undeland, William. P. Robbins, 'Power Electronics: Converters, Applications and Design, Wiley, Third edition, 2007

References:

1. Joseph Vithayathil,' Power Electronics, Principles and Applications', McGraw Hill Series, 6th Reprint, 2019.
2. Philip T. Krein, "Elements of Power Electronics" Oxford University Press, 2019 Edition.
3. P.S.Bimbra "Power Electronics" Khanna Publishers, Third Edition, 2019.
4. M.D. Singh and K.B. Khanchandani, "Power Electronics," McGraw Hill India, 2017.
5. NPTEL Video Lecture Notes on "Power Electronics" by Prof. D.Prasad, Prof. N.K. De, Dr. D.Kastha, Prof. Sabyasachi Sengupta, IIT Kharagpur.

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Ability to understand the operation of semiconductor devices and its dynamic characteristics.
CO2	Ability to analyse and choose the Uncontrolled and controlled converters for real time applications.
CO3	Ability to analyse the operation of DC- DC converter and its applications.
CO4	Able to Understand various PWM techniques and apply voltage control and harmonic elimination methods to inverter circuits.
CO5	Able to Understand the operation of AC voltage controllers and its applications.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**C**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	3	3	3	2	1	1	1	1	1	1	1	3	3	1
CO2	3	3	3	3	2	1	1	1	1	1	1	1	3	3	1
CO3	3	3	3	3	2	1	1	1	1	1	1	1	3	3	1
CO4	3	3	3	3	2	1	1	1	1	1	1	1	3	3	1
CO5	3	3	3	3	2	1	1	1	1	1	1	1	3	3	1

EE4502	**POWER SYSTEM ANALYSIS**	**L**	**T**	**P**	**C**
		2	**1**	**0**	**3**

Objectives

- To impart knowledge on the need for "power system analysis" and model various power system components.
- To formulate the power balance equations and to conduct the power flow analysis by Gauss Seidel and Newton-Raphson methods.
- To model and carry out short circuit studies of power system for symmetrical faults and to determine the fault levels of different buses.

- To learn about the symmetrical components and their application to carry out short circuit studies of power system for unsymmetrical faults and to determine the fault levels of different buses.
- To model and analyze the stability of the power system due to balanced faults by equal area criteria and explicit integration methods.

UNIT – I	**POWER SYSTEM OVERVIEW**	**9**
Need for system planning and operational studies - Power scenario in India - Power system components – Representation - Single line diagram - per unit quantities - p.u. impedance diagram p.u. reactance diagram - Network graph, Bus incidence matrix, Primitive network- Bus admittance matrix from primitive parameters - Representation of off-nominal transformer - Formation of bus admittance matrix of large power network.		**CO1**
UNIT – II	**POWER FLOW ANALYSIS**	**9**
Significance of Power Flow Analysis in planning and operation- Formulation of Power Flow problem in rectangular and polar coordinates - Bus classification - Power flow solution using Gauss-Seidel method - Handling of Voltage controlled buses - Power Flow Solution by Newton-Raphson method.		**CO2**
UNIT – III	**SYMMETRICAL FAULT ANALYSIS**	**9**
Importance of short circuit studies-Assumptions in short circuit analysis - Symmetrical short circuit analysis using Thevenin's theorem - Bus Impedance matrix by building algorithm (without mutual coupling) - Symmetrical fault analysis through bus impedance matrix - Post fault bus voltages – Fault level - Current limiting reactors.		**CO3**
UNIT – IV	**UNSYMMETRICAL FAULT ANALYSIS**	**9**
Symmetrical components - Sequence impedances – Sequence circuits of synchronous machine, transformer and transmission line-Sequence networks - Analysis of unsymmetrical faults: single-line to-ground, line-to-line and double-line-to-ground using Thevenin's theorem and Z-Bus - computation of post fault currents in symmetrical component and phasor domains.		**CO4**
UNIT – V	**STABILITY ANALYSIS**	**9**
Importance of stability studies-Classification of power system stability: rotor angle stability and voltage stability –Single Machine Infinite Bus (SMIB) system: Development of swing equation - Equal area criterion - Critical clearing angle and time - solution of the swing equation.		**CO5**
Total Periods:		**45**

Text Books:

1. John J. Grainger, William D. Stevenson, Jr, 'Power System Analysis', McGraw Hill Education (India) Private Limited, New Delhi, 2017.
2. Hadi Saadat, 'Power System Analysis', 3rd edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2011.

References:

1. Pai M A and Chatterjee, 'Computer Techniques in Power System Analysis', Tata McGraw-Hill Publishing Company Ltd., New Delhi, Third Edition, 2017.
2. J.Duncan Glover, Mulukutla S.Sarma, Thomas J. Overbye, 'Power System Analysis & Design', Cengage Learning, Sixth Edition, 2017.
3. Gupta B.R., 'Power System - Analysis and Design', Seventh Edition, S. Chand Publishing, 1998.

4. Kundur P., 'Power System Stability and Control', Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2006.
5. Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw-Hill Education, Third Edition, 2019.
6. NPTEL Video Lecture Notes on "Power System Analysis" by Prof. Debapriya Das, IIT Bombay.

Course Outcomes (CO)
Upon completion of the course, students will be able

CO1	To understand the modelling of the power system components and network modelling for the power system studies.
CO2	To understand the formulation of the power flow equation and its solutions using numerical methods.
CO3	To understand the basics of the symmetrical fault and its analysis using Thevenin's method and bus impedance matrix.
CO4	To understand the basics of the unsymmetrical faults, symmetrical components and its analysis using Thevenin's method and bus impedance matrix.
CO5	To understand the various stability problems in power systems and its solutions using equal area criterion and by using numerical methods.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	1	1	1	1	1	2	1	2	3	1	1
CO2	3	3	3	3	3	1	1	1	1	2	1	2	3	3	1
CO3	3	3	3	3	3	2	1	2	2	2	1	2	3	3	1
CO4	3	3	3	3	2	2	1	2	2	2	2	2	3	2	1
CO5	3	3	3	3	3	2	1	1	2	2	2	2	3	3	1

PRACTICALS

CS4561	DATA STRUCTURES USING C LABORATORY	L	T	P	C
		0	0	4	2
OBJECTIVES					

- To familiarize with C programming constructs.
- To implement linear data structures.
- To implement non-linear data structures.
- To understand the different operations of search trees.
- To get familiarized to sorting and searching algorithms.

LIST OF EXPERIMENTS

1. Basic C Programs – looping and data manipulations.	CO1
2. Programs using strings – string function implementation.	
3. Programs using structures.	CO2
4. Implementation of singly linked list.	
5. Array implementation of stacks.	
6. Array implementation of queue.	
7. Implementation of File Handling.	
8. Implementation of Tree Traversals	CO3
9. Implementation of Binary Search trees.	CO4
10. Implementation of Linear search	CO5
11. Implementation Bubble sort and Merge Sort	
12. Implementation of Hashing	
Total Periods	**60**

REFERENCES

1. Mark Allen Weiss, ―Data Structures and Algorithm Analysis in C, Second Edition, Pearson Education, 1997.

COURSE OUTCOMES(CO)

On completion of this course, the students will be able to:

CO1	Write basic and advanced programs in C.
CO2	Implement functions and recursive functions in C.
CO3	Develop applications in C using file processing.
CO4	Implement data structures using C.
CO5	Choose appropriate sorting algorithm for an application and implement it in a modularized way.

MAPPING OF COs WITH POs AND PSOs

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	1	1	-	-	2	2	2	-	2	3	3	2
CO2	3	3	3	1	1	-	-	2	2	2	-	2	3	3	2
CO3	2	3	3	1	1	-	-	2	2	2	-	2	3	3	2
CO4	2	3	3	1	1	-	-	2	2	2	-	2	3	3	2
CO5	2	3	3	1	1	-	-	2	2	2	-	2	3	3	2

EE4511	CONTROL AND INSTRUMENTATION LABORATORY	L	T	P	C
		0	**0**	**4**	**2**

Objectives

- To provide knowledge on analysis and design of control system along with basics of instrumentation.

LIST OF EXPERIMENTS

CONTROL SYSTEMS:

1. P, PI and PID controllers
2. Simulation of Stability Analysis
3. Modelling of Systems – Machines, Sensors and Transducers
4. Design of Lag, Lead and Lag-Lead Compensators
5. Position Control Systems
6. Synchro-Transmitter- Receiver and Characteristics
7. Simulation of Control Systems by Mathematical development tools.

INSTRUMENTATION:

8. Bridge Networks –AC and DC Bridges
9. Dynamics of Sensors/Transducers (a) Temperature (b) pressure (c) Displacement (d) Optical (e) Strain (f) Flow
10. Power and Energy Measurement
11. Signal Conditioning (a) Instrumentation Amplifier
    (b) Analog – Digital and Digital –Analog converters (ADC and DACs)
12. Process Simulation

Total Periods:	**60**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CONTROL SYSTEMS:

1. PID controller simulation and learner kit – 1 No.
2. Digital storage Oscilloscope for capturing transience- 1 No.
3 Personal Computer with control system simulation packages - 10 Nos
4. DC motor –Generator test set-up for evaluation of motor parameters
5. CRO 30MHz – 1 No.
6. Function Generator 2MHz – 1No.
7. Position Control Systems Kit (with manual) – 1 No.
8. Tacho Generator Coupling set
9. AC Synchro transmitter& receiver – 1No.
10. Sufficient number of Digital multi meters, speed and torque sensors

INSTRUMENTATION:

11. R, L, C Bridge kit (with manual)
12. a)Electric heater – 1No.
    Thermometer – 1No.
    Thermistor (silicon type)
    RTD nickel type – 1No.
    b) 30 psi Pressure chamber (complete set) – 1No.
    Current generator (0 – 20mA)
    Air foot pump – 1 No. (with necessary connecting tubes)
    c) LVDT20mm core length movability type – 1No.
    CRO 30MHz – 1No.
    d) Optical sensor – 1 No. Light source
    e) Strain Gauge Kit with Handy lever beam – 1No.
    100gm weights – 10 nos
    f) Flow measurement Trainer kit – 1 No.
    (1/2 HP Motor, Water tank, Digital Milliammeter, complete set)
13. Single phase Auto transformer – 1No.

Watt-hour meter (energy meter) – 1No.
Ammeter Voltmeter
Rheostat
Stop watch Connecting wires (3/20)
14. IC Transistor kit – 1No.
15. Instrumentation Amplifier kit-1 No.
16. Analog – Digital and Digital –Analog converters (ADC and DACs)- 1 No.

Course Outcomes (CO)

Upon completion of the course, students should have the

CO1	Ability to understand control theory and apply them to electrical engineering problems
CO2	Ability to analyze the various types of converters
CO3	Ability to design compensators. Ability to understand the basic concepts of bridge networks.
CO4	Ability to the basics of signal conditioning circuits.
CO5	Ability to study the simulation packages.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	3	2	2	1	2	2	3	2	3	3	1
CO2	3	3	3	3	3	2	2	1	2	2	3	2	3	3	1
CO3	3	3	3	3	3	2	2	1	2	2	3	2	3	3	1
CO4	3	3	3	3	3	2	2	1	2	2	3	2	3	3	1
CO5	3	3	3	3	3	2	2	1	2	2	3	2	3	3	1

EE4512	POWER ELECTRONICS AND DRIVES LABORATORY	L	T	P	C
		0	0	4	2

Objectives

- To study the VI characteristics of SCR, TRIAC, MOSFET and IGBT.
- To analyse the performance of semi converter, full converter, step up, step down choppers by simulation and experimentation.
- To study the behaviour of voltage waveforms of PWM inverter applying various modulation techniques
- To design and analyse the performance of SMPS
- To study the performance of AC voltage controller by simulation and Experimentation.

LIST OF EXPERIMENTS

1. Gate Pulse Generation using R, RC and UJT.
2. Characteristics of SCR and TRIAC
3. Characteristics of MOSFET and IGBT
4. AC to DC half-controlled converter
5. AC to DC fully controlled Converter
6. Step down and step up MOSFET based choppers
7. IGBT based single phase PWM inverter
8. IGBT based three phase PWM inverter
9. AC Voltage controller
10. Switched mode power converter.
11. Simulation of PE circuits (1Φ & 3Φ semi converters, 1Φ & 3Φ full converters, DC-DC

converters, AC voltage controllers)

Total Periods: **60**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. Device characteristics (for SCR, MOSFET, TRIAC, GTO, IGCT and IGBT kit with built-in / discrete power supply and meters) – 2 each
2. SinglephaseSCRbasedhalfcontrolledconverterandfullycontrolledconverteralong with built-in/separate/firing circuit/module and meter – 2 each
3. MOSFET based step up and step-down choppers (Built in/ Discrete) – 1each
4. IGBT based single phase PWM inverter module/Discrete Component – 2
5. IGBT based three phase PWM inverter module/Discrete Component – 2
6. Switched mode power converter module/Discrete Component –2
7. SCR &TRIAC based 1 phase AC controller along with lamp or rheostat load -2
8. Cyclo converter kit with firing module –1
9. Dual regulated DC power supply with common ground
10. Cathode ray Oscilloscope–10
11. Isolation Transformer – 5
12. Single phase Auto transformer–3
13. Components (Inductance, Capacitance) 3 set for each
14. Multimeter – 5
15. LCR meter – 3
16. Rheostats of various ranges – 2 sets of 10 value
17. Work table – 10
18. DC and AC meters of required ranges – 20
19. Component data sheets to be provided

Course Outcomes (CO)
Upon completion of the course, students will be

CO1	Able to Determine the characteristics of SCR, IGBT, TRIAC, MOSFET and IGBT
CO2	Able to Find the transfer characteristics of full converter, semi converter, step up and step-down choppers by simulation and experimentation.
CO3	Able to Analyse the voltage waveforms for PWM inverter using various modulation techniques.
CO4	Able to Design and experimentally verify the performance of basic DC/DC converter topologies used for SMPS
CO5	Able to Understand the performance of AC voltage controllers by simulation and experimentation

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	3	2	2	1	1	1	1	2	3	2	2
CO2	3	3	3	3	3	2	2	1	1	1	1	2	3	2	2
CO3	3	3	3	3	3	2	1	1	1	1	1	2	3	2	2
CO4	3	3	3	3	3	2	1	1	1	1	1	2	3	2	2
CO5	3	3	3	3	3	2	1	1	1	1	1	2	3	2	2

SEMESTER- VI

CS4651	OBJECT ORIENTED PROGRAMMING	L	T	P	C
		3	0	0	3
Objectives					

- To understand Object Oriented Programming concepts and basic Java Features
- To know the principles of packages, inheritance and interfaces
- To define exceptions and use I/O Streams
- To develop a java application with threads and generics classes
- To design and build simple Graphical User Interfaces

UNIT – I	**INTRODUCTION TO OOP AND JAVA FUNDAMENTALS**	**9**
Object Oriented Programming - Abstraction – objects and classes - Encapsulation-Inheritance-Polymorphism- OOP in Java – Characteristics of Java – The Java Environment - Java Source File- Structure –Compilation-.Fundamental Programming Structures in Java– Defining classes in Java–constructors,methods-accessspecifiers-staticmembers-Comments, Data Types, Variables, Operators, Control Flow, Arrays, Packages - JavaDoc comments		**CO1**
UNIT – II	**INHERITANCE AND INTERFACES**	**9**
Inheritance–Super classes-sub classes–Protected members–constructors in sub classes -the Object class–abstract classes and methods-final methods and classes–Interfaces–defining an interface, implementing interface, differences between classes and interfaces and extending interfaces – Object cloning-inner classes, Array Lists–Strings.		**CO2**
UNIT – III	**EXCEPTION HANDLING AND I/O**	**9**
Exceptions- exception hierarchy- throwing and catching exceptions–built-in exceptions, creating own exceptions, Stack Trace Elements. Input/Output Basics–Streams – Byte streams and Character streams– Reading and Writing Console–Reading and Writing Files.		**CO3**
UNIT – IV	**MULTITHREADING AND GENERIC PROGRAMMING**	**9**
Differences between multi-threading and multitasking, thread life cycle, creating threads, synchronizing threads, Inter-thread communication, daemon threads, thread groups. Generic Programming–Generic classes– generic methods– Bounded Types – Restrictions and Limitations.		**CO4**
UNIT – V	**EVENT DRIVEN PROGRAMMING**	**9**
Graphics programming - Frame – Components - working with 2D shapes - Using color, fonts, and images – Basics of event handling - event handlers - adapter classes - actions - mouse events - AWT event hierarchy – Introduction to Swing – layout management - Swing Components – Text Fields, Text Areas – Buttons- Check Boxes – Radio Buttons–Lists-choices-Scroll bars–Windows–Menus–Dialog Boxes..		**CO5**
Total Periods:		**45**

Text Books:

1. Herbert Schildt, "Java The complete reference",8th Edition, McGraw Hill Education, 2011.
2. Cay S. Horstmann, Gary cornell, "Core Java Volume – I Fundamentals", 9th Edition, Prentice Hall, 2013.

References:

1. Paul Deitel, Harvey Deitel, "Java SE8 for programmers", 3rd Edition, Pearson, 2015.
2. Steven Holzner,"Java2 Black book", Dream tech press,2011.
3. Timothy Budd, "Understanding Object –oriented programming with Java"

Course Outcomes (CO)

Upon completion of the course, students will be able	
CO1	To know the basic concepts of Object Oriented Programming
CO2	To learn to develop application with the concepts inheritance, interfaces and Strings
CO3	To implement Exception handling and I/O for reading and writing console
CO4	To apply programming concepts to develop Java applications with threads and generics classes
CO5	To Develop interactive Java programs using swings, Graphics programming and AWT.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	2	3	2	2	1	1	-	2	1	2	2	1	2
CO2	3	2	2	3	2	2	-	-	1	1	1	1	2	3	2
CO3	3	2	2	3	2	1	1	1	-	2	1	2	2	2	2
CO4	3	2	2	3	2	2	1	-	1	1	1	1	2	3	3
CO5	3	3	1	3	3	3	3	-	-	-	-	-	3	2	2

EE4601	POWER ELECTRONIC DRIVES AND CONTROL	L	T	P	C
		3	0	0	3

Objectives

- Steady state operation and transient dynamics of a motor load system.
- Analyze the operation of the converter/chopper fed dc drive, both qualitatively and quantitatively.
- Analyze the operation and performance of induction motor drives.
- Analyze the operation and performance of synchronous motor drives.
- Design the current and speed controllers for a closed loop solid state DC motor drive.

UNIT - I	DRIVE FUNDAMENTALS	9
Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, starting & stopping – typical load torque characteristics – Selection of motor.		CO1

UNIT - II	CONVERTER / 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		CO2

UNIT - III	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.		CO3

UNIT - IV	SYNCHRONOUS MOTOR DRIVES	9
V/f control and self-control of synchronous motor: Margin angle control and power factor control- Three phase voltage/current source fed synchronous motor- Applications.		CO4

UNIT - V	DESIGN OF CONTROLLERS FOR DRIVES	9

Transfer function for DC motor / load and converter – closed loop control with Current and speed feedback–armature voltage control and field weakening mode – Design of controllers; current controller and speed controller- converter selection and characteristics.	**CO5**

Total Periods:	**45**

Text Books:

1. Gopal K. Dubey, Fundamentals of Electrical Drives, Narosa Publishing House, Second edition 2001.
2. R. Krishnan, Electric Motor Drives- Modeling, Analysis, and Control, Prentice-Hall of India Private Limited, New Delhi, 2003.

References:

1. Vedam Subramanyam, "Electric Drives Concepts and Applications", 2e, McGraw Hill, 2016
2. Shaahin Felizadeh, "Electric Machines and Drives", CRC Press (Taylor and Francis Group), 2013.
3. N.K. De., P.K. SEN "Electric drives" PHI, 2012.
4. Bimal K. Bose, "Modern Power Electronics and AC Drives, Pearson Education (Singapore) Ltd., New Delhi, 2003.
5. NPTEL Video Lecture Notes on "Fundamentals of Electric Drives" by Prof. Shyama Prasad Das, IIT Kanpur.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Analyze the speed control mechanisms of electrical machines to justify the selection of drives for their effective usage
CO2	Evaluate the performance of converter and chopper fed DC motor drive
CO3	Understand the power electronic converters used for induction motor speed control.
CO4	Understand the power electronic converters used for synchronous motor speed control.
CO5	Design controllers for electric drives

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	3	2	3	1	1	1	1	1	3	3	1
CO2	3	3	3	3	3	2	3	1	1	1	1	1	3	3	1
CO3	3	3	3	3	3	2	3	1	1	1	1	1	3	3	1
CO4	3	3	3	3	3	2	3	1	1	1	1	1	3	3	1
CO5	3	3	3	3	3	2	3	1	1	1	1	1	3	3	1

EE4602	POWER SYSTEM OPERATION AND CONTROL	L	T	P	C
		2	1	0	3

OBJECTIVES

- Significance of power system operation and control.
- Real power– frequency interaction and design of power– frequency controller.
- Reactive power– voltage interaction and the compensators for maintaining the voltage profile.

- Generation scheduling and economic operation of power system.
- SCADA and its application for real time operation and control of power systems.

UNIT – I	**INTRODUCTION**	**9**
Power scenario in Indian grid – National and Regional load dispatching centres – Requirements of good power system – Necessity of voltage and frequency regulation – System load variation, load curves – Load forecasting – Computational methods in load forecasting – Load shedding and Islanding		**CO1**
UNIT – II	**REAL POWER – FREQUENCY CONTROL**	**9**
Basics of speed governing mechanisms and modelling – Load Frequency Control (LFC) of single area system – Static and dynamic analysis – LFC of two area system –Tie line modelling – Block diagram representation of two area system – Static and dynamic analysis – Tie line with frequency bias control – State variable model – Integration of economic dispatch control with LFC.		**CO2**
UNIT – III	**REACTIVE POWER – VOLTAGE CONTROL**	**9**
Generation and absorption of reactive power – Basics of reactive power control – Automatic Voltage Regulator (AVR) – Brushless AC excitation system – Block diagram representation of AVR loop static and dynamic analysis – Stability compensation – Voltage drop in transmission line – Methods of reactive power injection – Tap changing transformer, SVC and STATCOM for voltage control, Introduction to Dynamic Voltage Restorer.		**CO3**
UNIT – IV	**ECONOMIC OPERATION OF POWER SYSTEM**	**9**
Statement of economic dispatch problem – Input and output characteristics of thermal plant incremental cost curve – Optimal operation of thermal units without and with transmission losses (no derivation of transmission loss coefficients) – Lambda–iteration method – Base point and participation factors method. Statement of Unit Commitment (UC) problem – Constraints on UC problem – Solution of UC problem using priority list – Special aspects of short term and long term hydrothermal scheduling problems.		**CO4**
UNIT – V	**COMPUTER AIDED CONTROL OF POWER SYSTEM**	**9**
Need of computer control of power system – Concept of energy control centres and functions – PMU system monitoring, Data acquisition and controls – System hardware configurations – SCADA and EMS functions – State estimation – Measurements and errors – Weighted least square estimation – Various operating states – State transition diagram.		**CO5**
Total Periods:		**45**

Text Books:

1. Olle I. Elgerd, 'Electric Energy Systems theory – An introduction', McGraw Hill Education Pvt. Ltd., New Delhi, 36th reprint, 2014.
2. Allen J. Wood and Bruce F. Wollen berg, 'Power Generation, Operation and Control', John Wiley & Sons, Inc., 2016.

References:

1. Kothari D.P. and Nagrath I.J., 'Power System Engineering', Tata McGraw– Hill Education, Second Edition, Reprint 2018.
2. Hadi Saadat, 'Power System Analysis', McGraw Hill Education Pvt. Ltd., New Delhi, 3rd Edition.
3. Kundur P., 'Power System Stability and Control, McGraw Hill Education Pvt. Ltd., New Delhi, 12th reprint, 2015.
4. Abhijit Chakrabarti and Sunita Halder, 'Power System Analysis Operation and Control', PHI learning Pvt. Ltd., New Delhi, Third Edition, Reprint 2018.
5. NPTEL Video Lecture Notes on "Power System Operation and Control" by Dr. A.M. Kulkarni, IIT Bombay.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Understand the day-to-day operation of electric power system.
CO2	Acquire knowledge on real power-frequency interaction.
CO3	Understand the reactive power-voltage interaction.
CO4	Understand the significance of power system operation and control.
CO5	Design SCADA and its application for real time operation.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	3	3	3	3	2	3	1	1	1	1	1	3	3	1
CO2	3	3	3	3	3	2	3	1	1	1	1	1	3	3	1
CO3	3	3	3	3	3	2	3	1	1	1	1	1	3	3	1
CO4	3	3	3	3	3	2	3	1	1	1	1	1	3	3	1
CO5	3	3	3	3	3	2	3	1	1	1	1	1	3	3	1

EC4650	**EMBEDDED SYSTEMS AND IoT SYSTEM DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Objectives

- To provide students with good depth of knowledge of Designing Embedded and IoT Systems forvarious application
- To understand the design of a IoT system
- Knowledge for the design and analysis of Embedded and IoT Systems for Electronics Engineering students

UNIT - I	**INTRODUCTION TO EMBEDDED SYSTEMS**	**9**
Introduction to Embedded Systems and Elements of embedded Systems, Classification of an Embedded system. Structural units in Embedded processor. Memory management methods, Comparison of General-purpose computers vs embedded system, Embedded System Design Process, Design example: Model train controller- Design methodologies- Design flows.		**CO1**

UNIT - II	**HARDWARE DESIGN FOR EMBEDDED SYSTEMS**	**9**
Microcontrollers for embedded systems, Introduction to ARM Processors, ARM architectural details, The ARM programmer's model, ARM development tools, Block Diagram of ARM9		**CO2**

and ARM Cortex M3 MCU. Peripheral Interfacing with ARM. Basic Wire and Wireless Protocols like, UART, I2C, SPI.		
UNIT - III	**EMBEDDED FIRMWARE DEVELOPMENT ENVIRONMENT AND EMBEDDED OPERATING SYSTEMS**	**9**
Embedded Product Development Life Cycle- objectives, different phases of EDLC Operating system requirements for Embedded systems, Fundamentals of Real Time Operating System (RTOS), Operating system services, Process, Task and Thread, System calls, Timer and Event Function, Memory management, File and I/O subsystem management, Device Management, Device driver programming.		**CO3**
UNIT - IV	**INTRODUCTION TO IoT BASED EMBEDDED SYSTEMS**	**9**
Introduction to the concept of IoT, Basic architecture of an IoT based Embedded Systems, Physical design - protocols – Logical design of Embedded Hardware for IoT applications, IoT Design Methodology – Specifications Integration and Application Development.		**CO4**
UNIT - V	**APPLICATIONS OF IoT BASED EMBEDDED SYSTEMS**	**9**
Home automation – Cities: Smart parking – Environment: Weather monitoring – Agriculture: Smart irrigation – Data analytics for IoT – Software & management tools for IoT cloud storage models & Communication APIs – Cloud for IoT – Amazon Web Services for IoT.		**CO5**
	Total Periods	**45**

Text Books:

1. Honbo Zhou, "Internet of Things in the cloud:A middleware perspective", CRC press, 2012.
2. Muhammad Ali Mazidi,Shujen Chen, Sepehr Naimi,Sarmad Naimi, "Embedded Programming Using C Language", 1st Edition, Freescale ARM Cortex-M

References:

1. Rajkamal, "Embedded System: Architecture, Programming and Design", TMH3.
2. Dr. Ovidiu Vermesan, Dr. Peter Friess, "Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems", River Publisher

Course Outcomes (CO)
Upon completion of the course, the students will have

CO1	Knowledge of theory and practice related to Embedded and IoT System.
CO2	Ability to identify, formulate and solve engineering problems by using Embedded Systemswith IoT.
CO3	Ability to implement real field problem by gained knowledge of Embedded Systems with IoTcapability.
CO4	Ability to understand the OS based software Development of embedded systems.
CO5	Ability to study the various introduction of IoT based embedded systems

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	3	2	2	2	3	-	-	-	-	2	2	3	3	2
CO2	2	3	2	2	3	3	-	-	-	-	2	2	3	3	2
CO3	3	2	2	2	3	3	-	-	-	-	2	2	3	3	2
CO4	3	1	2	2	3	3	-	-	-	-	2	2	3	3	2

CO5	3	1	2	2	3	3	-	-	-	-	1	2	3	2	2

PRACTICALS

CS4661	**OBJECT ORIENTED PROGRAMMING LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVES

- To be familiar with basic java programming constructs and write simple programs
- To be exposed to concept of Inheritance and interfaces
- To learn to write programs to implement exception Handling mechanisms.
- To be able to understand Multithreading concept.
- To understand and develop GUI Programming using Applets and Swing

LIST OF EXPERIMENTS

1. Java Application to solve problems like Linear and Binary Search	CO1
2. Java Application to implement Stack and Queue data structures using classes.	
3. Java Application to implement Inheritance concept	CO2
4. Java program to demonstrate Abstract Class	
5. Implementation of the above program using Interfaces	
6. Java Application to implement Exception Handling.	
7. Java Application to implement Multi threading.	CO3
8. Java Application to demonstrate File Operations.	
9. Java Application to implement Generic classes	
10. Develop a Java Application to implement JavaFX Controls, Layouts and Menus	
11. Develop a mini project using all Java concepts.	
Total Periods	**60**

REFERENCES

1. Herbert Schildt, "Java The complete reference", 8th Edition, McGraw Hill Education, 2011

COURSE OUTCOMES(CO)

On completion of this course, the students will be able to:

CO1	Develop and implement Java programs for simple applications that make use of classes, and Data structures.
CO2	Develop and implement Java programs with Inheritance, Interfaces and Exception handling .
CO3	Develop and implement GUI concepts in Java using Swing and do Mini Project .

MAPPING OF COs WITH POs AND PSOs

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	2	1	2	1	1	1	1	1	2	2	2	1	2	2	1
CO2	2	1	1		1	1	1	1	1	1	1	1	2	2	1
CO3	2	1	2	1	1	1	1	1	2	2	2	1	2	2	1

EE4611	MINI PROJECT	L	T	P	C
		0	0	4	2

Objectives

- To develop their own innovative prototype of ideas.
- To train the students in preparing mini project reports and examination.

The students 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 PERIODS	**60**

Course Outcomes (CO)

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.

SEMESTER-VII

EE4701	PROTECTION AND SWITCHGEAR	L	T	P	C
		3	0	0	3

Objectives

- To teach the principles and need for protection schemes by different fault current calculations
- To teach the basic principles, construction and characteristics of different Electromagnetic relays
- To learn to protect different power equipments like transformer, generator etc.,
- To teach different aspects of static relays and numerical protection schemes
- To learn the principles, construction and problems associated with different types of circuit breaker

UNIT - I	PROTECTION SCHEMES	6
Principles and need for protective schemes – nature and causes of faults – types of faults– fault current calculation — Zones of protection and essential qualities of protection. Methods of neutral grounding.		**CO1**

UNIT - II	ELECTROMAGNETIC RELAYS	9
Operating principles of relays – Torque equation – R– X diagram – Electromagnetic Relays – Over current, Directional, Distance, Differential, Negative sequence and Under frequency relays		**CO2**

UNIT - III	APPARATUS PROTECTION	9
Application of Current transformers and Potential transformers in protection schemes – Sources of error. Protection of transformer, generator, motor, bus bars and transmission line.		**CO3**

UNIT - IV	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, distance protection of transmission lines.		**CO4**

UNIT - V	CIRCUIT BREAKERS	12
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, oil, SF6 and vacuum circuit breakers – comparison of different circuit breakers – Rating and selection of Circuit breakers.		**CO5**

Total Periods:	**45**

Text Books:

1. M.L.Soni, P.V.Gupta, U.S.Bhatnagar, A.Chakrabarti, A Text Book on Power System Engineering, Dhanpat Rai & Co., 1998.
2. Y.G.Paithankar and S.R.Bhide, Fundamentals of power system protection, Second Edition, Prentice Hall of India Pvt. Ltd., New Delhi – 2010

References:

1. Badri Ram ,B.H.Vishwakarma, Power System Protection and Switchgear, New Age International Pvt Ltd Publishers, Second Edition 2011.
2. Sunil S. Rao, Switchgear and Protection, Khanna publishers, New Delhi, 2008. Switchgear Protection and Power Systems (Theory, Practice & Solved Problems)
3. B. Rabindranath and N. Chander, Power System Protection and Switchgear, New Age International (P) Ltd., First Edition 2011.
4. C.L.Wadhwa, Electrical Power Systems, 6th Edition, New Age International (P) Ltd., 2010.
5. Ravindra P.Singh, "Switchgear and Power System Protection " PHI Learning Private Ltd., New Delhi 2009.
6. NPTEL Video Lecture Notes on "Power System Protection and Switchgear" by Prof. Bhaveshkumar R. Bhalja, IIT Roorkee

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Ability to understand the principles and need of protection schemes by different fault current calculation and also know the importance of grounding in power system.
CO2	Ability to understand the basic principles, construction and characteristics of different Electromagnetic relays
CO3	Ability to gain knowledge on CT and PT in protection schemes and learn to protect different power equipment like transformer, generator etc.,
CO4	Ability to understand the concept of Static relay and numerical protection schemes.
CO5	Ability to gain knowledge on theory of arc interruption and various type of circuit breakers.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	2	1	1	1	1	1	1	1	1	1	3	1	1
CO2	3	2	2	2	1	1	1	1	1	1	1	1	3	1	1
CO3	3	2	3	2	1	1	1	1	1	1	1	1	3	1	1
CO4	3	2	3	2	1	1	1	1	1	1	1	1	3	1	1
CO5	3	2	3	2	1	1	1	1	2	2	1	1	3	1	1

EE4702	**RENEWABLE ENERGY SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

- To create awareness about renewable and non-renewable Energy Sources, technologies and its impact on the environment.
- To learn wind energy conversion system and its issues with grid integration.
- To learn the concepts of solar PV and solar thermal systems.
- To learn other alternate energy sources such as Biomass, geothermal energy and hydro energy variety of issues in harnessing
- To understand the concept of tidal energy, hydrogen energy, ocean thermal energy and its significance.

UNIT – I	**RENEWABLE ENERGY SOURCES**	**9**
Conventional energy sources- Fossil Fuels, Types of fossil fuel, Environmental consequences of fossil fuel use, Non-Conventional energy sources- Renewable energy(RE) and its types,		**CO1**

Significances of renewable energy sources, Sustainable Design and development, Effects and Limitations of RE sources, Present Indian and international energy scenario of NRE and RE sources.		
UNIT – II	**WIND ENERGY**	**9**
Wind formation, Power in the Wind – WPP (wind power plant)- Components of WPPs -Types of Wind Power Plants (WPPs)– Working of WPPs- Siting of WPPs - Grid integration issues of WPPs.		**CO2**
UNIT - III	**SOLAR - THERMAL SYSTEMS AND PV SYSTEMS**	**9**
Solar Photovoltaic systems (SPV) : Basic Principle of SPV conversion – Types of PV Systems- Types of Solar Cells, Photovoltaic cell concepts: Cell, module, array, I-V Characteristics, Efficiency & Quality of the Cell, series and parallel connections, Grid Integration and Standalone system, maximum power point tracking, Applications.		**CO3**
UNIT - IV	**BIOMASS,GEOTHERMAL AND HYDRO ENERGY SOURCES**	**9**
Introduction - Bio mass resources – Energy from Bio mass: conversion processes-Biomass Cogeneration-Environmental Benefits. Geothermal Energy: Basics, Direct Use, Geothermal Electricity. Mini/micro hydro power: Classification of hydropower schemes, Classification of water turbine, Turbine theory, Essential components of hydroelectric system.		**CO4**
UNIT - V	**OTHER ENERGY SOURCES**	**9**
Tidal Energy: Energy from the tides, Barrage and Non Barrage Tidal power systems. Wave Energy: Energy from waves, wave power devices. Ocean Thermal Energy Conversion (OTEC)- Hydrogen Production and Storage- Fuel cell : Principle of working- various types - construction and applications. Energy Storage System- Hybrid Energy Systems		**CO5**
	Total Periods:	**45**

Text Books:

1. Joshua Earnest, Tore Wizeliu, 'Wind Power Plants and Project Development', PHI Learning Pvt.Ltd, New Delhi, 2015.
2. Scott Grinnell, "Renewable Energy & Sustainable Design", CENGAGE Learning, USA, 2016.

References:

1. A.K.Mukerjee and Nivedita Thakur," Photovoltaic Systems: Analysis and Design", PHI Learning Private Limited, New Delhi, 2011
2. Richard A. Dunlap," Sustainable Energy" Cengage Learning India Private Limited, Delhi, 2015.
3. Chetan Singh Solanki, " Solar Photovoltaics : Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2011
4. Bradley A. Striebig, Adebayo A. Ogundipe and Maria Papadakis," Engineering Applications in Sustainable Design and Development", Cengage Learning India Private Limited, Delhi, 2016.
5. Godfrey Boyle, "Renewable energy", Open University, Oxford University Press in association with the Open University, 2004. 6. Shobh Nath Singh, 'Non-conventional Energy resources' Pearson Education, 2015.
6. D.P.Kothari, K.C Singal, Rakesh Ranjan "Renewable Energy Sources and Emerging Technologies", PHI Learning Pvt.Ltd, New Delhi, 2013.
7. NPTEL Video Lecture Notes on "Introduction to Non Conventional Energy Systems" by Prof. Dr.L.Umanand, IISc Bangalore.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Create awareness about non- renewable and renewable Energy Sources and technologies
CO2	Acquire knowledge on the concepts of wind energy conversion system, siting and grid related issues.
CO3	Understand the solar PV and solar thermal systems
CO4	Analyse other types of renewable energy resources like biomass, geothermal and Hydro energy.
CO5	Acquire knowledge on tidal energy, hydrogen energy, ocean thermal energy and fuel cell.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	1	1	1	1	3	3	3	1	1	1	3	1	1	1
CO2	3	3	3	3	3	3	3	3	3	1	3	3	3	3	1
CO3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	1
CO4	3	3	3	3	3	3	2	3	3	1	2	3	3	3	1
CO5	3	3	3	3	3	3	2	3	3	1	2	3	3	3	1

PRACTICALS

EE4711	POWER SYSTEM SIMULATION LABORATORY	L	T	P	C
		0	0	4	2

Objectives

- To provide better understanding of power system analysis through digital simulation.

LIST OF EXPERIMENTS

1. Computation of Transmission Line Parameters
2. Formation of Bus Admittance and Impedance Matrices and Solution of 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 SMIB System
7. Economic Dispatch in Power Systems
8. Load – Frequency Dynamics of Single- Area and Two-Area Power Systems
9. State estimation: Weighted least square estimation
10. Electromagnetic Transient Analysis in power system by using EMTP

Total Periods: 60

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Personal computers (Intel i3, 80GB, 2GBRAM) – 30 nos
Printer laser- 1 No.
Dot matrix- 1 No.
Server (Intel i5, 80GB, 2GBRAM) (High Speed Processor) – 1 No.
Software: MATLAB simulation software with 5 user license and EMTP software.

Course Outcomes (CO)
Upon completion of the course, students will be able

CO1	To develop simple Matlab programs for the following basic requirements: a) Formation of bus admittance and impedance matrices and line parameters with solutions.
CO2	To understand the concepts of power flow solution of small systems using simple method, Gauss-Seidel P.F. method, Unit Commitment and Economic Dispatch.
CO3	To arrive the solutions through the standard algorithms and researches available and to confirm the same by implementing in the modern software packages available
CO4	To have experience in the usage of standard packages for the following analysis / simulation / control functions. a) Steady-state analysis of large system using NRPF method. b) Quasi steady-state (Fault) analysis for balanced and unbalanced faults.
CO5	To know the basics of transient stability and Load Frequency dynamics and to check the same in the simulation of multi-machine power system for effective control of power system.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	2	2	1	1	1	1	1	1	1	1	3	3	1
CO2	3	3	2	2	2	1	1	2	1	1	1	1	3	3	1

CO3	3	3	3	3	2	1	2	1	2	1	1	1	3	3	1
CO4	3	2	3	3	3	1	2	2	1	1	1	1	3	3	1
CO5	3	2	3	3	3	1	3	1	1	1	2	2	3	3	1

EE4712	**RENEWABLE ENERGY SYSTEMS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

OBJECTIVES

- To train the students in Renewable Energy Sources and technologies
- To provide adequate inputs on a variety of issues in harnessing Renewable Energy.
- 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 "VI-Characteristics and Efficiency of Solar PV System".
3. Simulation study on "Shadowing effect & diode based solution in 1kWp Solar PV System".
4. Simulation study on performance assessment of grid connected and Standalone 1kWp Solar power system.
5. Simulation study on Wind Energy Generator.
6. Simulation study on Hybrid (Solar-Wind) Power System.
7. Simulation study on Hydel Power.
8. Simulation study on Intelligent Controllers for Hybrid Systems.
9. Study of Solar PV Sizing, Battery Sizing and Inverter Sizing of a 1kWp system.

Total Periods: 60

Requirements for a batch of 30 students

S.No.	**Description of Equipment**	**Quantity required**
1	Personal computers (Intel i3, 80GB, 2GBRAM)	15
2	MATLAB simulation software with 5 user license	5 user
3	Hardware set up of Solar PV system	1

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Understand and analyse renewable energy systems.
CO2	Acquire knowledge about renewable energy sources and technologies.
CO3	Provide adequate inputs on a variety of issues in harnessing renewable energy.
CO4	Simulate the various renewable energy sources and to understand basics of Intelligent Controllers
CO5	Recognize current and possible future role of renewable energy sources.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	3	3	3	3	2	2	2	3	1	3	3	3	2	1

	CO2	3	3	3	3	3	2	2	2	3	1	3	3	3	2	1	
	CO3	3	3	3	3	3	2	2	2	3	1	3	3	3	2	1	
	CO4	3	3	3	3	3	2	2	2	3	1	3	3	3	2	1	
	CO5	3	3	3	3	3	2	2	2	3	1	3	3	3	2	1	

SEMESTER- VIII

GE4791	HUMAN VALUES AND ETHICS	L	T	P	C
		3	0	0	2

Objectives

- To enable the students to create an awareness on Engineering Ethics and Human Values, to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I	HUMAN VALUES	10
Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.		CO1

UNIT II	ENGINEERING ETHICS	9
Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.		CO2

UNIT III	ENGINEERING AS SOCIAL EXPERIMENTATION	9
Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.		CO3

UNIT IV	SAFETY, RESPONSIBILITIES AND RIGHTS	9
Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.		CO4

UNIT V	GLOBAL ISSUES	8
Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.		CO5

Total Periods:	45

Text Books:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.

References:

1. Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”, Cengage Learning, 2009.
3. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003
4. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.
5. Laura P. Hartman and Joe Desjardins, “Business Ethics: Decision Making for Personal Integrity and Social Responsibility” McGraw Hill education, India Pvt. Ltd.,New Delhi, 2013.
6. World Community Service Centre, ‘ Value Education’, Vethathiri publications, Erode, 2011.

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Students should be able to apply ethics in society, and realize the responsibilities and rights in the society.
CO2	Students should be able to discuss the ethical issues related to engineering
CO3	Understood the core values that shape the ethical behaviour of an engineer
CO4	Exposed awareness on professional ethics and human values
CO5	Known their role in technological development

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	-	-	-	-	-	2	2	3	2	-	-	2	3	1	1
CO2	-	-	-	-	-	2	2	3	2	-	-	2	3	1	1
CO3	-	-	-	-	-	2	2	3	2	-	-	2	3	1	1
CO4	-	-	-	-	-	2	2	3	2	-	-	2	3	1	1
CO5	-	-	-	-	-	2	2	3	2	-	-	2	3	1	1

EE4811	PROJECT WORK	L	T	P	C
		0	0	20	10

Objectives

- To develop the ability to solve a specific problem right from its identification and literature review till the successful solution of the same.
- To train the students in preparing project reports and to face reviews.

The students 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 prepare 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 PERIODS	**300**

Course Outcomes (CO)

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.

VERTICAL I - POWER ENGINEERING

EE4001	POWER QUALITY	L	T	P	C
		3	0	0	3

Objectives

To learn the basic definitions in Power Quality.
To study the power quality issues in Single Phase and Three Phase Systems.
To understand the principles of Power System Harmonics.
To know the way to use DSTATCOM for Harmonic Mitigation.
To learn the concepts related with Series Compensation.

UNIT - I	INTRODUCTION	(7+2 Skill) 9
Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Non-linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.		CO1

UNIT - II	ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM	(7+2 Skill) 9
Single phase linear and non-linear loads – single phase sinusoidal, non-sinusoidal source – supplying linear and nonlinear loads – three phase balanced system – three phase unbalanced system – three phase unbalanced and distorted source supplying non-linear loads – concept of power factor – three phase- three wire – three phase - four wire system.		CO2

UNIT - III	MITIGATION OF POWER SYSTEM HARMONICS	(7+2 Skill) 9
Introduction - Principle of Harmonic Filters – Series-Tuned Filters – Double Band-Pass Filters – damped Filters – Detuned Filters – Active Filters – Power Converters – Harmonic Filter Design – Tuned Filter – Second-Order Damped Filter – Impedance Plots for Filter Banks – Impedance Plots for a Three-Branch 33 kV Filter.		CO3

UNIT - IV	LOAD COMPENSATION USING DSTATCOM	(7+2 Skill) 9
Compensating single – phase loads – Ideal three phase shunt compensator structure – generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced – Realization and control of DSTATCOM – DSTATCOM in Voltage control mode.		CO4

UNIT - V	SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM	(7+2 Skill) 9
Rectifier supported DVR – DC Capacitor supported DVR – DVR Structure – Voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.		CO5

Total Periods:	**45**
SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/ Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)	**10**

1. Harmonic analysis of single phase power converters (Semi converters and Full Converters) with R and RL load via simulation

2. Harmonic analysis of three phase power converters (Semi converters and Full Converters) with R and RL load via simulation
3. Harmonic analysis of single phase inverters with R and RL load via simulation
4. Harmonic analysis of three phase inverters with R and RL load via simulation
5. Mitigation of Harmonics using Tuned Filter

List of Open Source Software/ Learning website:

1. http://nptel.iitm.ac.in/courses.php
2. https://old.amu.ac.in/emp/studym/2442.pdf
3. https://electricalacademia.com/electric-power
4. https://www.intechopen.com/books/6214
5. https://www.cde.com/resources/technical-papers/Mitigation-of-Harmonics.pdf
6. https://www.academia.edu/43237017/Use_Series_Compensation_in_Distribution_Networks_33_KV

Text Books:

1. Arindam Ghosh and Gerad Ledwich "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, First Edition,2002
2. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, Second Edition, 2011.
3. George J. Wakileh, "Power System Harmonics – Fundamentals, Analysis and Filter Design", Springer – Verlag Berlin Heidelberg, New York, 2019.

References:

1. R.C.Duggan "Electric Power Systems Quality", Tata MC Graw Hill Publishers, Third Edition, 2012.
2. Arrillga "Power System Harmonics", John Wiely and Sons, 2003 2nd Edition.
3. Derek A.Paice "Power Electronic Converter Harmonics" IEEE Press, 1995, Wiley – IEE Press 1999, 18th Edition.

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

CO1	Use various definitions of power quality for power quality issues
CO2	Describe the concepts related with single phase / three phase, linear / nonlinear loads and single phase / three phase sinusoidal, non-sinusoidal source.
CO3	Solve problems related with mitigation of Power System Harmonics
CO4	Use DSTATCOM for load compensation
CO5	Demonstrate the role of DVR, SAFs UPQC in power distribution systems

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	-	-	3	3	-	3	-	3	3	3	1
CO2	3	3	3	3	-	-	3	3	-	3	-	3	3	3	1
CO3	3	3	3	3	-	-	3	3	-	3	-	3	3	3	1
CO4	3	3	3	3	-	-	3	3	-	3	-	3	3	3	1
CO5	3	3	3	3	-	-	3	3	-	3	-	3	3	3	1

EE4002	HIGH VOLTAGE DIRECT CURRENT TRANSMISSION	L	T	P	C

	3	**0**	**0**	**3**

Objectives

To impart knowledge about the following topics:

- Planning of DC power transmission and comparison with AC power transmission.
- HVDC converters.
- HVDC system control.
- Harmonics and design of filters.
- Power flow in HVDC system under steady state.

UNIT - I	**INTRODUCTION**	**9**
DC Power transmission technology–Comparison of AC and DC transmission–Application of DC transmission–Description of DC transmission system–Planning for HVDC transmission–Modern trends in HVDC technology–DC breakers–Operating problems– HVDC transmission based on VSC –Types and applications of MTDC systems.		**CO1**

UNIT - II	**ANALYSIS OF HVDC CONVERTERS**	**9**
Line commutated converter -Analysis of Graetz circuit with and without overlap –Pulse number– Choice of converter configuration – Converter bridge characteristics– Analysis of a 12 pulse converter– Analysis of VSC topologies and firing schemes.		**CO2**

UNIT - III	**CONVERTER AND HVDC SYSTEM CONTROL**	**9**
Principles of DC link control–Converter control characteristics–System control hierarchy–Firing angle control– Current and extinction angle control–Starting and stopping of DC link –Power control –Higher level controllers –Control of VSC based HVDC link.		**CO3**

UNIT - IV	**REACTIVE POWER AND HARMONICS CONTROL**	**9**
Reactive power requirements in steady state–Sources of reactive power–SVC and STATCOM–Generation of harmonics –Design of AC and DC filters– Active filters.		**CO4**

UNIT - V	**POWER FLOW ANALYSIS IN AC/DC SYSTEMS**	**9**
Per unit system for DC quantities–DC system model –Inclusion of constraints –Power flow analysis –case study		**CO5**

Total Periods:	**45**

Text Books:

1. Padiyar,K.R.,"HVDC power transmission system", New Age International(P)Ltd. New Delhi, Second Edition,2010.
2. Arrillaga, J.,"High Voltage Direct Current Transmission", Peter Pregrinus, London,1983.

References:

1. Kundur P.," Power System Stability and Control", McGraw-Hill,1993.
2. Colin Adamson and Hingorani NG," High Voltage Direct Current Power Transmission", Garraway Limited, London, 1960.
3. Edward Wilson Kimbark," Direct Current Transmission", Vol.I, Wiley inter science, NewYork, London, Sydney,1971.
4. NPTEL Video lecture notes on High Voltage DC Transmission by Dr. S.N. Singh, IIT Kanpur

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Ability to get knowledge about principles, modern trends and planning of DC power transmission and also to know about the comparison with AC power transmission.
CO2	Ability to analyze and understand the concepts of HVDC converters.
CO3	Ability to acquire knowledge on DC link control and its control characteristics.
CO4	Ability to understand the concepts of reactive power management and harmonics control.
CO5	Ability to understand the importance of power flow in HVDC system under steady state.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	3	2	1	1	1	1	1	3	3	3	1
CO2	3	3	3	3	3	2	1	1	1	1	1	3	3	3	1
CO3	3	3	3	3	3	2	1	1	1	1	1	3	3	3	1
CO4	3	3	3	3	3	2	1	1	1	1	1	3	3	3	1
CO5	3	3	3	3	3	2	1	1	1	1	1	3	3	3	1

EE4003	HIGH VOLTAGE ENGINEERING	L	T	P	C
		3	0	0	3

Objectives

- To understand the various types of over voltages in power system and protection methods
- To impart knowledge on breakdown mechanisms of different dielectrics
- To learn about high voltage and high current generation techniques
- To teach the different measurements techniques of high voltages & currents
- To learn the Testing of power apparatus and insulation coordination

UNIT – I	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- Bewley's Lattice diagram -Protection against over voltages		CO1

UNIT – II	DIELECTRIC BREAKDOWN IN GASES, LIQUIDS AND SOLIDS.	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 - Breakdown mechanisms in solid and composite dielectrics.		CO2

UNIT – III	GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS	9
Generation of high D.C. voltages using voltage multiplier circuits - Greinacher Voltage Doubler - Cockroft Walton Voltage Multiplier - Electrostatic generator principle - Van de Graff generator -Generation of high AC voltages: cascaded transformers, Resonant transformer and Tesla coil- Generation of switching surges.		CO3

UNIT – IV	MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS	9
High Resistance with series ammeter – Dividers, Resistance, Capacitance and Mixed dividers – Peak Voltmeter, Generating Voltmeters - Capacitance Voltage Transformers, Electrostatic Voltmeters – Sphere Gaps - High current shunts- Digital techniques in high voltage measurement.		CO4

UNIT – V	HIGH VOLTAGE TESTING & INSULATION COORDINATION	9
High voltage testing of electrical power apparatus as per International and Indian standards – Power frequency, impulse voltage and DC testing of Insulators, circuit breakers, bushing, isolators and transformers- testing of cables-Insulation Coordination		CO5
Total Periods:		**45**

Text Books:

1. 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.

References:

1. L.L. Alston, 'High Voltage Technology', Oxford University Press, First Indian Edition, 2011.
2. Mazen Abdel – Salam, Hussein Anis, Ahdab A-Morshedy, Roshday Radwan, High Voltage Engineering – Theory &Practice, Second Edition Marcel Dekker, Inc., 2010.
3. Subir Ray,' An Introduction to High Voltage Engineering' PHI Learning Private Limited, New Delhi, Second Edition, 2013.
4. C.L. Wadhwa, 'High voltage Engineering', New Age International Publishers, Third Edition, 2010.
5. NPTEL Video lecture notes on High Voltage Engineering by Prof. Ravindra Arora, IIT Kanpur

Course Outcomes (CO)
Upon completion of the course, students will be

CO1	Able to understand the sources and effects of switching surges, lightning and temporary over voltages, corona and its effects in power systems, various protection mechanisms against overvoltage.
CO2	Able to understand the nature of various breakdown mechanisms in gas, liquid and solid dielectrics.
CO3	Able to understand and analyze the various methods of generating high voltage AC, DC and impulse voltages and currents.
CO4	Able to understand and analyze the various methods of measuring high voltage AC, DC and impulse voltages and currents.
CO5	Able to understand and analyze the various methods of testing insulators, circuit breakers, bushings, Isolators and transformers, insulation coordination.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	1	1	3	2	2	2	1	1	1	2	3	2	1
CO2	3	2	1	1	1	2	1	2	1	1	1	3	3	1	1
CO3	3	3	1	2	1	2	1	2	1	1	1	3	3	1	1
CO4	3	3	1	2	1	2	1	2	1	1	1	3	3	1	1
CO5	3	2	1	1	1	2	2	2	1	1	1	3	3	1	1

EE4004	ELECTRIC ENERGY UTILIZATION AND CONSERVATION	L	T	P	C
		3	0	0	3

OBJECTIVES

To impart knowledge on the following Topics

- To study the utilization and conservation of electrical power and energy efficient equipment.
- To understand the principle, design of illumination systems and energy efficiency lamps.
- To study the methods of industrial heating and welding.
- To understand the electric traction systems and their performance.

UNIT - I	**ILLUMINATION**	**9**
Importance of lighting – properties of good lighting scheme – laws of illumination – photometry - types of lamps – lighting calculations – basic design of illumination schemes for residential, commercial, street lighting, factory lighting and flood lighting – LED lighting and energy efficient lamps.		**CO1**

UNIT - II	**REFRIGERATION AND AIR CONDITIONING**	**9**
Refrigeration-Domestic refrigerator and water coolers - Air-Conditioning-Various types of air-conditioning system and their applications, smart air conditioning units – Energy Efficient motors: Standard motor efficiency, need for efficient motors, Motor life cycle, Direct Savings and payback analysis, efficiency evaluation factor.		**CO2**

UNIT - III	**HEATING AND WELDING**	**9**
Role of electric heating for industrial applications – resistance heating – induction heating – dielectric heating - electric arc furnaces. Brief introduction to electric welding – welding generator, welding transformer and the characteristics.		**CO3**

UNIT - IV	**TRACTION**	**9**
Merits of electric traction – requirements of electric traction system – supply systems – mechanics of train movement – traction motors and control – braking – recent trends in electric traction.		**CO4**

UNIT - V	**DOMESTIC UTILIZATION OF ELECTRICAL ENERGY**	**9**
Domestic utilization of electrical energy – House wiring. Induction based appliances, Online and OFF line UPS, Batteries - Power quality aspects – nonlinear and domestic loads – Earthing – Domestic, Industrial and Substation, BEE standards on energy efficiency		**CO5**
Total Periods:		**45**

Text Books:

1. Wadhwa, C.L. “Generation, Distribution and Utilization of Electrical Energy”, New Age International Pvt. Ltd, Reprint edition 2014.
2. Dr.Uppal S.L. and Prof. S. Rao, 'Electrical Power Systems', Khanna Publishers, New Delhi, 15th Edition, 2014.

References:

1. Partab.H, “Art and Science of Utilisation of Electrical Energy”, DhanpatRai and Co, New Delhi, Revised edition 2017.
2. Openshaw Taylor.E, “Utilization of Electrical Energy in SI Units”, Orient Longman Pvt. Ltd, Reprint 2012.
3. Gupta.J.B, “Utilization of Electric Power and Electric Traction”, S.K.Kataria and Sons, Reprint 2013.
4. Cleaner Production – Energy Efficiency Manual for GERIAP, UNEP, Bangkok prepared by National Productivity Council.
5. Energy Efficiency in Electric Utilities, BEE Guide Book, Revised 2015

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Acquire knowledge about the basics of illumination systems based on electrical energy
CO2	Gain knowledge on basics of refrigeration and air conditioning systems and the burden they create on electrical systems

CO3	Understand the process of heating and welding and different types of apparatus used
CO4	Acquire a comprehensive overview of traction systems and their significance
CO5	Understand the application of electrical energy in domestic appliances and energy conservation with BEE standards.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	3	3	1	1	1	1	1	1	1	1	3	1	1
CO2	3	3	3	1	1	1	1	1	1	1	1	2	3	3	1
CO3	3	2	3	3	1	1	1	1	1	1	2	1	3	3	1
CO4	3	3	3	2	2	1	3	1	1	1	1	1	3	3	1
CO5	3	3	3	1	3	1	1	1	1	1	2	1	1	2	1

EE4005	FLEXIBLE AC TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES

To impart knowledge on the following topics

- The start-of-art of the power system
- Performance of power systems with FACTS controllers
- FACTS controllers for load flow and dynamic analysis

UNIT - I	INTRODUCTION	(7+2 Skill) 9
Real and reactive power control in electrical power transmission lines–loads & system compensation-Uncompensated transmission line–shunt and series compensation.		CO1

UNIT - II	STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS	(7+2 Skill) 9
Voltage control by SVC–Advantages of slope in dynamic characteristics–Influence of SVC on system voltage–Design of SVC voltage regulator–TCR-FC-TCR- Modeling of SVC for power flow and fast transient stability– Applications: Enhancement of transient stability – Steady state power transfer –Enhancement of power system damping.		CO2

UNIT - III	THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS	(7+2 Skill) 9
Operation of the TCSC–Different modes of operation–Modelling of TCSC, Variability reactance model– Modelling for Power Flow and stability studies. Applications: Improvement of the system stability limit–Enhancement of system damping.		CO3

UNIT - IV	VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS	(7+2 Skill) 9
Static Synchronous Compensator (STATCOM)–Principle of operation–V-I Characteristics. Applications: Steady state power transfer-enhancement of transient stability-prevention of voltage instability. SSSC-operation of SSSC and the control of power flow–modelling of SSSC in load flow and transient stability studies- Dynamic voltage restorer(DVR).		CO4

UNIT - V	ADVANCED FACTS CONTROLLERS	(7+2 Skill) 9

Interline DVR(IDVR) - Unified Power flow controller (UPFC) - Interline power flow controller (IPFC) - Unified Power quality conditioner (UPQC).	**CO5**
Total Periods:	**45**
SKILL DEVELOPMENT ACTIVITIES (Group Seminar/Mini Project/ Assignment/ Content Preparation / Quiz/ Surprise Test / Solving GATE questions/ etc)	**10**

1. Simulation of FC+TSR connected to IEEE 5 bus system
2. Realization of reactive power, support by SVC in open loop and closed loop control in simulation.
3. Regulation of line flows employing TCSC in closed loop control in simulation
4. Regulation of line flows employing TSSC in closed loop control in simulation
5. Realization of four quadrant operation of VSC in open loop mode in simulation

Text Books:

1. R.Mohan Mathur, Rajiv K.Varma,"Thyristor–Based Facts Controllers for Electrical Transmission Systems", IEEE press andJohnWiley&Sons,Inc,2002.
2. NarainG. Hingorani, "Understanding FACTS-Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers Distributors,Delhi-110006,2011.
3. T.J.E Miller, Power Electronics in power systems, John Wiley and sons.

References:

1. K.R. Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International (P) Limited, Publishers, New Delhi, 2008
2. A.T.John,"FlexibleA.C.TransmissionSystems",InstitutionofElectricalandElectronic Engineers(IEEE), 1999.
3. V.K.Sood, HVDC and FACTS controllers–Applications of Static Converters in Power System, APRIL2004,KluwerAcademic Publishers,2004

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Ability to understand the concepts about load compensation techniques.
CO2	Ability to acquire knowledge on facts devices
CO3	Ability to understand the start-of-art of the power system
CO4	Ability to analyze the performance of steady state and transients of facts controllers
CO5	Ability to study about advanced FACTS controllers.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	2	3	3	1	1	1	1	1	1	1	1	3	1	1
CO2	3	3	3	1	1	1	1	1	1	1	1	2	3	3	1
CO3	3	2	3	3	1	1	1	1	1	1	2	1	3	3	1
CO4	3	3	3	2	2	1	3	1	1	1	1	1	3	3	1
CO5	3	3	3	1	3	1	1	1	1	1	2	1	1	2	1

EE4006	**POWER SYSTEM STABILITY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Objectives

To impart knowledge about the following topics:

- The fundamentals of power systems stability and its classification.
- Small signal stability modelling and analysis of power systems.
- Transient stability modelling of power system and to analyse using numerical methods.
- Voltage stability in power system and the various methods to control the voltageprofile.
- Methods to enhance small-signal & transient stability.

UNIT – I	**INTRODUCTION TO STABILITY**	**9**
Fundamental concepts - Stability and energy of a system - Power System Stability: Definition, Causes, Nature and Effects of disturbances, Classification of stability, Modelling of electrical components - Basic assumptions made in stability studies- Modelling of Synchronous machine for stability studies (classical model) – Rotor dynamics and the swing equation.		**CO1**
UNIT – II	**SMALL - SIGNAL STABILITY**	**9**
Basic concepts and definitions – State space representation, Physical Interpretation ofsmall–signal stability, Eigen properties of the state matrix: Eigen values andeigenvectors, modal matrices, eigen value and stability, mode shape and participationfactor. Small– signal stability analysis of a Single-Machine Infinite Bus (SMIB) Configuration with numerical example.		**CO2**
UNIT – III	**TRANSIENT STABILITY**	**9**
Review of numerical integration methods: modified Euler and Fourth Order Runge- Kutta methods, Numerical stability,. Interfacing of Synchronous machine (classicalmachine) model to the transient stability algorithm (TSA) with partitioned – explicit approaches- Application of TSA to SMIB system.		**CO3**
UNIT – IV	**VOLTAGE STABILITY**	**9**
Factors affecting voltage stability- Classification of Voltage stability-Transmissionsystem characteristics- Generator characteristics- Load characteristics- Characteristics of reactive power compensating Devices- Voltage collapse.		**CO4**
UNIT – V	**ENHANCEMENT OF SMALL-SIGNAL STABILITY AND TRANSIENT STABILITY**	**9**
Power System Stabilizer –. Principle behind transient stability enhancement methods: high-speed fault clearing, regulated shunt compensation, dynamic braking, reactor		**CO5**
	Total Periods:	**45**

Text Books:

1. Power system stability and control ,P. Kundur ; edited by Neal J. Balu, Mark G. Lauby, McGraw-Hill, 2008.
2. R.Ramnujam," Power System Dynamics Analysis and Simulation, PHI Learning Private Limited, New Delhi, 2010.

References:

1. Peter W., Saucer, Pai M.A., "Power System Dynamics and Stability,Pearson Education (Singapore), 9th Edition, 2007.
2. SB. Crary., "Power System Stability", John Wiley & Sons Limited, New Jersey,2002.
3. K.N. Shubhanga, "Power System Analysis" Pearson,2017.
4. Power systems dynamics: Stability and control / K.R. Padiyar, BS Publications,2008
5. Power system control and Stability P.M. Anderson, A.A. Foud, Iowa State University Press,2007.
6. NPTEL Video lecture notes on Power System Stability and Control by Dr. B. Kalyan Kumar, IIT Madras

Course Outcomes (CO)

Upon completion of the course, students will be

CO1	Able to understand the stability problems in power system and dynamic modelling of the synchronous machine.
CO2	Able to understand the small-signal modelling and the stability analysis.
CO3	Able to understand the transient stability modelling and its solution using classical and numerical methods.
CO4	Able to understand the voltage stability problems in power systems and its control.
CO5	Able to understand the design of power system stabilizer and the various methods of enhancing the power system stability.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	2	2	1	1	1	1	1	1	1	2	1	1	3	2	1
CO2	3	2	1	1	1	1	1	1	1	2	1	2	3	2	1
CO3	2	2	1	1	1	1	1	1	1	1	1	2	3	2	1
CO4	2	1	1	1	1	1	1	1	1	1	1	2	3	2	1
CO5	2	2	1	1	1	1	1	1	1	1	1	2	3	2	1

VERTICAL II: CONVERTERS AND DRIVES

EE4007	SPECIAL ELECTRICAL MACHINES	L	T	P	C
		3	0	0	3

Objectives

To impart knowledge about the following topics

- Construction, principle of operation, control and performance of stepping motors.
- Construction, principle of operation, control and performance of switched reluctance motors.
- Construction, principle of operation, control and performance of permanent magnet brushless D.C. motors.
- Construction, principle of operation and performance of permanent magnet synchronous motors.
- Construction, principle of operation and performance of other special Machines.

UNIT – I	STEPPER MOTORS	9
Constructional features –Principle of operation –Types – Torque predictions – Linear Analysis – Characteristics – Drive circuits – Closed loop control – Concept of lead angle – Applications		CO1

UNIT – II	SWITCHED RELUCTANCE MOTORS (SRM)	9
Constructional features –Principle of operation– Torque prediction–Characteristics Steady state performance prediction – Analytical Method – Power controllers – Control of SRM drive– Sensor less operation of SRM – Applications.		CO2

UNIT – III	PERMANENT MAGNET BRUSHLESS D.C. MOTORS	9
Fundamentals of Permanent Magnets– Types– Principle of operation– Magnetic circuit analysis– EMF and Torque equations– Power Converter Circuits and their controllers – Characteristics and control– Applications		CO3

UNIT – IV	PERMANENT MAGNET SYNCHRONOUS MOTORS (PMSM)	9
Constructional features –Principle of operation – EMF and Torque equations – Sine wavemotor with practical windings – Power controllers – performance characteristics –Digital controllers – Applications.		CO4

UNIT – V	OTHER SPECIAL MACHINES	9
Constructional features – Principle of operation and Characteristics of Hysteresis motor– Synchronous Reluctance Motor– Linear Induction motor– Repulsion motor– Applications.		CO5

	Total Periods:	45

Text Books:

1. T. J. E. Miller, 'Brushless Permanent–Magnet and Reluctance Motor Drives', Oxford University Press, 1989.
2. K. Venkataratnam, 'Special Electrical Machines', Universities Press (India) Private Limited, 2008.

References:

1. T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1984
2. E.G. Janardanan, 'Special electrical machines', PHI learning Private Limited, Delhi, 2014R. Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application', CRC Press, New York, 2001.

3. T. Kenjo and S. Nagamori, 'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1988.
4. T. J. E. Miller, 'Brushless Permanent–Magnet and Reluctance Motor Drives', Oxford University Press, 1989.
5. R. Srinivasan, 'Special Electrical Machines', Lakshmi Publications, 2013.
6. NPTEL Video Lecture Notes on "Special Electromechanical Systems" by Prof. Sreenivasa Murthy, IIT Delhi.

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Ability to analyse and design controllers for special Electrical Machines and knowledge on construction and operation of stepper motor.
CO2	Ability to acquire the knowledge on construction and operation of switched reluctance motors.
CO3	Ability to acquire the knowledge on construction and operation of permanent magnet brushless D.C. motors.
CO4	Ability to acquire the knowledge on construction and operation of permanent magnet synchronous motors.
CO5	Ability to select a special Machine for a particular application

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	1	1	1	1	1	1	1	2	1	1	3	2	2
CO2	3	2	1	1	1	1	1	1	1	2	1	2	3	2	2
CO3	3	2	1	1	1	1	1	1	1	1	1	2	3	2	2
CO4	3	1	1	1	1	1	1	1	1	1	1	2	3	2	2
CO5	3	2	1	1	1	1	1	1	1	1	1	2	3	2	2

EE4008	DESIGN OF ELECTRICAL APPARATUS	L	T	P	C
		3	0	0	3

Objectives

To impart knowledge about the following topics:

- Magnetic circuit parameters and thermal rating of various types of electrical machines.
- Armature and field systems for DC Machines.
- Core, yoke, windings and cooling systems of transformers.
- Design of stator and rotor of induction machines and synchronous machines.
- The importance of computer aided design method.

UNIT – I	DESIGN OF FIELD SYSTEM AND ARMATURE	9
Major considerations in Electrical Machine Design – Materials for Electrical apparatus – Design of Magnetic circuits – Magnetising current – Flux leakage – Leakage in Armature. Design of lap winding and wave winding.		CO1

UNIT – II	DESIGN OF TRANSFORMERS	9
Construction - KVA output for single and three phase transformers – Overall dimensions – design of yoke, core and winding for core and shell type transformers – Estimation of No load current –		CO2

Temperature rise in Transformers – Design of Tank and cooling tubes of Transformers. Computer program: Complete Design of single phase core transformer.		
UNIT – III	**DESIGN OF DC MACHINES**	**9**
Construction - Output Equations – Main Dimensions – Choice of specific loadings – Selection of number of poles – Design of Armature – Design of commutator and brushes – design of field Computer program: Design of Armature main dimensions.		**CO3**
UNIT – IV	**DESIGN OF INDUCTION MOTORS**	**9**
Construction - Output equation of Induction motor – Main dimensions – choice of specific loadings – Design of squirrel cage rotor and wound rotor –Magnetic leakage calculations – Operating characteristics : Magnetizing current - Short circuit current – Circle diagram - Computer program: Design of slip-ring rotor.		**CO4**
UNIT – V	**DESIGN OF SYNCHRONOUS MACHINES**	**9**
Output equations – choice of specific loadings – Design of salient pole machines – Short circuit ratio – Armature design – Estimation of air gap length – Design of rotor –Design of damper winding – Determination of full load field MMF – Design of field winding – Design of turbo alternators -Computer program: Design of Stator main dimensions-Brushless DC Machines.		**CO5**
Total Periods:		**45**

Text Books:

1. M V Deshpande 'Design and Testing of Electrical Machines' PHI learning Pvt Lt, 2011.
2. Sen, S.K., 'Principles of Electrical Machine Designs with Computer Programmes', Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, Second Edition,2009.

References:

1. Shanmugasundaram, G.Gangadharan, R.Palani 'Electrical Machine Design Data Book', New Age International Pvt. Ltd., Reprint2007.
1. 'Electrical Machine Design', Balbir Singh, Vikas Publishing House Private Limited, 1981.
2. V Rajini, V.S Nagarajan, 'Electrical Machine Design', Pearson,2017.
3. K.M.Vishnumurthy 'Computer aided design of electrical machines' B S Publications, 2008.
4. Sawhney, A.K., 'A Course in Electrical Machine Design', Dhanpat Rai& Sons, New Delhi, Fifth Edition,1984.
5. NPTEL Video Lecture Notes on "Modelling and Analysis of Electric Machines," by Dr. Krishna Vasudevan, IIT Madras

Course Outcomes (CO)
Upon completion of the course, students will be

CO1	Able to understand the design of field system and armature.
CO2	Able to design the single and three phase transformer.
CO3	Able to design armature and field of DC machines.
CO4	Able to design stator and rotor of induction motor.
CO5	Able to design and analyze synchronous machines.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	2	3	1	3	3	3	3	3	1	1	3	3	2	1

CO2	3	2	1	1	1	1	1	1	2	1	1	2	3	2	1
CO3	3	2	3	2	2	3	3	3	2	3	1	3	3	2	1
CO4	3	3	3	3	3	3	3	3	2	3	1	3	2	3	1
CO5	3	3	3	3	3	2	3	3	1	3	3	2	3	3	1

EE4009	**MULTILEVEL POWER CONVERTERS**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

Objectives

- To learn multilevel topology (Symmetry & Asymmetry) with common DC bus link.
- To study the working of cascaded H Bridge, Diode Clamped and Flying Capacitor MLI.
- To study the working of MLI with reduced switch count.
- To simulate three level diode clamped MLI and three level flying capacitor based MLI with resistive and reactive load
- To simulate the MLI with reduced switch count.

UNIT – I	**MULTILEVEL TOPOLOGIES**	**6**
Introduction – Generalized Topology with a Common DC bus – Converters derived from the generalized topology – symmetric topology without a common DC link – Asymmetric topology.		**CO1**

UNIT – II	**CASCADED H-BRIDGE MULTILEVEL INVERTERS**	**6**
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		**CO2**

UNIT – III	**DIODE CLAMPED MULTILEVEL CONVERTER**	**6**
Introduction – Converter structure and Functional Description – Modulation of Multilevel converters – Voltage balance Control – Effectiveness Boundary of voltage balancing in DCMC converters – Performance results.		**CO3**

UNIT – IV	**FLYING CAPACITOR MULTILEVEL CONVERTER**	**6**
Introduction – Flying Capacitor topology – Modulation scheme for the FCMC – Dynamic voltage balance of FCMC.		**CO4**

UNIT – V	**MULTILEVEL CONVERTER WITH REDUCED SWITCH COUNT**	**6**
Multilevel inverter with reduced switch count-structures, working principles and pulse generation methods.		**CO5**

Total Periods:	**30**

LAB COMPONENT: **30 PERIODS**

1. Simulation of Fixed PWM, Sinusoidal PWM for an inverter,
2. Simulation of H bridge inverter with R load.
3. Simulation of three level diode clamped MLI with R load.
4. Simulation of three level capacitor clamped MLI with R load
5. Simulation of MLI with reduced switch configuration.

TOTAL: 30+30 = 60 PERIODS

Text Books:

1. Rashid M.H, "Power Electronics Circuits, Devices and Applications", Prentice Hall India, Third Edition, New Delhi, 2014 Pearson 4th edition.
2. Sergio Alberto Gonzalez, Santiago Andres Verne, Maria Ines Valla, "Multilevel Converters for Industrial Applications", CRC Press, 22-Jul-2013, 2017 1st Edition.
3. BinWu, Mehdi Narimani, High Power Converters and AC drives by IEEE press 2017, 2nd 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, 1st Edition.
4. Ersan Kabalcı, Multilevel Inverters Introduction and Emergent Topologies, Academic Press Inc,2021, 1st Edition.
5. Iftekhar Maswood, Dehghani Tafti,Advanced Multilevel Converters and Applications in Grid Integration, Wiley, 2018, 1st Edition.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Examine the different topologies of multilevel inverters (MLIs) with and without DC link capacitor
CO2	Demonstrate the working principles of Cascaded H-Bridge MLI, diode clamped MLI, flying capacitor MLI and MLI with reduced switch count
CO3	Analyze the voltage balancing performance in Diode clamped MLI.
CO4	Simulate three level, capacitor clamed and diode clamped MLI with R and RL load.
CO5	Simulate MLI with reduced switch configuration using fundamental switching scheme.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	2	3	-	-	2	1	-	3	-	3	3	3	1
CO2	3	2	2	3	-	-	2	1	-	3	-	3	3	3	1
CO3	3	3	3	3	-	-	2	1	-	3	-	3	3	3	1
CO4	3	3	3	3	3	-	2	1	-	3	-	3	3	3	1
CO5	3	3	3	3	3	-	2	1	-	3	-	3	3	3	1

EE4010	ELECTRIC VEHICLE	L	T	P	C
		2	0	2	3

Objectives

- To provide knowledge of the operation and dynamics of electrical vehicles
- To impart knowledge on vehicle control for standard drive cycles of electrical vehicles (EVs)
- To estimate the energy requirement of EVs and Hybrid Electric Vehicles (HEVs)
- To provide knowledge about different energy sources and energy management in HEVs.
- To provide knowledge of supervisory control of EVs

UNIT - I	INTRODUCTION TO CONVENTIONAL AND ELECTRIC VEHICLES	6

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics. **Electric Vehicle:** EV system-History of evolution of Electric Vehicles - Series parallel architecture of Hybrid Electric Vehicles (HEV) - Plug-in Hybrid Electric Vehicles (PHEV)- Power train components and sizing, Gears, Clutches, Transmission and Brakes.	**CO1**

UNIT - II	**MECHANICS OF ELECTRIC VEHICLES**	**6**
Fundamentals of vehicle mechanics - tractive force, power and energy requirements for standard drive cycles of EV's - motor torque and power rating and battery capacity.		**CO2**

UNIT - III	**CONTROL OF DC AND AC MOTOR DRIVES**	**6**
Speed control for constant torque, constant HP operation of all electric motors - DC/DC chopper based four quadrant operation of DC motor drives, inverter based V/f Operation (motoring and braking) of induction motor drives, vector control operation of Induction motor and PMSM, Brushless DC motor drives, Switched reluctance motor (SRM) drives.		**CO3**

UNIT - IV	**ENERGY STORAGE AND MANAGEMENT SYSTEMS**	**6**
Battery: Principle of operation, types, models, Estimation of SOC & SOH, Traction Batteries and their capacity for standard drive cycles. **Alternate sources:** Fuel cells, Ultra capacitors, Fly wheels. Energy management systems-Classification of different management strategies		**CO4**

UNIT - V	**HYBRID VEHICLE CONTROL STRATEGY**	**6**
HEV supervisory control - Selection of modes - power spilt mode - parallel mode - engine brake mode - regeneration mode - series parallel mode.		**CO5**

Total Periods:	**30**

LAB COMPONENT: **30 PERIODS**

1. Simulation of buck, boost and buck boost converter-open loop
2. Simulation of boost converter based power factor correction.
3. Simulation of energy storage system for EV.
4. Lithium Ion Battery Handling
5. BLDC Hub Motor Control for EV

TOTAL: 30+30 = 60 PERIODS

Text Books:

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. Iqbal Husain, "Electric and Hybrid vehicles: Design fundamentals", CRC PRESS, Boca Raton London, New York Washington D.C, 2005.

References:

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. Larminie, James, and John Lowry, "Electric Vehicle Technology Explained" John Wiley and Sons, 2012.
4. Tariq Muneer and Irene Illescas García, "The automobile, In Electric Vehicles: Prospects and Challenges", Elsevier, 2017.
5. Sheldon S. Williamson, "Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles", Springer, 2013.

6. Wei Liu, "Hybrid Electric Vehicle System Modeling and Control", Second Edition, WILEY, 2017.
7. NPTEL Video Lecture Notes on “Electric Vehicles” By Prof. Amit Jain, IIT Delhi

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Learn the significance of Electric Vehicle compared to conventional vehicles.
CO2	Understand the mechanics of Electric Vehicles.
CO3	Acquire knowledge in Control of DC And AC Motor Drives.
CO4	Understand the analyse the different strategies related to battery technology and energy storage systems.
CO5	Acquire knowledge in control strategy for Hybrid Vehicle & Battery management systems for EV

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	3	2	2	1	3	2	3	3	3	3	1
CO2	3	3	3	3	3	2	2	1	3	2	3	2	3	3	1
CO3	3	3	3	3	2	2	2	1	2	2	3	3	3	3	1
CO4	3	3	3	3	3	3	3	1	3	3	3	3	3	3	1
CO5	3	3	3	3	3	3	3	1	3	3	3	3	3	3	1

EE4011	LINE COMMUTATED & ACTIVE RECTIFIERS	L	T	P	C
		3	0	0	3

Objectives

To impart knowledge about the following topics:

- Able to understand the diode, thyristor rectifiers with passive filtering
- Able to understand the multi pulse converter
- Able to understand the single–phase ac–dc single–switch boost converter
- Able to understand the isolated single–phase ac–dc flyback converter

UNIT – I	DIODE RECTIFIERS WITH PASSIVE FILTERING	9
Half–wave diode rectifier with RL and RC loads; 1–phase full–wave diode rectifier with L, C and LC filter; 3–phase diode rectifier with L, C and LC filter; continuous and discontinuous conduction, input current waveshape, effect of source inductance; commutation overlap.		CO1

UNIT – II	THYRISTOR RECTIFIERS WITH PASSIVE FILTERING	9
Half–wave thyristor rectifier with RL and RC loads; 1–phase thyristor rectifier with L and LC filter; 3–phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current waveshape.		CO2

UNIT – III	MULTI–PULSE CONVERTER	9

Review of transformer phase shifting, generation of 6–phase ac voltage from 3–phase ac, 6–pulse converter and 12–pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation.	**CO3**

UNIT – IV	**SINGLE–PHASE AC–DC SINGLE–SWITCH BOOST CONVERTER**	**9**
Review of dc–dc boost converter, power circuit of single–switch ac–dc converter, steady state analysis, unity power factor operation, closed–loop control structure. Review of 1–phase inverter and 3–phase inverter, power circuits of 1–phase and 3–phase ac–dc boost converter, steady state analysis, operation at leading, lagging and unity power factors. Rectification and regenerating modes. Phasor diagrams, closed–loop control structure.		**CO4**

UNIT – V	**ISOLATED SINGLE–PHASE AC–DC FLYBACK CONVERTER**	**9**
Dc–dc flyback converter, output voltage as a function of duty ratio and transformer turns ratio. Power circuit of ac–dc flyback converter, steady state analysis, unity power factor operation, closed loop control structure.		**CO5**

Total Periods:	**45**

Text Books:

1. G. De, 'Principles of Thyristorised Converters', Oxford & IBH Publishing Co, 1988.
2. J.G. Kassakian, M. F. Schlecht and G. C. Verghese, 'Principles of Power Electronics', Addison–Wesley, 1991.

References:

1. N. Mohan and T. M. Undeland, 'Power Electronics: Converters, Applications and Design', John Wiley & Sons, 2007.
2. R. W. Erickson and D. Maksimovic, 'Fundamentals of Power Electronics', Springer Science &Business Media, 2001.
3. L. Umanand, 'Power Electronics: Essentials and Applications', Wiley India, 2009.
4. NPTEL Video Lecture Notes on "DC Power Transmission Systems " By Prof. Amit Jain, IIT Delhi.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Analyse controlled rectifier circuits.
CO2	Understand the operation of line–commutated rectifiers with passive filtering.
CO3	Understand the operation of multi pulse converter.
CO4	Understand the operation of PWM rectifiers – operation in rectification and regeneration modes and lagging, leading and unity power factor mode
CO5	Know the concepts about the flyback converter

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	2	3	1	1	1	1	1	1	1	1	1	3	1	1
CO2	3	2	3	1	1	1	1	1	1	1	1	1	3	1	1
CO3	3	2	3	2	1	1	1	1	1	1	1	1	3	3	2
CO4	3	2	3	2	1	1	1	1	1	1	1	1	3	3	2

CO5	3	1	3	1	1	1	1	1	1	1	1	1	2	3	1

EE4012	**POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Objectives

To impart knowledge about the following topics:

- To provide knowledge about the stand alone and grid connected renewable energy systems.
- To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
- To analyse and comprehend the various operating modes of wind electrical generators and solar energy systems.
- To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.
- To develop maximum power point tracking algorithms.

UNIT – I	**INTRODUCTION**	**9**
Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.		**CO1**

UNIT – II	**ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION**	**9**
Reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.		**CO2**

UNIT – III	**POWER CONVERTERS**	**9**
Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing Wind: Three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters.		**CO3**

UNIT – IV	**ANALYSIS OF WIND AND PV SYSTEMS**	**9**
Stand alone operation of fixed and variable speed wind energy conversion systems and solar system- Grid connection Issues -Grid integrated PMSG, SCIG Based WECS, grid Integrated solar system		**CO4**

UNIT – V	**HYBRID RENEWABLE ENERGY SYSTEMS**	**9**
Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV Maximum Power Point Tracking (MPPT).		**CO5**

Total Periods:	**45**

Text Books:

1. S. N. Bhadra, D.Kastha, S.Banerjee, "Wind Electrical Systems", Oxford University Press, 2005.
2. B.H.Khan Non-conventional Energy sources Tata McGraw-hill Publishing Company, New Delhi, 2009.

References:

1. Rashid .M. H "power electronics Hand book", Academic press, 2001.
2. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.

3. Rai. G.D, “Non conventional energy sources”, Khanna publishes, 1993.
4. Gray, L. Johnson, “Wind energy system”, prentice hall linc, 1995.
5. Andrzej M. Trzynnadlowski, ‘Introduction to Modern Power Electronics’, Second edition, wiley India Pvt. Ltd, 2012.
6. NPTEL Video Lecture Notes on “Advance Power electronics and Control” by Prof. Avik Bhattacharya, IIT Roorkee.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Analyse impacts of renewable energy generation on environment.
CO2	Understand the operation of electrical machines for renewable energy conversion.
CO3	Understand the operation of converters used in renewable energy conversion.
CO4	Analyse the working of wind and PV systems.
CO5	Know the concepts about hybrid renewable energy systems.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	3	1	1	1	1	1	1	1	1	1	3	1	1
CO2	3	2	3	1	1	1	1	1	1	1	1	1	3	1	1
CO3	3	2	3	2	1	1	1	1	1	1	1	1	3	3	2
CO4	3	2	3	2	1	1	1	1	1	1	1	1	3	3	2
CO5	3	1	3	1	1	1	1	1	1	1	1	1	2	3	1

VERTICAL III – EMBEDDED SYSTEMS

EE4013	DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

Objectives

To impart knowledge about the following topics:

- Signals and systems & their mathematical representation.
- Discrete time systems.
- Transformation techniques & their computation.
- Filters and their design for digital implementation.
- Programmability digital signal processor & quantization effects.

UNIT – I	INTRODUCTION	9
Classification of systems: Continuous, discrete, linear, causal, stability, dynamic, recursive, time variance; classification of signals: continuous and discrete, energy and power; mathematical representation of signals; spectral density; sampling techniques, quantization, quantization error, Nyquist rate, aliasing effect.		**CO1**

UNIT – II	DISCRETE TIME SYSTEM ANALYSIS	9
Z-transform and its properties, inverse z-transforms; difference equation – Solution by ztransform, application to discrete systems - Stability analysis, frequency response – Convolution – Discrete Time Fourier transform , magnitude and phase representation.		**CO2**

UNIT – III	DISCRETE FOURIER TRANSFORM & COMPUTATION	9
Discrete Fourier Transform- properties, magnitude and phase representation - Computation of DFT using FFT algorithm – DIT &DIF using radix 2 FFT – Butterfly structure.		**CO3**

UNIT – IV	DESIGN OF DIGITAL FILTERS	9
FIR & IIR filter realization – Parallel & cascade forms. FIR design: Windowing Techniques – Need and choice of windows – Linear phase characteristics. Analog filter design – Butterworth and Chebyshev approximations; IIR Filters, digital design using impulse invariant and bilinear transformation Warping, pre warping.		**CO4**

UNIT – V	DIGITAL SIGNAL PROCESSORS	9
Introduction – Architecture – Features – Addressing Formats – Functional modes - Introduction to Commercial DS Processors.		**CO5**

Total Periods:	**45**

Text Books:

1. J.G. Proakis and D.G. Manolakis, 'Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, New Delhi, PHI. 2003.
2. S.K. Mitra, 'Digital Signal Processing – A Computer Based Approach', McGraw Hill Edu, 2013.

References:

1. Poorna Chandra S, Sasikala. B, Digital Signal Processing, Vijay Nicole/TMH,2013.
2. Robert Schilling & Sandra L.Harris, Introduction to Digital Signal Processing using MATLAB", Cengage Learning,2014.

3. B.P.Lathi, 'Principles of Signal Processing and Linear Systems', Oxford University Press, 2010
4. Taan S. ElAli, 'Discrete Systems and Digital Signal Processing with Mat Lab', CRC Press, 2009.
5. Lonnie C. Ludeman ,"Fundamentals of Digital Signal Processing",Wiley,2013.
6. Dimitris G.Manolakis, Vinay K. Ingle, Applied Digital Signal Processing, Cambridge,2012
7. NPTEL Video Lecture Notes on "Digital Signal Processing" by Prof. S.C.Dutta Roy, IIT Delhi.

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Ability to acquire knowledge on Signals and systems & their mathematical representation.
CO2	Ability to understand and analyze the discrete time systems.
CO3	Ability to analyze the transformation techniques & their computation.
CO4	Ability to understand the types of filters and their design for digital implementation.
CO5	Ability to acquire knowledge on programmability digital signal processor & quantization effects.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	3	3	3	2	1	1	1	2	1	3	2	3	1
CO2	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1
CO3	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1
CO4	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1
CO5	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1

EE4014	MEMS AND NEMS	L	T	P	C
		3	0	0	3

Objectives

- To introduce the concepts of micro and nano electromechanical devices
- To know the fabrication process of Microsystems
- To know the design concepts of micro sensors and micro actuators
- To introduce the concepts of quantum mechanics and nano systems

UNIT – I	INTRODUCTION TO MEMS AND NEMS	9
Introduction to Design of MEMS and NEMS, Overview of Nano and Micro electromechanical Systems, Applications of Micro and Nano electromechanical systems, Materials for MEMS and NEMS: Silicon, silicon compounds, polymers, metals.		CO1

UNIT – II	MEMS FABRICATION TECHNOLOGIES	9
Photolithography, Ion Implantation, Diffusion, Oxidation, CVD, Sputtering Etching techniques, Micromachining: Bulk Micromachining, Surface Micromachining, LIGA.		CO2

UNIT – III	MICRO SENSORS	9
MEMS Sensors: Design of Acoustic wave sensors, Vibratory gyroscope, Capacitive Pressure sensors, Case study: Piezoelectric energy harvester.		CO3

UNIT – IV	MICRO ACTUATORS	9
Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces, Case Study:RF Switch.		CO4

UNIT – V	NANO DEVICES	9
Atomic Structures and Quantum Mechanics, Shrodinger Equation, ZnO nanorods based NEMS device: Gas sensor.		CO5

Total Periods: 45

Text Books:

1. Marc Madou, "Fundamentals of Microfabrication", CRC press 1997.
2. Stephen D. Senturia," Micro system Design", Kluwer Academic Publishers, 2001

References:

1. Tai Ran Hsu ,"MEMS and Microsystems Design and Manufacture" ,Tata Mcraw Hill, 2002.
2. Chang Liu, "Foundations of MEMS", Pearson education India limited, 2006,
3. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures" CRC Press, 2002
4. NPTEL Video Lecture Notes on "MEMS and Microsystems" by Prof. Santiram Kal, IIT Kharagpur.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Interpret the basics of micro/nano electromechanical systems including their applications and advantages
CO2	Recognize the use of materials in micro fabrication and describe the fabrication processes including surface micromachining, bulk micromachining and LIGA.
CO3	Analyze the key performance aspects of sensors.
CO4	Analyze the key performance aspects of actuators.
CO5	Comprehend the theoretical foundations of quantum mechanics and Nano systems

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	3	3	3	2	1	1	1	2	1	3	2	3	1
CO2	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1
CO3	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1
CO4	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1
CO5	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1

EE4015	OPERATING SYSTEMS	L	T	P	C
		3	0	0	3

UNIT – I	OPERATING SYSTEMS OVERVIEW	9

Operating system overview: Objectives – functions - Computer System Organization-Operating System Structure - Operating System Operations- System Calls, System Programs.		**CO1**
UNIT – II	**PROCESS MANAGEMENT**	**9**
Processes: Process Concept - Process Scheduling - Operations on Processes – Inter process Communication. Process Synchronization: The Critical-Section Problem - Semaphores - Classic Problems of Synchronization – Monitors.		**CO2**
UNIT – III	**SCHEDULING AND DEADLOCK MANAGEMENT**	**9**
CPU Scheduling: Scheduling Criteria - Scheduling Algorithms. Deadlocks: Deadlock Characterization - Methods for Handling Deadlocks - Deadlock Prevention - Deadlock Avoidance - Deadlock Detection - Recovery from Deadlock.		**CO3**
UNIT – IV	**MEMORY MANAGEMENT**	**9**
Main Memory: Swapping - Contiguous Memory Allocation, Segmentation, Paging. Virtual Memory: Demand Paging - Page Replacement - Allocation of Frames - Thrashing.		**CO4**
UNIT – V	**STORAGE MANAGEMENT**	**9**
Mass Storage Structure: Disk Structure - Disk Scheduling - Disk Management. File-System Interface: File Concepts, Directory Structure - File Sharing – Protection. File System. Case Study: Linux operating system and Windows10		**CO5**
	Total Periods:	**45**

Text Books:

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, "Operating System Concepts", 9th Edition, John Wiley and Sons Inc., 2012.
2. Richard Petersen, "Linux: The Complete Reference", 6th Edition, Tata McGraw-Hill, 2008.

References:

1. Andrew S. Tanenbaum, "Modern Operating Systems", 4th Edition, Prentice Hall, Wesley, 2014.
2. William Stallings, "Operating Systems – Internals and Design Principles", 7th Edition, Prentice Hall, 2011.
3. Harvey M. Deitel, "Operating Systems", 7th Edition, Prentice Hall, 2003.
4. D M Dhamdhere, "Operating Systems: A Concept-Based Approach", 2nd Edition, Tata McGraw-Hill Education, 2007.
5. Charles Crowley, "Operating Systems: A Design-Oriented Approach", Tata McGraw Hill Education", 1996.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Explain the operating system program, structures and operations with system calls
CO2	Apply the process management concept for real time problems.
CO3	Illustrate CPU scheduling algorithms and to handle the deadlock for the given situation.
CO4	Explain the concepts of various memory management techniques.
CO5	Summarize the storage concepts of disk and file.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	1	2	2	-	-	-	-	-	-	-	-	-	2	3	1
CO2	1	3	2	2	2	-	1	2	1	-	1	2	3	3	1
CO3	1	3	2	2	1	-	-	-	1	-	-	-	3	3	1
CO4	1	2	2	2	1	-	-	2	-	-	-	1	3	3	1
CO5	1	2	2	1	-	1	-	-	-	-	-	1	3	3	1

EE4016	MICROCONTROLLER BASED SYSTEM DESIGN	L	T	P	C
		3	0	0	3

Objectives

To impart knowledge about the following topics:

- Architecture of PIC microcontroller
- Interrupts and timers
- Peripheral devices for data communication and transfer
- Functional blocks of ARM processor
- Architecture of ARM processors

UNIT - I	INTRODUCTION TO PIC MICROCONTROLLER	9
Introduction to PIC Microcontroller–PIC 16C6x and PIC16C7x Architecture- Pipelining - Program Memory considerations – Register File Structure - Instruction Set - Addressing modes – Simple Operations.		CO1

UNIT - II	INTERRUPTS AND TIMER	9
PIC micro controller Interrupts- External Interrupts-Interrupt Programming–Loop time subroutine Timers-Timer Programming– Front panel I/O-Soft Keys– State machines and key switches– Display of Constant and Variable strings.		CO2

UNIT - III	PERIPHERALS AND INTERFACING	9
I^2C Bus for Peripherals Chip Access: Bus operation-Bus subroutines– Serial EEPROM-Analog to Digital Converter, UART-Baud rate selection–Data handling circuit–Initialization , LCD and keyboard Interfacing, ADC, DAC and Sensor Interfacing.		CO3

UNIT - IV	ARM ORGANIZATION	9
3-Stage Pipeline ARM Organization– 5-Stage Pipeline ARM Organization–ARM Instruction Execution - ARM Implementation– ARM Instruction Set– ARM coprocessor interface– Architectural support for High Level Languages		CO4

UNIT - V	APPLICATIONS	9
Embedded ARM & PIC Applications. Temperature control system –stepper motor control - Usage of IDE for assembly language programming.		CO5

Total Periods:	45

Text Books:

1. Peatman,J.B., "Design with PIC Micro Controllers"PearsonEducation,3rdEdition, 2004.
2. Furber,S., "ARM System on Chip Architecture" Addison Wesley trade Computer Publication, 2000.

References:

1. Mazidi M.A.,"PIC Microcontroller" Rollin Mckinlay, Danny causey, Prentice Hall of India, 2007.
2. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey 'PIC Microcontroller and Embedded Systems using Assembly and C for PIC18', Pearson Education 2008
3. John Iovine, 'PIC Microcontroller Project Book', McGraw Hill 2000
4. NPTEL Video Lecture Notes on "Embedded System Design with ARM" by Prof. Indranil Sengutta, Prof. Kamalika Datta, IIT Kharagpur.

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Ability to understand the concepts of Architecture of PIC microcontroller
CO2	Ability to acquire knowledge on Interrupts and timers.
CO3	Ability to understand the importance of Peripheral devices for data communication and to understand the basics of sensor interfacing
CO4	Ability to acquire knowledge in Architecture of ARM processors
CO5	Ability to acquire knowledge on ARM Organization in embedded application.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	3	3	3	2	1	1	1	2	1	3	2	3	3
CO2	3	3	3	3	3	2	1	1	1	2	1	3	3	3	3
CO3	3	3	3	3	3	2	1	1	1	2	1	3	3	3	3
CO4	3	3	3	3	3	2	1	1	1	2	1	3	3	3	3
CO5	3	3	3	3	3	2	1	1	1	2	1	3	3	3	3

EE4017	VLSI DESIGN	L	T	P	C
		3	0	0	3

Objectives

To impart knowledge about the following topics:

- This course deals comprehensively with all aspects of transistor level design of all the digital building blocks common to all CMOS microprocessors, DPSs, network processors, digital backend of all wireless systems etc.
- The focus will on the transistor level design and will address all important issues related to size, speed and power consumption.
- The units are classified according to the important building and will introduce the principles and design methodology in terms of the dominant circuit choices, constraints and performance measures.

UNIT - I	MOS TRANSISTOR PRINCIPLES AND CMOS INVERTER	9
MOS(FET) Transistor Characteristic under Static and Dynamic Conditions, MOS Transistor Secondary Effects, Process Variations, Technology Scaling, CMOS Inverter - Static Characteristic, Dynamic Characteristic, Power, Energy, and Energy Delay parameters.		**CO1**

UNIT - II	COMBINATIONAL LOGIC CIRCUITS	9
Propagation Delays, Stick diagram, Layout diagrams, Examples of combinational logic design, Elmore's constant, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation, Low Power Design principles.		**CO2**

UNIT - III	SEQUENTIAL LOGIC CIRCUITS	9
Static Latches and Registers, Dynamic Latches and Registers, Timing Issues, Pipelines, Pulse and sense amplifier based Registers, Nonbistable Sequential Circuits		**CO3**

UNIT - IV	ARITHMETIC BUILDING BLOCKS AND MEMORY ARCHITECTURES	9
Data path circuits, Architectures for Adders, Accumulators, Multipliers, Barrel Shifters, Speed and Area Tradeoffs, Memory Architectures, and Memory control circuits.		**CO4**

UNIT - V	INTERCONNECT AND CLOCKING STRATEGIES	9
Interconnect Parameters – Capacitance, Resistance, and Inductance, Electrical Wire Models, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design.		**CO5**

Total Periods:	**45**

Text Books:

1. Neil H.E. Weste, David Money Harris "CMOS VLSI Design: A Circuits and Systems Perspective", 4th Edition, Pearson , 2017
2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje. Nikolic, "Digital Integrated Circuits:A Design perspective", Second Edition, Pearson, 2016.

References:

1. Jacob Baker "CMOS: Circuit Design, Layout, and Simulation, Third Edition", Wiley IEEE Press 2010 3rd Edition
2. M J Smith, "Application Specific Integrated Circuits", Addisson Wesley, 1997.
3. Sung-Mo kang, Yusuf leblebici, Chulwoo Kim "CMOS Digital Integrated Circuits:Analysis & Design",4th edition McGraw Hill Education,2013
4. NPTEL Video Lecture Notes on "CMOS Digital VLSI Design" by Prof. Sudeb Dasgupta, IIT Roorkee.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Realize the concepts of digital building blocks using MOS transistor.
CO2	Design combinational MOS circuits and power strategies.
CO3	Design and construct Sequential Circuits and Timing systems.
CO4	Design arithmetic building blocks and memory subsystems.
CO5	Apply and implement FPGA design flow and testing.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**

CO1	3	2	3	3	3	2	1	1	1	2	1	3	2	3	1	
CO2	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1	
CO3	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1	
CO4	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1	
CO5	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1	

EE4018	**SMART SYSTEM DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Objectives

To impart knowledge about the following topics:

1. To understand about the smart system technologies and its role in real time applications
2. To expose students to different open-source platforms and attributes.
3. To teach the architecture and requirements of Home Automation.
4. To provide an insight into smart appliances and energy management concepts.
5. To familiarize the design and development of embedded system based system design..

UNIT - I	**INTRODUCTION**	**9**
Overview of a smart system - Design Requirements - Hardware and software selection & co-design - Smart sensors and Actuators – Communication protocols used in smart systems – Data Analytics: Need & Types – Open-source Analytics Platform for embedded systems (IFTTT &Thingspeak) – Smart Microcontrollers - Embedded system for Smart card design and development – Recent trends.		**CO1**

UNIT - II	**HOME AUTOMATION**	**9**
Home Automation – Design Considerations: Control Unit, Sensing Requirements, Communication, Data Security - System Architecture - Essential Components - Linux and Raspberry Pi – Design and Real-Time implementation.		**CO2**

UNIT - III	**SMART APPLIANCES AND ENERGY MANAGEMENT**	**9**
Energy Management: Demand-side Load Management: Energy scheduling – Significance of smart appliances in energy management - Embedded and Integrated Platforms for Energy Management - Smart Meters: Significance, Architecture & Energy Measurement Technique - Smart Networks for Embedded Appliances – Security Considerations.		**CO3**

UNIT - IV	**SMART WEARABLE DEVICES**	**9**
Application of Smart Wearables in Healthcare & Activity Monitoring - Functional requirements– Selection of body sensors, Hardware platform, OS and Software platform – Selection of suitable communication protocol. Case Study: Design of a wearable, collecting heart-beat, temperature and monitoring health status using a smartphone application.		**CO4**

UNIT - V	**EMBEDDED SYSTEMS AND ROBOTICS**	**9**
Robots and Controllers components - Aerial Robotics - Mobile Robot Design - Three-Servo Ant Robot - Autonomous Hex copter System.		**CO5**

Total Periods:	**45**

Text Books:

1. Raj Kamal, "Embedded Systems - Architecture, Programming and Design", McGraw- Hill, 2008
2. Nilanjan Dey, Amartya Mukherjee, "Embedded Systems and Robotics with Open-Source Tools", CRC press, 2016.

References:

1. Thomas Braunl, "Embedded Robotics", Springer, 2003.
2. Grimm, Christoph, Neumann, Peter, Mahlknech and Stefan, "Embedded Systems for Smart Appliances and Energy Management", Springer 2013.
3. Robert Faludi, "Wireless Sensor Networks", O'Reilly, 2011.
4. Karim Yaghmour, "Embedded Android", O'Reilly, 2013.
5. Steven Goodwin, "Smart Home Automation with Linux and Raspberry Pi", Apress, 2013

Course Outcomes (CO)
Upon completion of the 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	Apply and improve Employability and entrepreneurship capacity due to knowledge upgradation on embedded system technologies.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	3	3	3	2	1	1	1	2	1	3	2	3	1
CO2	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1
CO3	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1
CO4	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1
CO5	3	3	3	3	3	2	1	1	1	2	1	3	3	3	1

VERTICAL IV: ADVANCED CONTROL

EE4019	INDUSTRIAL AUTOMATION	L	T	P	C
		3	0	0	3

Objectives

- To educate on design of signal conditioning circuits for various applications.
- To Introduce signal transmission techniques and their design.
- Study of components used in data acquisition systems interface techniques.
- To educate on the components used in distributed control systems.
- To introduce the communication buses used in automation industries.

UNIT - I	INTRODUCTION	9
Automation overview, Requirement of automation systems, Architecture of Industrial Automation system, Introduction of PLC and supervisory control and data acquisition (SCADA). Industrial bus systems : Modbus &Profibus		**CO1**

UNIT - II	AUTOMATION COMPONENTS	9
Sensors for temperature, pressure, force, displacement, speed, flow, level, humidity and pH measurement. Actuators, process control valves, power electronics devices DIAC, TRIAC, power MOSFET and IGBT. Introduction of DC and AC servo drives for motion control.		**CO2**

UNIT - III	COMPUTER AIDED MEASUREMENT AND CONTROL SYSTEMS	9
Role of computers in measurement and control, Elements of computer aided measurement and control, man-machine interface, computer aided process control hardware, process related interfaces, Communication and networking, Industrial communication systems, Data transfer techniques, Computer aided process control software, Computer based data acquisition system, Internet of things (IoT) for plant automation		**CO3**

UNIT – IV	PROGRAMMABLE LOGIC CONTROLLERS	9
Programmable controllers, Programmable logic controllers, Analog digital input and output modules, PLC programming, Ladder diagram, Sequential flow chart, PLC Communication and networking, PLC selection, PLC Installation, Advantage of using PLC for Industrial automation, Application of PLC to process control industries.		**CO4**

UNIT – V	DISTRIBUTED CONTROL SYSTEM	9
Overview of DCS, DCS software configuration, DCS communication, DCS Supervisory Computer Tasks, DCS integration with PLC and Computers, Features of DCS, Advantages of DCS.		**CO5**

Total Periods:	**45**

Text Books:

1. S.K.Singh, "Industrial Instrumentation", Tata Mcgraw Hill, 2nd edition companies,2003.
2. C D Johnson, "Process Control Instrumentation Technology", Prentice Hall India,8th Edition, 2006.

References:

1. E.A.Parr, Newnes ,NewDelhi,"Industrial Control Handbook",3rd Edition, 2000.
2. Gary Dunning, Thomson Delmar, "Programmable Logic Controller", Ceneage Learning, 3rd Edition, 2005.

3. NPTEL Video Lecture Notes on "Industrial Automation and Control" by Prof. S. Mukhopadhyay, Prof. S. Sen, IIT Kharagpur.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Understand the basics and Importance of communication buses in applied automation Engineering.
CO2	Apply the various sensors in industrial process control.
CO3	Study the basic principles of computer aided measurement.
CO4	Implement programmable logic controllers for industrial automation.
CO5	Acquire detailed knowledge on data acquisition system.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	2	3	3	3	3	2	3	1	1	3	3	1	3	2	1
CO2	3	3	3	3	3	2	3	1	1	3	3	1	3	3	1
CO3	2	3	3	3	3	2	3	1	1	3	3	1	3	3	1
CO4	3	3	3	3	3	2	3	1	1	3	3	1	3	3	1
CO5	2	3	3	3	3	2	3	1	1	3	3	1	3	3	1

EE4020	SYSTEM IDENTIFICATION AND ADAPTIVE CONTROL	L	T	P	C
		3	0	0	3

Objectives

To impart knowledge about the following topics:

- The concept of system identification and adaptive control
- Black-box approach based system identification
- Batch and recursive identification
- Computer Controlled Systems
- Design concept for adaptive control schemes

UNIT - I	NON-PARAMETRIC METHODS	9
Non-parametric methods - Transient analysis - frequency analysis - Correlation analysis - Spectral analysis - Input signal design for identification		CO1

UNIT - II	PARAMETRIC METHODS	9
Least squares estimation – Analysis of the least squares estimate - Best linear unbiased estimate – Model parameterizations - Prediction error methods.		CO2

UNIT - III	RECURSIVE IDENTIFICATION METHODS	9
The recursive least square method - Model validation –Model structure determination - Introduction to closed loop system identification. of the Cell, series and parallel connections, maximum power point tracking, Applications.		CO3

UNIT - IV	ADAPTIVE CONTROL SCHEMES	9

Introduction – Auto-tuning of PID controller using relay feedback approach – Types of adaptive control, Gain scheduling, Model reference adaptive control, Self–tuning controller – Design of gain scheduled adaptive controller – Applications of gain scheduling.	**CO4**

UNIT - V	**MODEL-REFERENCE ADAPTIVE SYSTEM (MRAS) and SELF-TUNING REGULATOR (STR)**	**9**
STR – Pole placement design – Indirect STR and direct STR – MRAC - MIT rule – Lyapunov theory – Relationship between MRAC and STR.		**CO5**
Total Periods:		**45**

Text Books:

1. T. Soderstrom and Petre Stoica, System Identification, Prentice Hall International (UK) Ltd. 1989
2. Karl J. Astrom and Bjorn Witten mark, Adaptive Control, Pearson Education, Second edition, Fifth impression, 2009

References:

1. L. Ljung, System Identification - Theory for the User, 2nd edition, PTR Prentice Hall, 112 Upper Saddle River, N.J., 1999.
2. K. S. Narendra and A. M. Annaswamy, Stability Adaptive Systems, Prentice-Hall,1989.
3. H. K. Khalil, Nonlinear Systems, Prentice Hall, 3rd edition, 2002.
4. William S.Levine, "Control Systems Advanced Methods, the Control Handbook, CRC Press 2011.
5. S. Sastry and M. Bodson, Adaptive Control, Prentice-Hall, 1989

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Ability to understand various system identification techniques and features of adaptive control like STR and MRAC
CO2	Ability to understand the concept of system identification and adaptive control
CO3	Ability to understand about Black-box approach based system identification
CO4	Ability to get knowledge about batch and recursive identification, Ability to design concept for adaptive control schemes
CO5	Ability to study about computer controlled systems,

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	1	1	1	1	3	3	3	1	1	1	3	1	1	1
CO2	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3	3	1	2	3	3	3	3
CO5	3	3	3	3	3	3	2	3	3	1	2	3	3	3	3

EE4021	PRINCIPLES OF ROBOTICS	L	T	P	C
		3	0	0	3

Objectives

To impart knowledge on the following topics:

- To introduce the functional elements of Robotics
- To impart knowledge on the direct and inverse kinematics
- To introduce the manipulator differential motion and control
- To educate on various path planning techniques
- To introduce the dynamics and control of manipulators

UNIT – I	**BASIC CONCEPTS**	**9**
Brief history–Types of Robot–Technology–Robot classifications and specifications–Design and control issues– Various manipulators – Sensors – work cell – Programming languages.		**CO1**
UNIT – II	**DIRECT AND INVERSE KINEMATICS**	**9**
Mathematical representation of Robots – Position and orientation – Homogeneous transformation– Various joints– Representation using the Denavit Hattenberg parameters – Degrees of freedom–Direct kinematics–Inverse kinematics– SCARA robots– Solvability – Solution methods–Closed form solution.		**CO2**
UNIT – III	**MANIPULATOR DIFFERENTIAL MOTION AND STATICS**	**9**
Linear and angular velocities–Manipulator Jacobian–Prismatic and rotary joints–Inverse –Wrist and arm singularity – Static analysis – Force and moment Balance.		**CO3**
UNIT – IV	**PATH PLANNING**	**9**
Definition–Joint space technique–Use of p–degree polynomial–Cubic polynomial–Cartesian space technique – Parametric descriptions – Straight line and circular paths – Position and orientation planning.		**CO4**
UNIT – V	**DYNAMICS AND CONTROL**	**9**
Lagrangian mechanics – 2DOF Manipulator–Lagrange Euler formulation–Dynamic model – Manipulator control problem – Linear control schemes –PID control scheme–Force control of robotic manipulator.		**CO5**
Total Periods:		**45**

Text Books:

1. R. K. Mittal and I. J. Nagrath, 'Robotics and Control', Tata McGraw Hill, New Delhi, 4th Reprint, 2005.
2. John J. Craig, 'Introduction to Robotics Mechanics and Control', Third edition, Pearson Education, 2009.

References:

1. Ashitava Ghoshal, 'Robotics–Fundamental Concepts and Analysis', Oxford University Press, Sixth impression, 2010.
2. M. P. Groover, M. Weiss, R.N. Nagel and N. G. Odrej, 'Industrial Robotics', McGraw – Hill Singapore, 1996.
3. Edwin Wise, 'Applied Robotics', Cengage Learning, 2003.
4. R. D. Klafter, T. A. Chimielewski and M. Negin, 'Robotic Engineering–An Integrated Approach', Prentice Hall of India, New Delhi, 1994.
5. B. K. Ghosh, 'Control in Robotics and Automation: Sensor Based Integration', Allied Publishers, Chennai, 1998.

6. S. Ghoshal, 'Embedded Systems & Robotics' – Projects using the 8051 Microcontroller', Cengage Learning, 2009.
7. NPTEL Video Lecture Notes on "Introduction to Robotics" Dr. Krishna Vasudevan, Dr. T Asokan, Dr. Balaraman Ravindran, IIT Madras.

Course Outcomes (CO)
Upon completion of the course, students will be

CO1	Able to understand the basic concept of robotics.
CO2	Able to analyze Instrumentation systems and their applications to various
CO3	Able to know about the differential motion add statics in robotics
CO4	Able to know about the various path planning techniques.
CO5	Able to know about the dynamics and control in robotics industries.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	1	1	1	1	1	1	1	2	1	1	3	2	2
CO2	3	2	1	1	1	1	1	1	1	2	1	2	3	2	2
CO3	3	2	1	1	1	1	1	1	1	1	1	2	3	2	2
CO4	3	1	1	1	1	1	1	1	1	1	1	2	3	2	2
CO5	3	2	1	1	1	1	1	1	1	1	1	2	3	2	2

EE4022	ADVANCED CONTROL SYSTEM	L	T	P	C
		3	0	0	3

Objectives

To impart knowledge on the following topics:

- To provide knowledge on design state feedback control and state observer.
- To provide knowledge in phase plane analysis.
- To give basic knowledge in describing function analysis.
- To study the design of optimal controller.
- To study the design of optimal estimator including Kalman Filter

UNIT – I	STATE VARIABLE ANALYSIS	9
Introduction- concepts of state variables and state model-State model for linear continuous time systems, Diagonalisation- solution of state equations- Concepts of controllability and observability.		CO1

UNIT – II	STATE VARIABLE DESIGN	9
Introduction to state model: Effect of state feedback - Pole placement design: Necessary and sufficient condition for arbitrary pole placement, State regulator design, Design of state observers- Separation principle- Design of servo systems: State feedback with integral control.		CO2

UNIT – III	SAMPLED DATA ANALYSIS	9
Introduction spectrum analysis of sampling process signal reconstruction difference equations The Z transform function, the inverse Z transform function, response of Linear discrete system,		CO3

the Z transform analysis of sampled data control systems, response between sampling instants, the Z and S domain relationship. Stability analysis and compensation techniques.	

UNIT – IV	**NON LINEAR SYSTEMS**	**9**
Introduction - common physical non linearity's, The phase plane method: concepts, singular points, stability of nonlinear systems, construction of phase trajectories system analysis by phase plane method. The describing function method, stability analysis by describing function method, Jump resonance.		**CO4**

UNIT – V	**OPTIMAL CONTROL**	**9**
Introduction: Classical control and optimization, formulation of optimal control problem, Typical optimal control performance measures - Optimal state regulator design: Lyapunov equation, Matrix Riccati equation - LQR steady state optimal control – Application examples.		**CO5**

Total Periods:	**45**

Text Books:

1. M. Gopal, "Digital Control and State Variable Methods", 4th edition, McGraw Hill India, 2012
2. K. Ogata, 'Modern Control Engineering', 5th Edition, Pearson,2012.

References:

1. M. Gopal, Modern Control System Theory, 3rd edition, New Age International Publishers, 2014.
2. William S Levine, "Control System Fundamentals," The Control Handbook, CRC Press, Tayler and Francies Group, 2011.
3. Ashish Tewari, 'Modern Control Design with Matlab and Simulink', John Wiley, New Delhi, 2002.
4. T. Glad and L. Ljung,, "Control Theory –Multivariable and Non-Linear Methods", Taylor & Francis, 2002.
5. K. P. Mohandas, "Modern Control Engineering", Sanguine Technical Publishers, 2006.
6. NPTEL Video Lecture Notes on "Advanced Control Systems" Prof. S. Majhi, IIT Guwahati.

Course Outcomes (CO)
Upon completion of the course, students will be

CO1	Able to understand the modelling of state equation and its solution.
CO2	Able to understand the state model, observer and feedback system.
CO3	Able to understand the sampled data analysis, various transforms, stability and compensation techniques.
CO4	Able to understand the nonlinear systems and various methods of analysis.
CO5	Able to understand and design optimal controller.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	2	2	1	1	1	1	1	1	1	2	1	1	3	2	2
CO2	3	2	1	1	1	1	1	1	1	2	1	2	3	2	2
CO3	2	2	1	1	1	1	1	1	1	1	1	2	3	2	2
CO4	2	1	1	1	1	1	1	1	1	1	1	2	3	2	2
CO5	2	2	1	1	1	1	1	1	1	1	1	2	3	2	2

EE4023	PROCESS MODELLING AND SIMULATION	L	T	P	C
		3	0	0	3

Objectives

- To give an overview of various methods of process modelling, different computational techniques for simulation.
- To analyze the steady state lumped systems.
- To analyze the unsteady state lumped systems
- To analyze the steady state distributed systems
- To analyze the unsteady state distributed systems and various modelling approaches.

UNIT – I	INTRODUCTION	7
Introduction to modelling and simulation, classification of mathematical models, conservation equations and auxiliary relations.		CO1

UNIT – II	STEADY STATE LUMPED SYSTEMS	9
Degree of freedom analysis, single and network of process units, systems yielding linear and non- linear algebraic equations, flow sheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.		CO2

UNIT – III	UNSTEADY STATE LUMPED SYSTEMS	9
Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.		CO3

UNIT – IV	STEADY STATE DISTRIBUTED SYSTEM	7
Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.		CO4

UNIT – V	UNSTEADY STATE DISTRIBUTED SYSTEM & OTHER MODELLING APPROACHES	13
Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor. Empirical modelling, parameter estimation, population balance and stochastic modelling.		CO5

Total Periods:	45

Text Books:

1. Ramirez, W.; "Computational Methods in Process Simulation ", 2nd Education., Butterworths Publishers, New York,2000.
2. Luyben, W.L., " Process Modelling Simulation and Control ",2nd Education, McGraw-Hill Book Co., 1996

References:

1. Felder,R.M. and Rousseau,R.W., "Elementary Principles of Chemical Processes", John Wiley, Fourth edition 2018.

2. Franks, R. G. E., "Mathematical Modelling in Chemical Engineering ", John Wiley, 2014.
3. Amiya K. Jana, "Process Simulation and Control Using ASPEN", 2nd Education, PHI Learning Ltd (2012).
4. Amiya K. Jana, "Chemical Process Modelling and Computer Simulation" 2nd Education,PHI Learning Ltd,(2012).
5. NPTEL Video Lecture Notes on "Process Modelling and Simulation" Dr. V. K. Agrawal, IIT Roorkee.

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Ability to understand the development of process models based on conservation principles and process data and computational techniques to solve the process models.
CO2	Ability to analyze steady state lumped system
CO3	Ability to analyze unsteady state lumped system
CO4	Ability to analyze steady state distributed system
CO5	Ability to understand unsteady state distributed system and various modelling approaches

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	E	f	g	h	I	j	k	l	1	2	3
CO1	3	2	2	1	1	2	2	1	1	1	1	1	2	2	1
CO2	3	3	3	3	2	2	2	1	2	1	1	1	3	3	1
CO3	3	3	3	3	2	2	2	1	2	1	1	1	3	3	1
CO4	3	3	3	3	2	2	2	1	2	1	1	1	3	3	1
CO5	3	3	3	3	2	2	2	1	2	1	1	1	3	3	1

EE4024	OPTIMAL CONTROL	L	T	P	C
		3	0	0	3

Objectives

- To highlight the significance of optimal control in process industries and the different methods of optimization
- To introduce the concept of variational approach for the design of optimal control system.
- To formulate linear quadratic optimal control strategy with specified degree of stability
- To impart knowledge about discrete time linear state regulator system and discrete time linear quadratic tracking system
- To illustrate the application of dynamic programming and HJB equation for the design of constrained and time optimal control systems.

UNIT – I	INTRODUCTION TO OPTIMAL CONTROL	9
Statement of optimal Control problem - problem formulation and forms of optimal control - performance measures - various methods of optimization - Linear programming - nonlinear programming.		**CO1**

UNIT – II	CALCULUS OF VARIATIONS	9
Basic concepts – variational problem - Extreme functions with conditions - variational approach to optimal control systems.		**CO2**

UNIT – III	LINEAR QUADRATIC OPTIMAL CONTROL SYSTEM	9
Problem formulation - finite time LQR - infinite time LQR - Linear Quadratic tracking system		**CO3**

– LQR with a specified degree of stability.		
UNIT – IV	**DISCRETE TIME OPTIMAL CONTROL SYSTEM**	**7**
Variational calculus for DT system – DT optimal control system - DT linear state regulator system -- DT linear quadratic tracking system.		**CO4**
UNIT – V	**PONTRYAGIN MINIMUM PRINCIPLE**	**13**
Pontryagin minimum principle - Dynamic programming – Hamilton - Jacobi - Bellman equation - LQR system using HJB equation – Time optimal control – fuel optimal control system - optimal control system with constraints.		**CO5**
Total Periods:		**45**

Text Books:

1. Naidu D.S, Optimal Control System, CRC Press, 2003

References:

1. Kirk D.E, Optimal Control Theory, Dover publication, 2004
2. Lewis F.L. DragunaVrabia, Syrmos V.L, Optimal control, Johhn Wiley & sons, 2012.
3. NPTEL Video Lecture Notes on "Optimal Control" Prof. Barjeev Tyagi, IIT Roorkee.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Formulate the optimization problem based on the requirements and evaluate the performance of optimal controller
CO2	Apply the variational approach for optimal control systems with conditions.
CO3	Differentiate finite time LQR and infinite time LQR and design linear quadratic tracking system.
CO4	Analyze discrete time optimal control systems used in different applications.
CO5	Design constrained optimal control system and time optimal control system.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**I**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	2	2	1	1	2	2	1	1	1	1	1	2	2	1
CO2	3	3	3	3	2	2	2	1	2	1	1	1	3	3	1
CO3	3	3	3	3	2	2	2	1	2	1	1	1	3	3	1
CO4	3	3	3	3	2	2	2	1	2	1	1	1	3	3	1
CO5	3	3	3	3	2	2	2	1	2	1	1	1	3	3	1

VERTICAL V: DIVERSIFIED COURSES

EE4025	SOFT COMPUTING TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES

- Get familiarized with different architectures and training algorithms of neural networks.
- Get exposed to the various neural modeling and control techniques with case study using simulation tool box.
- Gain Knowledge on fuzzy set theory and fuzzy rules.
- Able to design and implement the fuzzy logic controller with case study using simulation tool box.
- Capable of designing hybrid control schemes, selected optimization algorithms with case study using simulation tool box.

UNIT - I	ARTIFICIAL NEURAL NETWORK	9
Review of fundamentals – Biological neuron, artificial neuron, activation function, single layer perception – Limitation – Multi layer perception – Back propagation algorithm (BPA) – Recurrent neural network (RNN) – Adaptive resonance theory (ART) based network – Radial basis function network – online learning algorithms, BP through time – RTRL algorithms – Reinforcement learning.		**CO1**

UNIT - II	MODELLING OF ARTIFICIAL NEURAL NETWORKS AND ASSOCIATIVE MEMORY	9
Modelling of non-linear systems using ANN – Generation of training data – Optimal architecture–Model validation – Control of non-linear systems using ANN – Direct and indirect Neuro control schemes, Counter propagation network, Hopfield network, Boltzman Machine – Adaptive Resonance Theory		**CO2**

UNIT - III	FUZZY LOGIC AND APPLICATIONS	9
Fuzzy set theory – Fuzzy sets – Operation on fuzzy sets – Scalar cardinality, fuzzy cardinality, union and intersection, complement (Yager and Sugeno), equilibrium points, aggregation, projection, composition, cylindrical extension, fuzzy relation – Fuzzy membership functions - Fuzzification – Knowledge base – Decision making logic – Defuzzification – Adaptive fuzzy systems – Familiarization with fuzzy logic toolbox.		**CO3**

UNIT - IV	GENETIC ALGORITHM AND OTHER EVOLUTIONARY ALGORITHMS	9
Evolutionary programs – Genetic algorithms, genetic programming and evolutionary programming - Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators - Optimization problems using GA-discrete and continuous - Single objective and multi-objective problems - Procedures in evolutionary programming, Particle Swarm Optimization and ANT Colony algorithm.		**CO4**

UNIT - V	HYBRID CONTROL SCHEMES	9
Fuzzification and rule base using ANN–Neuro fuzzy systems-ANFIS – Fuzzy Neuron - Optimization of membership function and rule base using Genetic Algorithm –Introduction to Support Vector Machine- Evolutionary Programming Case study with Particle Swarm Optimization - Familiarization of NN, FLC and ANFIS Tool Box.		**CO5**

Total Periods:	45

Text Books:

1. Laurene V. Fausett, "Fundamentals of Neural Networks: Architectures, Algorithms And Applications", Pearson Education. 2017
2. T. Ross, "Fuzzy Logic with Engineering Applications", Tata McGraw Hill, New Delhi, 2015.

References:

1. S N Sivanandam and Deepa, Principles of Soft Computing Techniques Wiley and Sons 2015
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications" Wiley India,2012.
3. Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011
4. David E. Goldberg, "Genetic Algorithms in Search, Optimization, and Machine Learning", Pearson Education, 2014.
5. Ethem Alpaydin, "Introduction to Machine Learning (Adaptive Computation and Machine Learning Series)", MIT Press,2014.
6. NPTEL Video Lecture Notes on "Introduction to Soft Computing" Prof. Debasis Samanta, IIT Kharagpur.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Articulate the main concepts, key technologies, strengths and limitations of Artificial Neural Network.
CO2	Learn the key and enabling technologies that help in modelling of ANN and associated memory.
CO3	Develop the ability to understand and use the architecture of fuzzy logic service and delivery models.
CO4	Explain the optimisation using genetic algorithm and PSO.
CO5	Install and use current control technologies and Choose the appropriate technologies and approaches for implementation and use of soft computing techniques.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	2	0	0	0	0	2	2	2	1	2	2
CO2	3	3	3	3	2	0	0	0	0	2	2	2	1	2	2
CO3	3	3	3	3	2	0	0	0	0	2	2	2	1	2	2
CO4	3	3	3	3	2	0	0	0	0	2	2	2	1	2	2
CO5	3	3	3	3	2	0	0	0	0	2	2	2	1	2	2

EE4026	POWER SYSTEMS TRANSIENTS	L	T	P	C
		3	0	0	3

Objectives

To impart knowledge about the following topics:

- Generation of switching transients and their control using circuit – theoretical concept.
- Mechanism of lighting strokes and the production of lighting surges.
- Propagation, reflection and refraction of travelling waves.
- Voltage transients caused by faults, circuit breaker action and load rejection on integrated power system.

UNIT - I	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 RLC circuit transients. Different types of power system transients - effect of transients on power systems – role of the study of transients in system planning.		**CO1**
UNIT – II	**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 - normal and abnormal switching transients. Current suppression - current chopping - effective equivalent circuit. Capacitance switching - effect of source regulation - capacitance switching with a restrike, with multiple restrikes. Illustration for multiple restriking transients – Ferro resonance.		**CO2**
UNIT – III	**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.		**CO3**
UNIT – IV	**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 - Bewely's lattice diagram - standing waves and natural frequencies - reflection and refraction of travelling waves.		**CO4**
UNIT – V	**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 – overvoltage induced by faults -switching surges on integrated system Qualitative application of EMTP for transient computation.		**CO5**
Total Periods:		**45**

Text Books:

1. Allan Greenwood, 'Electrical Transients in Power Systems', Wiley Inter Science, New York, 2nd Edition,1991.
2. Pritindra Chowdhari, "Electromagnetic transients in Power System", John Wiley and Sons Inc., Second Edition, 2009.

References:

1. M.S.Naidu and V.Kamaraju, 'High Voltage Engineering', 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.
4. Akihiro ametani," Power System Transient theory and applications", CRC press, 2013.
5. C.S. Indulkar, D.P.Kothari, K. Ramalingam, 'Power System Transients – A statistical approach', PHI Learning Private Limited, Second Edition,2010.

Course Outcomes (CO)

Upon completion of the course, students will be able to

CO1	Understand and analyse switching and lightning transients.
CO2	Acquire knowledge on generation of switching transients and their control.
CO3	Analyse the mechanism of lighting strokes.
CO4	Understand the importance of propagation, reflection and refraction of travelling waves.

CO5	Understand the concept of circuit breaker action, load rejection on integrated power system.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	1	1	1	1	3	3	3	1	1	1	3	1	1	1
CO2	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3	3	1	2	3	3	3	3
CO5	3	3	3	3	3	3	2	3	3	1	2	3	3	3	3

EE4027	INDUSTRY 4.0	L	T	P	C
		3	0	0	3

OBJECTIVES

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

- Understand the basics of Industrial Revolution
- Understand the basic concepts of Industry 4.0
- Understand the Concepts of Industrial IOT in various sectors
- Understand the applications of Industrial IOT
- Understand the Business issues in Industry 4.0

UNIT – I	INTRODUCTION TO INDUSTRY 4.0	9
The Various Industrial Revolutions - Digitalisation and the Networked Economy - Drivers, Enablers, Compelling Forces and Challenges for Industry 4.0 - The Journey so far: Developments in USA, Europe, China and other countries - Comparison of Industry 4.0 Factory and Today's Factory - Trends of Industrial Big Data and Predictive Analytics for Smart Business Transformation.		CO1

UNIT – II	ROAD TO INDUSTRY 4.0	9
Internet of Things (IoT) & Industrial Internet of Things (IIoT) & Internet of Services – Smart Manufacturing - Smart Devices and Products - Smart Logistics - Smart Cities - Predictive Analytics		CO2

UNIT – III	IIOT	9
Fourth Revolution – Sustainability assessment of Manufacturing Industry – Lean Production system – Smart and connected business perspective – smart factories – cyber-physical systems – collaboration platform and PLM		CO3

UNIT – IV	APPLICATIONS	9
Inventory Management and Quality Control – Plant security and safety – Facility management – oil, chemical and Pharmaceutical Industry – Milk processing and packaging industries		CO4

UNIT – V	BUSINESS ISSUES IN INDUSTRY 4.0	9
Opportunities and Challenges - Future of Works and Skills for Workers in the Industry 4.0 Era – Strategies for competing in an Industry 4.0 world		CO5
Total Periods:		**45**

Text Books:

1. Bernd Klein, Christian Zinke, Sebastian Feldmann "Industry 4.0: An Introduction" Springer, 2019.
2. Alasdair Gilchrist "Industry 4.0: The Industrial Internet of Things" Create Space Independent Publishing Platform., 2016

References:

1. Alp Ustundag, Emre Cevikcan "Industry 4.0: Managing The Digital Transformation" Springer, 2018.
2. Volker Johanning "Industry 4.0: The Ultimate Guide to Digitize, Automate and Optimize Your Business" Independently published, 2020.
3. "Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries" by OECD (Organisation for Economic Co-operation and Development), OECD Publishing, 2017.
4. NPTEL Video Lecture Notes on "Introduction to Industry 4.0 and Industrial Internet of Things"Prof. Sudip Misra, IIT Kharagpur.

Course Outcomes (CO)

Upon completion of the course, students will be able to

CO1	Understand the basics of Industrial Revolution
CO2	Understand the basic concepts of Industry 4.0
CO3	Understand the Concepts of Industrial IOT in various sectors
CO4	Understand the applications of Industrial IOT
CO5	Understand the Business issues in Industry 4.0

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	3	2	3	1	1	3	3	1	3	3	3
CO2	3	3	3	3	3	2	3	1	1	3	3	1	3	3	3
CO3	2	3	3	3	3	2	3	1	1	3	3	1	3	2	2
CO4	3	3	3	3	3	2	3	1	1	3	3	1	3	3	3
CO5	2	3	3	3	3	2	3	1	1	3	3	1	3	3	3

EE4028	EHVAC TRANSMISSION	L	T	P	C
		3	0	0	3

Objectives

To impart knowledge about the following topics:

- EHVAC Transmission lines
- Electrostatic field of AC lines
- Corona in E.H.V. lines

UNIT – I	INTRODUCTION	9
EHVAC Transmission line trends and preliminary aspect – standard transmission voltages – Estimation at line and ground parameters–Bundle conductors: Properties – Inductance and Capacitance of EHV lines – Positive, negative and zero sequence impedance – Line Parameters for Modes of Propagation.		CO1

UNIT – II	ELECTROSTATIC FIELDS	9

Electrostatic field and voltage gradients – Calculations of electrostatic field of AC lines – Effect of high electrostatic field on biological organisms and human beings – Surface voltage gradients and Maximum gradients of actual transmission lines – Voltage gradients on sub conductor.	**CO2**

UNIT – III	**POWER CONTROL**	**9**
Electrostatic induction in un energized lines – Measurement of field and voltage gradients for three phase single and double circuit lines – Un energized lines. Power Frequency Voltage control and overvoltage in EHV lines: No load voltage – Charging currents at power frequency– Voltage control – Shunt and Series compensation – Static VAR compensation		**CO3**

UNIT – IV	**CORONA EFFECTS AND RADIO INTERFERENCE**	**9**
Corona in EHV lines – Corona loss formulae–Charge voltage diagram– Attenuation of traveling waves due to Corona – Audio noise due to Corona, its generation, characteristic and limits. Measurements of audio noise radio interference due to Corona – properties of radio noise – Frequency spectrum of RI fields – Measurements of RI and RIV.		**CO4**

UNIT – V	**STEADY STATE AND TRANSIENT LIMITS**	**9**
Design of EHV lines based on steady state and transient limits – EHV cables and their characteristics–Introduction six phase transmission – UHV		**CO5**

Total Periods:	**45**

Text Books:

1. Rokosh Das Begamudre, 'Extra High Voltage AC Transmission Engineering' – Wiley Eastern Ltd., New Delhi 1990.
2. S. Rao, 'HVAC and HVDC Transmission, Engineering and Practice' Khanna Publisher, Delhi, 1990.

References:

1. Subir Ray, 'An Introduction to High Voltage Engineering', Prentice Hall of India Private Limited, 2013.
2. RD Begamudre, 'Extra High Voltage AC Transmission Engineering'– New Academic Science Ltd; 4th edition 2011.
3. Edison,' EHV Transmission line'– Electric Institution, GEC, 1968.
4. NPTEL Video Lecture Notes on "Advances in UHV Transmission and Distribution " Prof Subba Reddy B, IISc Bangalore.

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Ability to understand the principles and types of EHVAC system.
CO2	Ability to analyze the electrostatic field of AC lines
CO3	Ability to study about the compensation.
CO4	Ability to study about the corona in E.H.V. lines
CO5	Ability to understand the EHV cables and analyze the steady state and transient limits.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	2	2	1	1	1	1	1	1	1	1	1	3	1	1
CO2	3	2	2	1	1	1	1	1	1	1	1	1	3	1	1

CO3	3	2	2	2	1	1	1	1	1	1	1	1	3	3	2
CO4	3	2	2	2	1	1	1	1	1	1	1	1	3	3	2
CO5	3	1	1	1	1	1	1	1	1	1	1	1	2	3	1

EE4029	**SMART ENERGY GRID**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

To impart knowledge about the following topics:

- Smart Grid technologies, different smart meters and advanced metering infrastructure.
- The power quality management issues in Smart Grid.
- The high performance computing for Smart Grid applications

UNIT – I	**INTRODUCTION**	**9**
Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, National and International Initiatives in Smart Grid.		**CO1**

UNIT – II	**SMART GRID TECHNOLOGIES**	**9**
Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAR control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plugin Hybrid Electric Vehicles(PHEV).		**CO2**

UNIT – III	**SMART METERS AND ADVANCED METERING INFRASTRUCTURE**	**9**
Introduction to Smart Meters, Advanced Metering infrastructure(AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED)&their application for monitoring & protection.		**CO3**

UNIT – IV	**POWER QUALITY MANAGEMENT IN SMART GRID**	**9**
Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.		**CO4**

UNIT – V	**HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS**	**9**
Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broad band over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.		**CO5**
Total Periods:		**45**

Text Books:

1. Stuart Borlase, "Smart Grid: Infrastructure, Technology and Solutions",CRC Press 2012.
2. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, AkihikoYokoyama, "Smart Grid: Technology and Applications",Wiley 2012.

References:

1. Vehbi C. Gungor, Dilan Sahin, Taskin Kocak, Salih Ergut, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, "Smart Grid Technologies: Communication Technologies and Standards" IEEE Transactions On Industrial Informatics, Vol.7,No.4, November 2011.
2. Xi Fang, Satyajayant Misra, Guoliang Xue, and DejunYang "SmartGrid –The New and Improved Power Grid: A Survey" ,IEEE Transaction on Smart Grids,vol.14,2012.
3. James Momohe "Smart Grid: Fundamentals of Design and Analysis,", Wiley-IEEE Press, 2012.
4. NPTEL Video Lecture Notes on"Smart Grid: Basics to Advanced Technologie" Prof. N.P. Padhy, Prof. Premalata Jena IIT Roorkee

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Ability to understanding on the concepts of Smart Grid and its present developments.
CO2	Ability to gain knowledge about different Smart Grid technologies.
CO3	Ability to acquire knowledge about different smart meters and advanced metering infrastructure.
CO4	Ability to acquire knowledge on power quality management and issues in Smart Grids.
CO5	Ability to develop more understanding on LAN, WAN and Cloud Computing for Smart Grid applications.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	3	2	3	1	1	3	3	1	3	3	2
CO2	3	3	3	3	3	2	3	1	1	3	3	1	3	3	2
CO3	2	3	3	3	3	2	3	1	1	3	3	1	3	2	2
CO4	3	3	3	3	3	2	3	1	1	3	3	1	3	3	2
CO5	2	3	3	3	3	2	3	1	1	3	3	1	3	3	2

EE4030	ENERGY STORAGE SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES

To impart knowledge about the following topics:
1. To understand the various types of energy storage technologies and its applications.
2. To study the various modeling techniques of energy storage systems.
3. To learn working concepts and types of batteries.
4. To make the students to get understand the concepts of Hydrogen and Biogas storage.
5. To provide the insights on super capacitor, Fly wheel and compressed energy storage system.

UNIT – I	INTRODUCTION	9
Necessity of energy storage–types of energy storage–comparison of energy storage technologies– Applications.		CO1

UNIT – II	THERMAL STORAGE SYSTEM	9
Thermal storage–Types–Modelling 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.		CO2

UNIT – III	ELECTRICAL ENERGY STORAGE	9
Fundamental concept of batteries–measuring of battery performance, charging and discharging of a battery, storage density, energy density, and safety issues. Types of batteries – Lead Acid,		CO3

Nickel– Cadmium, Zinc Manganese di oxide and modern batteries for example (i)zinc-Air(ii)Nickel Hydride,(iii)Lithium Battery.		
UNIT – IV	**HYDROGEN AND BIOGAS STORAGE**	**9**
Hydrogen storage options–compressed gas–liquid hydrogen–Metal Hydrides, chemical Storage, Biogas storage-comparisons. Safety and management of hydrogen and Biogas storage - Applications.		**CO4**
UNIT – V	**ALTERNATE ENERGY STORAGE TECHNOLOGIES**	**9**
Flywheel, Super capacitors, Principles & Methods–Applications, Compressed air Energy storage, Concept of Hybrid Storage – Applications.		**CO5**
Total Periods:		**45**

Text Books:

1. Robert Huggins, "Energy Storage",2nd edition, Springer,2015
2. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2010.

References:

1. Viswanathan, Fuel cell principle and applications university press, 2006.
2. Luisa F.Cabeza, Advances in Thermal Energy Storage Sy stems: Methods and Applications, Elsevier Wood head Publishing, 2015
3. Ru-shiliu, Leizhang, Xueliang sun, Electrochemical technologies for energy storage and conversion, Wiley publications, 2012.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Identify the energy storage technologies for suitable applications.
CO2	Analyze the energy storage systems.
CO3	Summarise the concepts and types of batteries.
CO4	Examine the principle of operation of Hydrogen and Biogas storage systems.
CO5	Explain the working of super capacitor, Flywheel and compressed energy storage systems.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	3	2	3	1	1	3	3	1	3	3	2
CO2	3	3	3	3	3	2	3	1	1	3	3	1	3	3	2
CO3	2	3	3	3	3	2	3	1	1	3	3	1	3	2	2
CO4	3	3	3	3	3	2	3	1	1	3	3	1	3	3	2
CO5	2	3	3	3	3	2	3	1	1	3	3	1	3	3	2

OPEN ELECTIVE–I (V SEMESTER)

OEC411	IOT CONCEPTS AND APPLICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT.
- To teach a student how to analyze requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms.
- To introduce the technologies for implementing Internet of Things (IoT).

UNIT – I	INTRODUCTION TO INTERNET OF THINGS	9
Definition of IoT - Characteristics of IoT – Evolution of IoT– Study of IoT Enabling Technologies – Architecture of IoT based Systems – Fog, Applications of Cloud and Edge in IoT		**CO1**

UNIT – II	IoT COMPONENTS	9
Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects - IoT levels and deployment templates. Study of Communication Modules – Wifi, Bluetooth, GSM. Zigbee		**CO2**

UNIT – III	IoT PROTOCOLS	9
IoT Access Technologies: Physical Layer of IoT and MAC layer concepts of IoT, Architecture, topology and Security of IEEE 802.15.4 Network Layer: IP versions, Optimizing IP for IoT: IPv6, 6LoWPAN, MQTT. Introductory concepts of cloud computing.		**CO3**

UNIT – IV	TOOLS FOR IoT IMPLEMENTATION	9
Introduction to Python, Basic programming concepts of Python, Python development tools like Jupyter, Co-lab - Introduction to different IoT tools, Applications development through IoT tools, Sensor based application through embedded system platform-devlopment, Implementation of IoT techniques using Python.		**CO4**

UNIT – V	IoT BASED APPLICATIONS	9
Various applications of IoT based in Home automations – Design of IoT in Smart cities – Implementing in Environment – Case study of IoT based system in Logistics – Agriculture – Industry - Health and life style.		**CO5**
Total Periods:		**45**

Text Books:

1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017.
2. Samuel Greengard, The Internet of Things, The MIT Press, 2015

References:

1. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012
2. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.

3. Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things" Springer-Verlag Berlin Heidelberg, 2011.
4. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015.

Course Outcomes (CO)

Upon completion of the course, students will be able to

CO1	Explain the concept of IoT.
CO2	Analyze the networking and sensors communications with IoT Components
CO3	Understand the communication models and various protocols for IoT.
CO4	Analyze and design different models for IoT implementation.
CO5	Analyze applications of IoT in real time scenario.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	1	2	2	2	1	-	-	-	-	-	2	3	1	3	1
CO2	2	2	2	2	1	-	-	-	-	-	2	3	2	3	1
CO3	2	2	2	3	1	-	-	-	-	-	2	3	2	3	1
CO4	2	1	3	3	1	-	-	-	-	-	2	3	1	3	1
CO5	3	1	3	3	2	-	-	-	-	-	2	3	3	2	2

OEC412	FOUNDATIONS OF ROBOTICS	L	T	P	C
	(Common to CSE, IT, ADS, EEE & Mechanical)	3	0	0	3

OBJECTIVES

- To comprehend robot's fundamental parts work.
- To examine how different Ends of Effector and sensors are used.
- To disseminate information on programming and robot kinematics.
- To learn about the economics, safety, and future of robots.

UNIT – I	FUNDAMENTALS OF ROBOT	9
Robot - Definition - Robot Anatomy - Coordinate Systems, Work Envelope Types, and Classification – Specifications - Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load - Robot Parts and their Functions - Need for Robots - Different Applications.		CO1

UNIT – II	SYSTEMS FOR ROBOT DRIVE AND ENDEFFECTORS	9
Pneumatic Drives - Hydraulic Drives - Mechanical Drives - Electrical Drives - D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison - End effectors - Classification, Types of Mechanical actuation, Gripper design, Robot drive system Types, Position, and velocity feedback devices - Robot joints and links - Types, Motion interpolation.		CO2

UNIT – III	SENSORS AND MACHINE VISION	9
Sensors in robots: Touch Sensors, Tactile Sensors, Proximity, and range sensors, Force sensor, Light sensors, Pressure sensors - Triangulation Principles Structured - Lighting Approach, Time of Flight, Camera, Frame Grabber, Sensing and Digitizing Image Data - Signal Conversion, Image Storage, Lighting Techniques, Image Processing, and Analysis - Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications Inspection, Identification, Visual Serving and Navigation.		CO3

UNIT – IV	KINEMATICS AND PROGRAMMING FOR ROBOTS	9

Robot kinematics – Basics of direct and inverse kinematics, Robot trajectories, 2D and 3D Transformation -Scaling, Rotation, Translation Homogeneous transformation. Control of robot manipulators – Point-to-point, Continuous Path Control, Robot programming - Introduction to Artificial Intelligence.	**CO4**

UNIT – V	**ROBOT APPLICATIONS AND ECONOMIC IMPLEMENTATION**	**9**
RGV, AGV, Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defense, and Disaster management. Applications, Micro and Nanorobots, Future Applications. - Robotics adoption in Industries - Safety Considerations for Robot Operations - Economic Analysis of Robots.		**CO5**
Total Periods:		**45**

Text Books:

1. Klafter R.D., Chmielewski T.A, and Negin M., "Robotic Engineering - An Integrated Approach", Prentice Hall, 2003.
2. Bruno Siciliano, Oussama Khatib, "Springer Handbook of Robotics", Springer, 2008.

References:

1. Deb.S.R and Sankha Deb, "Robotics Technology and Flexible Automation", Tata McGraw Hill Publishing Company Limited, 2010.
2. Mikell P. Groover, Mitchell Weiss, Roger N Nagel, Nicholas G Odrey, "Industrial Robotics Technology, Programming and Applications", Tata –McGraw Hill Pub. Co., 2008.
3. Craig J.J., "Introduction to Robotics Mechanics and Control", Pearson Education, 2008.
4. Janakiraman P.A., "Robotics and Image Processing", Tata McGraw Hill, 1995.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	List and describe the fundamental components of industrial robots.
CO2	Examine the kinematics and control strategies of the robot.
CO3	Improve performance, classify the numerous robot sensors.
CO4	Apply basic engineering knowledge for the design of robotics
CO5	List the different commercial and non commercial uses of robots.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	2	2	2	-	-	-	-	2	1	3	2	1
CO2	3	3	3	3	2	3	-	-	-	-	2	1	3	2	1
CO3	3	2	3	3	2	2	-	-	-	-	2	1	3	2	1
CO4	3	3	3	2	2	2	-	-	-	-	2	2	3	2	1
CO5	3	2	3	3	2	3	-	-	-	-	2	1	3	2	1

OEC414	BIOMEDICAL INSTRUMENTATION	L	T	P	C
	(Common to CSE, IT, ADS, EEE & Mechanical)	**3**	**0**	**0**	**3**

OBJECTIVES

- To study about the biopotentials and its propagation
- To understand the different types of electrodes and its placement for various recording
- To study the design of bio amplifier for various physiological recording
- To learn different measurement techniques for non-physiological parameters

- To discuss the recent trends in the field of diagnostic and therapeutic equipment

UNIT – I	BIOPOTENTIAL RECORDING AND ELECTRODE TYPES	9
Biopotential origin and its propagation. Types of electrodes and its equivalent circuits - surface, needle and micro electrodes. Recording problems - measurement with two electrodes		CO1

UNIT – II	FEATURES OF BIOSIGNAL AND ELECTRODE CONFIGURATIONS	9
Features of Bio-signal – frequency and amplitude ranges. ECG – Einthoven's triangle, standard 12 lead system. EEG – unipolar, bipolar, average mode and 10-20 electrode system. EMG– unipolar and bipolar mode.		CO2

UNIT – III	BIOAMPLIFIER CIRCUITS AND ASSIST DEVICES	9
Basic requirements for bio-amplifier - differential bio-amplifier, PLI, Right leg driven ECG amplifier, Band pass filtering. Assist Devices- Dialyzer, Cardiac Pacemakers, and Heart Lung Machine.		CO3

UNIT – IV	MEASUREMENT OF NON-ELECTRICAL AND BIO-CHEMICAL PARAMETERS	9
Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - Auscultatory method, direct methods: electronic manometer, Systolic, diastolic pressure, Blood flow and cardiac output measurement: Indicator dilution, and dye dilution method. Calorimeter, Sodium Potassium Analyzer, auto analyzer (simplified schematic description).		CO4

UNIT – V	CURRENT TRENDS IN MEDICAL DEVICES	9
Laser in medicine and its applications, Thermograph – System, working, endoscopy unit, Cryogenic application, Introduction to tele-medicine.		CO5
Total Periods:		**45**

Text Books:

1. Leslie Cromwell, "Biomedical Instrumentation and measurement", Prentice hall of India, New Delhi,2007.
2. John G. Webster, "Medical Instrumentation: Application and Design", John Wiley and sons, NewYork,2004.(Unit I,II&III).

References:

1. MyerKutz, "Standard Handbook of Biomedical Engineering and Design", McGraw Hill Publisher, 2003.
2. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw-Hill, NewDelhi, 2003.(Unit II&IV)
3. Joseph J. Carr and John M Brown, "Introduction to Biomedical Equipment Technology", Pearson Education, 2004.
4. Chan and Anthony Y.K, ''Biomedical Device Technology: Principles and Design'', Springfield, Illinois : Charles C. Thomas publisher Limited, 2016.

Course Outcomes (CO)
Upon completion of the course, students will be able

CO1	To acquire knowledge about bio-potentials and its propagation
CO2	To get familiarized with different electrode placements for various physiological recording
CO3	To design bio amplifiers for various physiological recording
CO4	To understand various techniques for non-electrical and physiological measurements
CO5	To understand the recent trends in the field of diagnostic and therapeutic equipment

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	2	2	2	-	1-	3	-	-	1	-	-	-	1	2	1
CO2	2	2	2	-	1-	3	-	-	1	-	-	-	1	2	1
CO3	3	3	3	-	3	3	-	-	2	-	-	-	2	3	2
CO4	2	2	3	-	3	3	-	-	2	-	-	-	2	3	2
CO5	2	2	3	-	3	3	-	-	2	-	-	-	2	3	2

OIT411	FUNDAMENTALS OF DATABASE DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES

- The role of database management system in an organization and learn the database concepts.
- The design databases using data modelling and data normalization techniques.
- Construct database queries using relational algebra and calculus.
- The concept of a database transaction and related database facilities.
- To learn the basic concepts of Transactions, concurrency control techniques, and recovery procedures

UNIT – I	CONCEPTUAL MODELLING	9
Introduction database design-Database Environment, - Data Models: Entity Relationship Model, Relational Model- Database Development Lifecycle		CO1

UNIT – II	RELATIONAL MODELS	9
Integrity Constraints- SQL Data Manipulation and Definition- Views- Relational Models-Hierarchical and Network		CO2

UNIT – III	INTRODUCTION TO SQL	9
Introduction to Structured Query Language-DDL Commands-DML Commands-TCL Commands -views-Index-Synonyms- Sub queries- SQL Functions-Joins-PL/SQL–simple programs		CO3

UNIT – IV	RELATIONAL DATABASE DESIGN AND NORMALIZATION	9
ER and EER to relationship Model-ER Diagrams--Functional Dependencies-First, Second and Third Normal Forms-Dependency preservation		CO4

UNIT – V	TRANSACTION MANAGEMENT	9
Transaction Concepts- Properties- Schedules- Serializability- Concurrency Control – Two phase locking techniques		CO5
Total Periods:		45

Text Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, "Database System Concepts", McGraw-Hill, 4th Edition, 2002.
2. http://www.e-booksdirectory.com/details.php?ebook=10166
3. http://www.e-booksdirectory.com/details.php?ebook=7400re

References:

1. Ramez Elmasri, Shamkant B. Navathe, "Fundamental Database Systems", Pearson Education, 3rd Edition, 2003.
2. Raghu Ramakrishnan, "Database Management System", Tata McGraw-Hill Publishing Company, 3rd Edition, 2003.
3. Hector Garcia Molina, Jeffrey D. Ullman, Jennifer Widom, "Database System Implementation", Pearson Education, United States, 1st Edition, 2000.
4. Peter Rob, Corlos Coronel, "Database System, Design, Implementation and Management", Thompson Learning Course Technology, 5th Edition, 2003.
5. https://www.youtube.com/results?search_query=DBMS+onluine+classes
6. http://www.w3schools.in/dbms/
7. http://beginnersbook.com/2015/04/dbms-tutorial

Course Outcomes (CO)

CO1	The fundamentals of Database systems are vital components of modern information systems.
CO2	Understand the need for Databases and relational Model concepts.
CO3	Database applications all pervasive and range in size from small in-memory databases to terabytes or even larger in various applications domains.
CO4	The course focuses and the fundamentals of knowledgebase and relational database management systems, and the current developments in database theory and their practices.
CO5	Write Queries in SQL andexecute multiple sub-queries, functions and joins.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	3	3	3	3	2	3	1	1	3	3	1	3	3	2
CO2	3	3	3	3	3	2	3	1	1	3	3	1	3	3	2
CO3	2	3	3	3	3	2	3	1	1	3	3	1	3	2	2
CO4	3	3	3	3	3	2	3	1	1	3	3	1	3	3	2
CO5	2	3	3	3	3	2	3	1	1	3	3	1	3	3	2

OME416	TESTING OF MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the various destructive and non-destructive testing methods of materials and its industrial applications.

UNIT – I	INTRODUCTION TO MATERIALS TESTING	9
Overview of materials, Classification of material testing, Purpose of testing, Selection of material, Development of testing, Testing organizations and its committee, Testing standards, Result Analysis, Advantages of testing.		CO1

UNIT – II	MECHANICAL TESTING	9
Introduction to mechanical testing, Hardness test (Vickers, Brinell, Rockwell), Tensile test, Impact test (Izod, Charpy) - Principles, Techniques, Methods, Advantages and Limitations, Applications. Bend test, Shear test, Creep and Fatigue test - Principles, Techniques, Methods, Advantages and Limitations.		CO2

UNIT – III	NON DESTRUCTIVE TESTING	9

Visual inspection, Liquid penetrant test, Magnetic particle test, Thermography test – Principles, Techniques, Advantages and Limitations, Applications. Radiographic test, Eddy current test, Ultrasonic test, Acoustic emission- Principles, Techniques, Methods, Advantages and Limitations, Applications.	**CO3**

UNIT – IV	**MATERIAL CHARACTERIZATION TESTING**	**9**
Macroscopic and Microscopic observations, Optical and Electron microscopy (SEM and TEM) - Principles, Types, Advantages and Limitations, Applications. Diffraction techniques, Spectroscopic Techniques, Electrical and Magnetic Techniques- Principles, Types, Advantages and Limitations, Applications.		**CO4**

UNIT – V	**OTHER TESTING**	**9**
Thermal Testing: Differential scanning calorimetry, Differential thermal analysis. Thermo mechanical and Dynamic mechanical analysis: Principles, Advantages, Applications. Chemical Testing: X-Ray Fluorescence, Elemental Analysis by Inductively Coupled Plasma-Optical Emission Spectroscopy and Plasma-Mass Spectrometry.		**CO5**
Total Periods:		**45**

Text Books:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing" Narosa Publishing House, 2009.
2. Cullity, B. D., "Elements of X-ray diffraction", 3rd Edition, Addison-Wesley Company Inc., New York, 2000.
3. P. Field Foster, "The Mechanical Testing of Metals and Alloys" 7th Edition, Cousens Press, 2007.

References:

1. Metals Handbook: Mechanical testing, (Volume 8) ASM Handbook Committee, 9th Edition, American Society for Metals, 1978.
2. ASM Metals Handbook, "Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA.
3. Brandon D.G., "Modern Techniques in Metallography", Von Nostrand Inc. NJ, USA, 1986

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	Know about testing standards and selection of materials.
CO2	Understand the different types of mechanical testing.
CO3	Understand the different types of Non- destructive testing methods.
CO4	Identify suitable testing technique like macroscopic and microscopic observationsto inspect industrial component.
CO5	Know about different thermal, chemical and Optical testing methods.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	3	3	2	3	-	2	-	-	-	2	-	3	-	2	-
CO2	3	3	2	3	-	2	-	-	-	2	-	3	-	2	-

CO3	3	3	2	3	-	2	-	-	-	2	-	3	-	2	-
CO4	3	3	2	3	-	2	-	-	-	2	-	3	-	2	-
CO5	3	3	2	3	-	2	-	-	-	2	-	3	-	2	-

OPEN ELECTIVE–II (VII SEMESTER)

OAD421	**DATA SCIENCE FUNDAMENTALS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

UNIT – I	**DATASCIENCE IN BIG DATA**	**9**
Data Science: Benefits and uses – facets of data - Data Science Process: Overview – Defining research goals – Retrieving data – Data preparation - Exploratory Data analysis – build the model–presenting findings and building applications.		**CO1**

UNIT – II	**DESCRIBING DATA**	**9**
Types of Data - Types of Variables -Describing Data with Tables and Graphs –Describing Data with Averages - Describing Variability - Normal Distributions and Standard (z) Scores		**CO2**

UNIT – III	**RELATIONSHIPS FOR ORGANIZING**	**9**
Correlation –Scatter plots –correlation coefficient for quantitative data –computational formula for correlation coefficient – Regression –regression line –least squares regression line – Standard errorof estimate.		**CO3**

UNIT – IV	**PYTHON MAGIC COMMANDS**	**9**
Basics of Numpy array –comparisons, masks, boolean logic – fancy indexing – structured arrays – Data manipulation with Pandas – data indexing and selection — missing data — Hierarchical indexing — combining datasets — Aggregation and grouping		**CO4**

UNIT – V	**VISUALIZATION WITH MATPLOTLIB**	**9**
Importing Matplotlib – Line plots – Scatter plots – visualizing errors – density and contour plots –Histograms – legends – colors – subplots – text and annotation – three dimensionalplotting - Visualization with Seaborn.		**CO5**
Total Periods:		**45**

Text Books:

1. David Cielen, Arno D.B.Meysman, and Mohamed Ali, "Introducing Data Science" Manning Publications, 2016. (Unit I)
2. Robert S.Witteand John S.Witte, "Statistics", Eleventh Edition, Wiley Publications, 2017. (Units II and III)
3. Jake Vander Plas,"Python Data Science Handbook",O'Reilly,2016.(Units IV and V)

Course Outcomes (CO)
Upon completion of the course, students should

CO1	Define the data science process
CO2	Understand different types of data description for data science process
CO3	Apply data processing methods for processing health care data.
CO4	Use the Python Libraries for Data Wrangling
CO5	Apply visualization Libraries in Python to interpret and explore data

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	1	-	-	-	-	-	-	-	-	-	2	2	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	2	2	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	2	2	-
CO4	3	3	3	-	-	-	-	-	-	-	-	-	2	2	-
CO5	3	3	3	-	-	-	-	-	-	-	-	-	2	2	-

OCS422	MACHINE LEARNING TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES

- To understand the basic concepts of machine learning and probability theory.
- To learn the supervised learning and their algorithms.
- To understand unsupervised learning like clustering.
- To understand the theoretical and practical aspects of probabilistic graphical models.
- To learn other learning aspects such as reinforcement learning, representation learning, deep learning, neural networks and other technologies.

UNIT – I	INTRODUCTION	9
Machine Learning – Types of Machine Learning – Supervised Learning – Unsupervised Learning – Basic Concepts in Machine Learning – Machine Learning Process – Weight Space – Testing Machine Learning Algorithms – A Brief Review of Probability Theory – Turning Data into Probabilities – Candidate Elimination Algorithm		CO1

UNIT – II	SUPERVISED LEARNING	9
Linear Models for Regression – Bayesian Linear Regression – Common Regression Algorithms – Simple Linear Regression – Multiple Linear Regression –Common Classification Algorithms – k-Nearest Neighbors – Decision Trees – Random Forest model – Support Vector Machines		CO2

UNIT – III	UNSUPERVISED LEARNING	9
K-Means Clustering – Dirichlet Process Mixture Models – Spectral Clustering – Hierarchical Clustering – The Curse of Dimensionality – Dimensionality Reduction – Principal Component Analysis – Latent Variable Models (LVM) – Latent Dirichlet Allocation (LDA)		CO3

UNIT – IV	GRAPHICAL MODELS	9
Bayesian Networks – Conditional Independence – Naive Bayes Classifiers – Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution – Markov Random Fields – Hidden Markov Model.		CO4

UNIT – V	INTELLIGENCE AND APPLICATIONS	9
Natural language processing-Morphological Analysis – Syntax analysis – Semantic Analysis – Ail applications – Language Models – Information Retrieval – Information Extraction – Machine Translation – Machine Learning - Symbol-Based – Machine Learning		CO5
Total Periods:		**45**

Text Books:

1. Ethem Alpaydin, "Introduction to Machine Learning," Third Edition, Prentice Hall of India, 2015.
2. Stephen Marsland, ―Machine Learning – An Algorithmic Perspective‖, Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series, 2014.

References:

1. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.
2. Kevin P. Murphy, "Machine Learning: A Probabilistic Perspective", MIT Press, 2012.
3. Tom Mitchell, "Machine Learning", McGraw-Hill, 2017.
4. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Second Edition, Springer, 2008.
5. Fabio Nelli, "Python Data Analytics with Pandas, Numpy, and Matplotlib", Second Edition, Apress, 2018.

Course Outcomes (CO)
Upon completion of the course, students should

CO1	Gain knowledge about basic concepts of machine learning techniques and terminology.
CO2	Develop predictive model based on both input and output data using supervised algorithms
CO3	Understand the unsupervised learning algorithm and dimensionality reduction techniques
CO4	Design systems that use the appropriate graphical models of machine learning
CO5	Improve problem solving skills using the acquired knowledge in the areas of natural language processing with machine learning

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	2	3	3	2	1	-	-	-	-	-	-	1	2	2	1
CO2	2	3	3	2	2	-	-	-	-	-	-	1	2	2	1
CO3	2	3	3	2	3	-	-	-	-	-	-	1	2	2	2
CO4	2	3	3	2	3	-	-	-	-	-	-	1	2	2	2
CO5	2	2	3	2	1	-	-	-	-	-	-	1	2	2	2

OCS423	AUGMENTED AND VIRTUAL REALITY	L	T	P	C
		3	0	0	3

OBJECTIVES

- To gain the knowledge of historical and modern overviews and perspectives on virtual reality.
- To learn the fundamentals of sensation, perception, and perceptual training.
- To have the scientific, technical, and engineering aspects of augmented and virtual reality systems.
- To learn the evaluation of virtual reality from the lens of design.
- To learn the technology of augmented reality and implement it to have practical knowledge.

UNIT – I	INTRODUCTION	9
Introduction to Augmented-Virtual and Mixed Reality, Taxonomy, technology and features of augmented reality, difference between AR, VR and MR, Challenges with AR, AR systems and functionality, Augmented reality methods, visualization techniques for augmented reality.		CO1

UNIT – II	VR SYSTEMS	9
VR as a discipline, Basic features of VR systems, Architecture of VR systems, VR hardware: VR input hardware: tracking systems, motion capture systems, data gloves, VR output		CO2

hardware: visual displays, Methodology and terminology, user performance studies, VR health and safety issues, Usability of virtual reality system.	

UNIT – III	**STEREOSCOPIC VISION & HAPTIC RENDERING**	**9**
Fundamentals of the human visual system, Depth cues, Stereopsis, Retinal disparity, Haptic sense, Haptic devices, Algorithms for haptic rendering and parallax, Synthesis of stereo pairs.		**CO3**

UNIT – IV	**VR DEVELOPMENT**	**9**
Challenges of VR in Mechanical development, Control Architectures, Rendering mechanical components, 3D interaction techniques: Manipulation Techniques and Input Devices, Interaction Techniques for 3D Manipulation.		**CO4**

UNIT – V	**APPLICATIONS**	**9**
AR software, Camera parameters and camera calibration, Marker-based augmented reality, AR Toolkit, Medical, military & mechanical applications, Advanced Real time Tracking, other applications, games, movies, simulations, therapy, Understanding Meta, AR VR in Cyber Currency, Mechanics in VR, Matlab.		**CO5**
Total Periods:		**45**

Text Books:

1. George Mather, Foundations of Sensation and Perception: Psychology Press; 2ndedition, 2009.
2. The VR Book: Human-Centered Design for Virtual Reality, by Jason Jerald
3. Learning Virtual Reality by Tony Parisi, O' Reilly
4. Burdea, G. C. and P. Coffet. Virtual Reality Technology, Second Edition.Wiley, IEEE Press, 2003/2006.
5. Alan B. Craig, Understanding Augmented Reality, Concepts and Applications, Morgan Kaufmann, 2013.

References:

1. Steven M. LaValle, "Virtual Reality", Cambridge University Press, 2016
2. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
3. Schmalstieg / Hollerer, "Augmented Reality: Principles & Practice", Pearson Education India; First edition (12 October 2016), ISBN-10: 9332578494

Course Outcomes (CO)
Upon completion of the course, students should

CO1	Identify, examine, and develop software that reflects fundamental techniques for the design and deployment of VR and AR experiences.
CO2	Describe how VR and AR systems work.
CO3	Choose, develop, explain, and defend the use of particular designs for AR and VR experiences.
CO4	Evaluate the benefits and drawbacks of specific AR and VR techniques on the human body.
CO5	Identify and examine state-of-the-art AR and VR design problems and solutions from the industry and academia.

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**1**	**2**	**3**
CO1	-	1	2	1	-	-	-	-	-	-	-	-	2	2	1
CO2	1	2	2	-	2	-	-	-	-	-	-	1	2	2	1

CO3	1	2	2	-	-	-	-	-	-	-	-	2	2	2	2
CO4	1	2	2	-	2	-	-	-	-	-	-	1	2	2	2
CO5	1	2	2	2	3	-	-	-	-	-	-	2	2	2	2

OME421	**ENERGY CONSERVATION AND MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

OBJECTIVES

At the end of the course, the student is expected to

- ❖ Understand and analyze the energy data of industries
- ❖ Carryout energy accounting and balancing
- ❖ Conduct energy audit and suggest methodologies for energy savings and
- ❖ Utilize the available resources in optimal ways

UNIT – I	**INTRODUCTION**	**9**
Definition of energy management - Energy conservation schemes - Optimizing steam usage - Waste heat management - Insulation - Optimum selection of pipe size – Energy conservation in space conditioning – Energy and cost indices - Energy diagrams – Energy auditing.		**CO1**

UNIT – II	**THERMODYNAMIC SYSTEMS**	**9**
Thermodynamic availability analysis – Thermodynamic efficiencies -Available energy and fuel, Thermodynamic Cycles: topping, bottoming and combined cycle - organic rankine cycles – performance indices of cogeneration systems, waste heat recovery – sources and types – concept of tri generation. Configuration and thermodynamic performance – steam turbine cogeneration systems, gas turbine cogeneration systems, reciprocating IC engines cogeneration systems, combined cycles cogeneration systems, advanced cogeneration systems, fuel cell, Stirling engines, Heat Recovery Steam Generators.		**CO2**

UNIT – III	**WASTE HEAT RECOVERY SYSTEMS**	**9**
Thermodynamic cycles for low temperature application, Introduction to Heat Exchangers, Analysis – LMTD and NTU method Analysis of Heat Exchanger Problem solving, Special Heat Exchangers for Waste Heat Recovery, Systems of Heat Exchanger Network of Heat pipes &Vapor Chambers, Direct conversion technologies – Thermoelectric Generators. Direct conversion technologies – Thermoelectric Generators, Thermionic conversion, Thermo-PV, MHD Heat Pump; Heat Recovery from Incinerators, Sorption Systems Selection criteria for waste heat recovery systems – Recuperators, Regenerators, Economizers, Thermic fluid heaters, Waste heat boilers – classification, location, service conditions, design considerations.		**CO3**

UNIT – IV	**ENERGY STORAGE TECHNIQUES**	**9**
Energy Storage Techniques – Pumped hydro, Compressed Air, Flywheel, Superconducting Magnetic Storage Energy Storage Techniques – Thermal storage (Sensible & Latent), Battery, Chemical Energy Storage, Fuel cell		**CO4**

UNIT – V	**ECONOMICS**	**9**
Investment cost – economic concept – Analysis of economic performance – procedure for economic analysis – examples – procedure for optimized system selection and design – load curves - sensitivity analysis – regulatory and financial frame work for cogeneration and waste heat recovery systems.		**CO5**
Total Periods:		**45**

Text Books:

1. Energy Management and Conservation , P. Venkataseshaiah K.V. Sharma, Wiley Publication, January 2020
2. Energy Engineering and Management, Amlan Chakrabarti, PHI publishers, Second Edition January 2019

References:

1. Fuel Economy in furnaces and Waste heat recovery - PCRA
2. Heat Recovery Systems by D.A.Reay, E &F.N.Span, London,.
3. Ibrahim Dincer and Mark A. Rosen, Thermal Energy Storage Systems and Applications, John Wiley & Sons 2002
4. Trivedi, PR, Jolka KR, Energy Management, Commonwealth Publication, New Delhi, 1997

Course Outcomes (CO)
Upon completion of the course, students should

CO1	Understand about need for Energy Conservation and Management.
CO2	Apply concepts of thermodynamics to engineering systems.
CO3	Study the different measures for energy conservation.
CO4	Study the various applications of energy storage systems
CO5	Develop optimized model for energy planning.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	2	-	-	2	2	-	-	-	2	2	2	2	-
CO2	3	2	2	-	-	2	2	-	-	-	2	2	2	2	-
CO3	3	2	2	-	-	2	2	-	-	-	2	2	2	2	-
CO4	3	2	2	-	-	2	2	-	-	-	2	2	2	2	-
CO5	3	2	2	-	-	2	2	-	-	-	2	2	2	2	-

OME422	AIR POLLUTION AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES

- To impart knowledge on the principle and design of control of Indoor/ particulate/ gaseous air pollutant and its emerging trends.

UNIT – I	INTRODUCTION	9
Structure and composition of Atmosphere – Definition, Scope and Scales of Air Pollution – Sources and classification of air pollutants and their effect on human health, vegetation, animals, property, aesthetic value and visibility- Ambient Air Quality and Emission standards.		CO1

UNIT – II	METEOROLOGY	9
Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Atmospheric Diffusion Theories – Dispersion models, Plume rise.		CO2

UNIT – III	CONTROL OF PARTICULATE CONTAMINANTS	9
Factors affecting Selection of Control Equipment – Gas Particle Interaction – Working principle - Gravity Separators, Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators.		CO3

UNIT – IV	CONTROL OF GASEOUS CONTAMINANTS	9
Factors affecting Selection of Control Equipment – Working principle - absorption, Adsorption, condensation, Incineration, Bio filters – Process control and Monitoring.		CO4

UNIT – V	INDOOR AIR QUALITY MANAGEMENT	9
Sources, types and control of indoor air pollutants, sick building syndrome and Building related illness Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive.		CO5
Total Periods:		**45**

Text Books:

1. Lawrence K. Wang, Norman C. Pareira, Yung Tse Hung, "Air Pollution Control Engineering",
2. Tokyo, Springer science + science media LLC, 2004.
3. Noel de Nevers, "Air Pollution Control Engineering", Waveland press,Inc 2017.
4. Anjaneyulu. Y, "Air Pollution and Control Technologies", Allied Publishers (P) Ltd., India 2002.

References:

1. David H.F. Liu, Bela G. Liptak, "Air Pollution", Lweis Publishers, 2000.
2. Arthur C. Stern, "Air Pollution (Vol.I – Vol.VIII)", Academic Press, 2006.
3. Wayne T.Davis, "Air Pollution Engineering Manual", John Wiley & Sons, Inc, 2000.
4. M.N Rao and HVN Rao, "Air Pollution",TataMcgraw Hill Publishing Company Limited, 2007.
5. C.S. Rao, "Environmental Pollution Control Engineering",New Age International(P) Limited Publishers,2006.

Course Outcomes (CO)
Upon completion of the course, students should have the

CO1	An understanding of the nature and characteristics of air pollutants, noise pollution and basic concepts of air quality management
CO2	To identify, formulate and solve air and noise pollution problems
CO3	To design stacks and particulate air pollution control devices to meet applicable standards.
CO4	To select control equipments.
CO5	To ensure quality, control and preventive measures.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	-	-	2	-	3	3	-	-	-	-	3	-	2	-
CO2	3	-	-	2	-	3	3	-	-	-	-	3	-	2	-
CO3	3	-	-	2	-	3	3	-	-	-	-	3	-	2	-
CO4	3	-	-	2	-	3	3	-	-	-	-	3	-	2	-

CO5	3	-	-	2	-	3	3	-	-	-	-	3	-	2	-

MANDATORY COURSES

MX4001	INTRODUCTION TO WOMEN AND GENDER STUDIES	L	T	P	C
	(Common to all branches of B.E. / B. Tech Programmes)	3	0	0	0

Objectives

- ❖ To enhance social sensitivity, sensibility and responsibility thereby instilling the life skills among students, through applied learning.
- ❖ To upgrade knowledge and comprehension of gender issues for attitudinal and behavioural changes among marginalized groups to claim the right to life with dignity and equality through extension and collaborative activities.
- ❖ To evolve inclusive approach for holistic development in order to promote women empowerment

UNIT - I	INTRODUCTION TO WOMEN'S STUDIES	9

Key concepts in Gender studies - Need, Scope and challenges of Women's Studies – Women's Studies as an academic discipline -Women's Studies to Gender Studies -Need for Gender Sensitization - Women's Movements–global and local: Pre-independence -Post-independence and Contemporary Debates – National Committees and Commissions for Women.

UNIT – II	FEMINIST THINKERS AND THEORIES	9

Liberal Feminism – Marxist Feminism – Radical Feminism –Socialist Feminism – Indian Feminism – Black Feminism - Eco-Feminism – New Feminist Debates- Post Colonial/Post Modern – Masculinity Studies – Contemporary Contestations –Intersex and Transgender Movements. Feminist thinkers in 18^{th} ,19^{th} , 20^{th} and 21^{st} Century.

UNIT – III	GENDER AND EDUCATION	9

Women's Education – Gender diversities and disparities in enrolment, Curriculum content, Dropouts, profession and Gender – Gendered Education-Family, Culture, Gender roles, Gender Identities – Education for the Marginalized Women – Recent Trends in Women's Education –Committees and Commissions on Education – Vocational education and skill development for women.

UNIT – IV	WOMEN, WORK AND EMPLOYMENT	9

Theoretical Perspective: Fredrick Engels, Rosa Luxemburg, Sandra Whiteworth, Boserup Esther – Concept of Work– Productive and non– productive work–Use value and market value – Gender Division of Labour–Mode of Production–Women in organized and unorganized sector – New Economic Policy and its impact on Women's Employment–Globalization–Structural Adjustment Programs.

UNIT – V	GENDER AND ENTREPRENEURSHIP	9

Concept and meaning, Importance of Entrepreneurship, Entrepreneurial traits, Factors contributing to Entrepreneurship, enabling environment, small Enterprises, women in agri-business – Gender and emerging Technology – Impact - Self-help Groups and Micro Credit – Gender mainstreaming, Gender budgeting, planning and Analysis.

Total Periods:	**45**

Text Books:

1. Jaya Kothari Pillai- 1995, Women and Empowerment, New Delhi: Gyan Publishing House
2. JoRoland: 1997, Questioning Empowerment, Oxfam Oxford.

3. Janet Townsend etal-: 1999, Women and Power, Fighting Patriarchy and Poverty. Zed Books, London.
4. Naila Kabeer: 1996, Reversed Realities, Kali for women, New Delhi.

Course Outcomes (CO)
Upon completion of the course, students will be able

CO1	To enhance the social sensitivity, sensibility and responsibility thereby instilling the life skills among students.
CO2	To upgrade knowledge and comprehension of gender issues for attitudinal and behavioural change among men, women and transgender etc. to claim the right to life with dignity and equality.
CO3	To bring social, economic, political and cultural empowerment and gender equality in personal as well Professional life.
CO4	To crystallize the teaching of Women's Studies in term of teaching, research and extension. in order
CO5	To create more gender equality and equity world by education, sensitization and empowerment.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	-	-	-	-	-	1	-	1	-	-	-	1	-	-	1
CO2	-	-	-	-	-	1	-	1	-	-	-	1	-	-	1
CO3	-	-	-	-	-	1	-	1	-	-	-	1	-	-	1
CO4	-	-	-	-	-	1	-	1	-	-	-	1	-	-	1
CO5	-	-	-	-	-	1	-	1	-	-	-	1	-	-	1

MX4002	ELEMENTS OF LITERATURE	L	T	P	C
	(Common to all branches of B.E. / B. Tech Programmes)	3	0	0	0

Objectives

- To understand the recent contexts, concepts and ideologies.
- To acquaint themselves with the major generic divisions in English literature.
- To acknowledge the conventions of literary research and documentation.

UNIT - I	KEY ELEMENTS OF LITERATURE	9

Language - Plot - Setting/Milieu - Character - Theme - Point of View - Tone/Mood.

UNIT – II	PROSE	9

The form of prose - written and spoken prose - individual and common style - simplicity and ornamentation - abstract and concrete - realism, romance and unreality - the science of rhetoric.

UNIT – III	POETRY	9

The importance of form - the physical form of poetry - metre - variation - rhyme - internal pattern - logical sequence - the use of associations - patterns of imagery the main types of poetry.

UNIT – IV	**NOVEL**	**9**
The concept of fiction - verisimilitude - the point of view - plot - character - character revealed - conversation - scene and background - dominant themes - the experimental novel.		
UNIT – V	**DRAMA**	**9**
Live literature - action - plots - conventional divisions - direct experience of characters - dialogue and conversation - verse and prose - types of drama - drama and history - use of notes – interpretation.		
Total Periods:		**45**

Text Books:

1. Barnet Sylvan, Types of Drama; Plays and Essays, Boston, Little Brown, 1981.
2. Brooks, Peter, Reading for the Plot; Design and Intention in Narrative, Oxford, Clarendon Press, 1984.
3. Hardings D.W., Words Into Rhythm; English Speech, OUP, New Delhi, 1976.
4. Murfin, Ross, and Supriya M. Ray. The Bedford Glossary of Critical and Literary Terms. New York: Macmillan Press Ltd., 1997.
5. Paul, Poplawski, ed. English Literature in Context. London: CUP,2008.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Comprehend various forms of literature like prose, poetry, drama and fiction.
CO2	Interpret and appreciate the didactic purpose in literature.
CO3	Identify the poetic devices to the connection of poems.
CO4	Describe the process and origin of the development of drama in its structure with the text.
CO5	Define the various types of novels with their structure

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	-	-	-	-	-	1	-	1	-	-	-	1	-	-	1
CO2	-	-	-	-	-	1	-	1	-	-	-	1	-	-	1
CO3	-	-	-	-	-	1	-	1	-	-	-	1	-	-	1
CO4	-	-	-	-	-	1	-	1	-	-	-	1	-	-	1
CO5	-	-	-	-	-	1	-	1	-	-	-	1	-	-	1

MX4003	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L	T	P	C
	(Common to all branches of B.E. / B. Tech Programmes)	3	0	0	0

Objectives

- ❖ To develop inter personal skills and be an effective goal-oriented team player.
- ❖ To develop professionals with idealistic, practical and moral values.
- ❖ To develop communication and problem-solving skills.
- ❖ To re-engineer attitude and understand its influence on behaviour.

UNIT - I	**NEETISATAKAM-HOLISTIC DEVELOPMENT OF PERSONALITY-I**	**9**

Verses- 19,20,21,22 (wisdom), Verses- 29,31,32 (pride & heroism), Verses- 26,28,63,65 (virtue)		
UNIT – II	**NEETISATAKAM-HOLISTIC DEVELOPMENT OF PERSONALITY-II**	**9**
Verses- 52,53,59 (don'ts), Verses- 71,73,75,78 (do's)		
UNIT – III	**APPROACH TO DAY-TO-DAY WORK AND DUTIES**	**9**
Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48, Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, Chapter 18-Verses 45, 46, 48.		
UNIT – IV	**STATEMENTS OF BASIC KNOWLEDGE**	**9**
Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68, Chapter 12 -Verses 13, 14, 15, 16, 17, 18		
UNIT – V	**PERSONALITY OF ROLE MODEL**	**9**
Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39, Chapter18 – Verses 37,38,63.		
Total Periods:		**45**

Text Books:

1. "Srimad Bhagavad Gita" by Swami Swarupananda, Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi

Course Outcomes (CO)

CO1	Study of Shrimad Bhagwad Geeta will help the student in developing his personality and achieve the highest goal in life.
CO2	The person who has studied Geeta will lead the nation and mankind to peace and prosperity.
CO3	Study of Neetishatakam will help in developing versatile personality.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	-	-	-	-	-	1	-	1	-	-	-	1	-	-	1
CO2	-	-	-	-	-	1	-	1	-	-	-	1	-	-	1
CO3	-	-	-	-	-	1	-	1	-	-	-	1	-	-	1

MX4004	DISASTER MANAGEMENT	L	T	P	C
	(Common to all branches of B.E. / B. Tech Programmes)	3	0	0	0

Objectives

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction.
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

UNIT I	**INTRODUCTION TO DISASTERS**	**9**
Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire etc - Classification, Causes, Impacts including		

social, economic, political, environmental, health, psychosocial, etc.- Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don'ts during various types of Disasters.		**CO1**
UNIT – II	**APPROACHES TO DISASTER RISK REDUCTION (DRR)**	**9**
Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processess and Framework at State and Central Level- State Disaster Management Authority(SDMA) – Early Warning System – Advisories from Appropriate Agencies.		**CO2**
UNIT – III	**INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT**	**9**
Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use etc.- Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.		**CO3**
UNIT – IV	**DISASTER RISK MANAGEMENT IN INDIA**	**9**
Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness), Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.		**CO4**
UNIT – V	**DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS**	**9**
Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.		**CO5**
Total Periods:		**45**

Text Books:

1. Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
2. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., 2012. ISBN-10: 1259007367, ISBN-13: 978-1259
3. Gupta Anil K, Sreeja S. Nair "Environmental Knowledge for Disaster Risk Management", NIDM, New Delhi, 2011
4. Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010.

References:

1. Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005
2. Government of India, National Disaster Management Policy, 2009.

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Differentiate the types of disasters, causes and their impact on environment and society

CO2	Assess vulnerability and various methods of risk reduction measures as well as mitigation
CO3	Draw the hazard and vulnerability profile of India, Scenarios in the Indian context,
CO4	Know about the relief measures, Disaster damage assessment and management.
CO5	Learn through case studies about the damages caused due to various disasters.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	-	-	3	-	-	3	3	-	-	-	-	2	-	-	2
CO2	-	-	3	-	-	3	3	-	-	-	-	2	-	-	2
CO3	-	-	3	-	-	3	3	-	-	-	-	2	-	-	2
CO4	-	-	3	-	-	3	3	-	-	-	-	2	-	-	2
CO5	-	-	3	-	-	3	3	-	-	-	-	2	-	-	2

MX4005	WELL BEING WITH TRADITIONAL PRACTICES	L	T	P	C
	(Common to all branches of B.E. / B. Tech Programmes)	3	0	0	0

Objectives

- Explaining the purpose of well being and impact it has on their work and life.
- To teach basic methods used in the systems of Ayurveda, Siddha and Yoga.
- Identify key factors that contribute to work place burnout and sustainability.

UNIT - I	HEALTH AND HAPPINESS	9

Mental and physical health, physical and emotional safety, and a feeling of belonging, sense of purpose, achievement and success.Need for Managing Self, Positive Psychology and Yoga.

UNIT – II	WELL BEING	9

Health and Wellbeing: Perspectives from Positive Psychology, Yoga and Ayurveda, Attaining Wellbeing – Methods, Obstacles, Realms and Types of Interventions for Managing Self and Career

UNIT – III	YOGA PRACTICES	9

Definitions of Eight parts of yoga (Ashtanga) Asan and Pranayam - Various yoga poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

UNIT – IV	AYURVEDA PRACTICS	9

Health Benefits of Ayurveda, Ayurvedic techniques: Diet, Herbal, Acupuncture, Massage and Meditation. Ayurveda and allied disciplines –Approach to health disease in Ayurveda

UNIT – V	BASIC CONCEPTS AND PRINCIPLES OF SIDDHA MEDICINE	9

Principles of Siddha- the five natural elements and three humours, Physical constituents.

Total Periods:	45

Text Books:

1. Mental health and well being in workplace by Gill hassan and Donna Butler.
2. Yogic Asanas for Group Training - Part- I": Janardan Swami Yogabhyasi Mandal, Nagpur.
3. Textbook of Ayurveda: Volume 1 - Fundamental Principles of Ayurveda by Dr Vasant Lad.
4. Siddha medicine handbook of traditional remedies by Paul Joseph

References:

1. The Social Psychology of Mental Health: Basic Mechanisms and Applications by Diane N Ruble
2. "Raja yoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama Publication Department, Kolkata.

Course Outcomes (CO)
Upon completion of the course, students will be able

CO1	To create awareness about health and happiness
CO2	To develop healthy mind in a healthy body thus improving social health also
CO3	To educate the importance of various yoga asanas
CO4	To know the values of ayurveda system
CO5	To understand the importance of siddha medicine.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	3	2	3	2	3	2	2	2	3	2	2	2	2	2	1
CO2	3	2	3	3	2	2	2	2	2	2	2	3	2	2	1
CO3	3	3	2	3	2	2	2	3	3	2	2	2	2	2	1
CO4	3	3	3	2	2	2	3	3	3	2	2	2	2	2	1
CO5	2	3	2	2	3	2	2	2	3	2	2	2	2	2	1

MX4006	HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA	L	T	P	C
	(Common to all branches of B.E. / B. Tech Programmes)	3	0	0	0

Objectives

- To provide an exposure to the development of science and technology in India
- To impart authentic knowledge of India's scientific and technological traditions.
- To provide an understanding of the socio-cultural and philosophical context in which science and technology developed.
- To help in repositioning India's contributions in science and technology.

UNIT - I INTRODUCTION **9**

Logic and methodology of Indian sciences - An overview of Indian contributions to sciences - An overview of Indian contributions to technology.

UNIT – II ASTRONOMY **9**

Development of astronomy in India- Pancanga: Indian calendrical computations- The distinct features of Indian planetary models- Computation of eclipses: Its simplicity- elegance and efficiency- Observational astronomy in India.

UNIT – III MATHEMATICS **9**

An overview of the development of mathematics in India – Mathematics contained in Sulbasutras – combinatorial aspects of the Chandassastra – Solutions to the first and second order indeterminate equations- Weaving mathematics into beautiful poetry: Bhaskaracarya – The evolution of sine function in India – The discovery of calculus by Kerala astronomers.

UNIT – IV	AYURVEDA	9

History of Ayurveda – Rational foundations of Ayurveda – Textual sources in Ayurveda – Ayurveda and allied disciplines –Approach to health disease in Ayurveda – Approach to diet and nutrition in Ayurveda – Ayurveda and modern medicine – Ayurveda and Yoga

UNIT – V	TECHNOLOGICAL DEVELOPMENT IN INDIA	9

Agriculture: Origin and development- Ancient crops- Traditional practices
Water management: Overview- Harappan water management- Other case studies- Medieval Water structures
Pottery: Overview- Technical aspects
Silpasastra: Architecture and Construction: An introduction to Silpasastra- Construction Technology
Metallurgy: Copper/Bronze/Zinc- Iron and Steel Technology in India

Total Periods:	**45**

Text Books:

1. Suvobrata Sarkar, History of Science, Technology, Environment, and Medicine in India, Taylor & Francis, London
2. Neera Misra, Sabareesh P.a. 2022, A Brief History of Science in India, Garuda Prakashan Private Limited.
3. Prittam Dutta 2021, WHAT IS ASTRONOMY?, Notion Press

References:

1. D. P. Chatpathayaya, History of science, philosophy, and culture in India civilization, Uma das Gupta, Pearson Education.
2. Bryan Bunch, Bryan H. Bunch, Alexander Hellemans, The History of Science and Technology, Houghton Mifflin.
3. Projit Bihari Mukharji 2016, Doctoring Traditions-Ayurveda, Small Technologies, and Braided Sciences, University of Chicago Press

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Gain knowledge on Indian sciences
CO2	Understand the evolution of stars as well as of the large scale structure of the Universe
CO3	Solve problems involved in arithmetic, algebra, geometry, and other fields of mathematics
CO4	Understand each individual at a very subtle, personal level and gives a detailed protocol for diet, daily routines and activities to be followed.
CO5	Gain knowledge on origin of agriculture, technical aspects of pottery and silpasastra

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	-	-	-	1	-	-	2	2	-	-	-	2	2	1	1
CO2	2	2	1	1	1	2	2	1	-	-	1	3	2	1	1
CO3	3	3	2	1	1	-	-	-	1	-	1	2	2	1	1
CO4	1	-	-	-	-	3	3	1	-	-	-	3	2	1	1
CO5	2	2	1	1	2	3	3	1	-	-	-	2	2	1	1

MX4007	POLICAL AND ECONOMIC THOUGHT FOR HUMAN SOCIETY	L	T	P	C

(Common to all branches of B.E. / B. Tech Programmes)	3	0	0	0

Objectives

- To understand the concept of political science and theories of political science.
- To know the types of political socialization and their role.
- To explore various theories of economic thought.
- To learn the importance of human values of life.

UNIT - I	POLITICAL THOUGHTS	9

Political science: Definition, Nature & Scope; Relation of Political Science with other Social Sciences; Traditional approaches to the study of Political Science: Normative, Empirical and Feminist-State: Definition; Elements; Relation with other organizations; Theories of origin of state (Theory of Divine, Force, and Evolutionary); Sovereignty- definition and characteristics.

UNIT – II	POLITICAL CULTURE AND POLITICAL SOCIALIZATION	9

Meaning and dimensions of political culture, meaning and types of political socialization agencies of political socialization and their role-Meaning and types of political participation, political apathy – reasons for political apathy, Determinants of political participation – psychological, social and political.

UNIT–III	HISTORY OF ECONOMIC THOUGHT	9

Nature and Importance of Economic thought – Approaches of Economic Thought – Scholastics – Mercantilism, French and English – Thomas Munn – Scientific Method and the French Physiocrats – Quesnay – The Classical School – Adam Smith – Division of Labour – Ricardo and Theory of Rent – Comparative Cost Theory – Stationary State – Malthus and Theory of Population and Theory of Gluts.

UNIT–IV	ECONOMIC BEHAVIOUR AND MORAL SENTIMENTS	9

Importance of ethics in economics; Outcomes of ethical analysis; Duties, rules and virtues; Economic behaviour: Self-interest and rational behaviour- Adam Smith and self-interest - Social Philosophy (Naturalism, Optimism, Self Interest, Invisible hand, Laisseze faire); Economic ideas: Wealth, Labour& Division of labour, Value, Distribution.

UNIT – V	HUMAN VALUES	9

Value Education, Self-Exploration- its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self-exploration, Continuous Happiness and Prosperity- A look at basic Human Aspirations, Right understanding, Relationship - the basic requirements for fulfillment of aspirations of every human being with their correct priority, Method to fulfill the human Values, understanding and living in harmony at various levels.

Total Periods:	**45**

Text Books:

1. Bhargava, R. (2008) 'What is Political Theory', in Bhargava, R and Acharya, A. (eds.) Political Theory: An Introduction. New Delhi: Pearson Longman.
2. Olivier Blanchard and David R. Johnson, Macroeconomics, Sixth Edition, Pearson, 2017.
3. R R Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.

References:

1. O.P.Gauba, (2015) An Introduction to Political Theory, New Delhi: Mayur Publishers.
2. Ashaf, Ali and Sharma B.N. 2001.Political Sociology, University Press, Hyderabad .
3. Jonathan Conlin, Great Economic Thinkers: From Adam Smith to Amartya Sen, Speaking Tiger Publishing, 2018.
4. Linda Yueh, The Great Economists: How Their Ideas Can Help Us Today, Viking, 2018.

5. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Book.
6. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.
7. Irene van Staveren, The Values of Economics: An Aristotelian Perspective, London: Routledge, 2001

Course Outcomes (CO)
Upon completion of the course, students will be able

CO1	To explain the traditional approached of political science and theories of state.
CO2	To identify the political culture, socialization, participation and apathy.
CO3	To understand the importance of economic thought and their approaches.
CO4	To explore the economic behaviour and moral sentiments of the individuals.
CO5	To learn the human values for harmony and to build better relationships.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	1	1	1	3	1	1	1	1	2	2	1	2	2	2	1
CO2	1	1	1	3	1	2	1	1	2	2	1	2	2	2	1
CO3	1	2	1	3	1	2	1	2	2	2	1	2	2	2	1
CO4	1	2	2	3	1	2	3	2	2	3	1	2	2	2	1
CO5	1	2	1	3	1	1	3	3	3	3	1	2	2	2	1

MX4008	INDUSTRIAL SAFETY	L	T	P	C
	(Common to all branches of B.E. / B. Tech Programmes)	3	0	0	0

Objectives

- To impart knowledge on safety engineering fundamentals and safety management practices..

UNIT I	INTRODUCTION	9
Evolution of modern safety concepts – Fire prevention – Mechanical hazards – Boilers, Pressure vessels, Electrical Exposure.		CO1

UNIT – II	CHEMICAL HAZARDS	9
Chemical exposure – Toxic materials – Ionizing Radiation and Non-ionizing Radiation - Industrial Hygiene – Industrial Toxicology.		CO2

UNIT – III	ENVIRONMENTAL CONTROL	9
Industrial Health Hazards – Environmental Control – Industrial Noise - Noise measuring instruments, Control of Noise, Vibration, - Personal Protection.		CO3

UNIT – IV	HAZARD ANALYSIS	9
System Safety Analysis –Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis and Risk Assessment		CO4

UNIT – V	INDUSTRIAL SAFETY	9

Explosions – Disaster management – catastrophe control, hazard control, Safety education and training - Factories Act, Safety regulations Product safety – Case studies.	**CO5**
Total Periods:	**45**

Text Books:

1. John V. Grimaldi, "Safety Management", AITB S Publishers, 2003.

References:

1. Safety Manual, "EDEL Engineering Consultancy", 2000.
2. David L. Goetsch, "Occupational Safety and Health for Technologists, Engineers and Managers", 7th Edition, Pearson Education Ltd., 2013

Course Outcomes (CO)
Upon completion of the course, students will be able to

CO1	Understand the modern safety concepts and Mechanical hazards
CO2	Identify the effects of Chemical exposure and Toxic materials
CO3	Understand the Industrial Health Hazards due to environment
CO4	Understand the System Safety Analysis Techniques
CO5	Understand the Factories Act, Safety regulations

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	a	b	c	d	e	f	g	h	i	j	k	l	1	2	3
CO1	-	-	3	-	-	3	2	2	-	-	-	3	-	-	2
CO2	-	-	3	-	-	3	2	2	-	-	-	3	-	-	2
CO3	-	-	3	-	-	3	2	2	-	-	-	3	-	-	2
CO4	-	-	3	-	-	3	2	2	-	-	-	3	-	-	2
CO5	-	-	3	-	-	3	2	2	-	-	-	3	-	-	2

Faculty of Electrical and Electronics Engineering

MINUTES OF MEETING OF BOARD OF STUDIES

The Second meeting of Board of Studies was held on **14.02.2023 Tuesday, 10:00 AM**.

The following members were present for the meeting:

S. No	Designation	Name	Phone no / mail id
1.	Chairman	Dr.D.Kirubakaran Professor & Head Department of Electrical and Electronics Engineering St. Joseph's Institute of Technology	9840009248 hodeeestaffaffairs@stjosephstechnology.ac.in
2.	University Nominee	Dr. Bogaraj T Professor , Department of Electrical and Electronics Engineering PSG College of Technology	8838020959 tbr.eee@psgtech.ac.in
3.	Subject Experts from outside parent University	Dr.S.Senthil Kumar Associate Professor National Institute of Technology, Tiruchirappalli	9443165211 skumar@nitt.edu
		Dr.K.Vijayakumar Assistant Professor Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram	9549659069 vijayakumar@iiitdm.ac.in
4.	Industry expert	Mr.S.Selvakumar Business Head Power Projects, Chennai	9962188337 selvaspecial@gmail.com
5.	Post Graduate Meritorious Alumni	Mr.Rahulkumar J Junior Research Fellow & Research Scholar Department of EEE SRM Institute of Science and Technology, Chennai	6380680391 rahulkumarjkb@gmail.com
6.	Department Faculty for each specialization	All Faculty Members	9840009248 hodeeestaffaffairs@stjosephstechnology.ac.in

List of Internal Faculty Members

Dr. S. Hemalatha/ Professor
Mr. R. Manivannan/Assistant Professor
Mrs. M.R Faridha Banu /Assistant Professor
Mr. I. Cephas / Assistant Professor
Mrs. M. Latha Devi /Assistant Professor
Mr. S. Karthick /Assistant Professor
Mrs. P. Dhivya / Assistant Professor
Mr.R. Sampath Kumar/Assistant Professor
Mrs.S.Vasanthi / Assistant Professor
Mrs.S. Ranjani / Assistant Professor
Mrs.G.Konamma / Assistant Professor
Mrs.S.Izzath Fathima / Assistant Professor
Mr. S.V.Prabhu / Assistant Professor

- Dr.D.Kirubakaran, Chairman of BoS formally welcomed the members for the second BoS meeting and presented the B.E Electrical and Electronics Engineering curriculum and Syllabus of the I to VIII semester Electrical based courses under Autonomous Regulations R2022 to the members of the board.

BoS 02.01: To consider and approve the curriculum of the B.E. Electrical and Electronics Engineering program and syllabi of I to VIII semester Electrical based courses under Autonomous Regulations R2022 with effect from the academic year 2022 - 2023 onwards.

The following suggestions were discussed.

- **Credit Points**
  - It is recommended that the credit points can be changed from 171 to 169 by transferring courses EE4301 - Electromagnetic Theory and EE4701 — High Voltage Engineering to the professional electives and by adding one credit point to EE4303 — Electric Circuit Analysis.

- **Semester - III**
  - EE4304 - Analog and Digital Electronics is discussed and proposed to be separated as two courses such as (1) Analog Electronic Circuits and (2) Integrated Circuits and Digital Electronics.

- **Semester - IV**
  - EE4402 - Transmission and Distribution can be renamed as Generation, Transmission and Distribution by including Generation topics in the Unit I.

- **Semester - VI**
  - EE4602 - Protection and Switchgear can be shifted to seventh semester.
  - Embedded System from Professional Elective can be shifted to sixth semester as core subject.
  - EE4601 - Solid State Drives subject can be renamed as Power Electronic Drives and Control.

RESOLVED TO APPROVE the curriculum and syllabi of I to VIII Semesters for the B.E. Electrical and Electronics Engineering Program under Autonomous Regulations R2022 after incorporating the above suggestions and modifications.

The meeting concluded with the vote of thanks by Board Chairman to all the external and internal members for having spared their time and participated in the first Board of Studies Meeting.

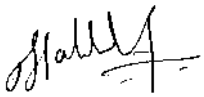
Dr.D.Kirubakaran
Chairman, Board of Studies
Professor & Head
Department of Electrical and Electronics Engineering
St. Joseph's Institute of Technology OMR, Chennai.

Dr. Bogaraj T
Professor
Department of Electrical and Electronics Engineering
PSG College of Technology, Coimbatore

Dr.K.Vijayakumar
Assistant Professor
Indian Institute of Information Technology, Design and Manufacturing, Kancheepuram.

Dr.S.Senthil Kumar
Associate Professor
National Institute of Technology, Tiruchirappalli

Mr.S.Selvakumar
Business Head
Power Projects,
Chennai



Mr.Rahulkumar J
Junior Research Fellow & Research Scholar
Department of EEE
SRM Institute of Science and Technology, Chennai