GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)

Coimbatore - 641 013

Curriculum For

Under Graduate

B. E. Electrical and Electronics Engineering

(Full Time)

2022

Regulations

OFFICE OF THE CONTROLLER OF EXAMINATIONS
GOVERNMENT COLLEGE OF TECHNOLOGY
THADAGAM ROAD, COIMBATORE - 641 013
PHONE 0422 - 2433355 FAX: +91 0422 - 2433355
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GOVERNMENT COLLEGE OF TECHNOLOGY
(An Autonomous Institution Affiliated to Anna University, Chennai)
Coimbatore-641013

VISION AND MISSION OF THE INSTITUTION

VISION

To emerge as a centre of excellence and eminence by imparting futuristic technical education in keeping with global standards, making our students technologically competent and ethically strong so that they can readily contribute to the rapid advancement of society and mankind

MISSION

To achieve Academic excellence through innovative teaching and learning practices
To enhance employability and entrepreneurship
To improve the research competence to address societal needs
To inculcate a culture that supports and reinforces ethical, professional behaviours for a harmonious and prosperous society

GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)

Coimbatore - 641 013

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

VISION AND MISSION OF THE DEPARTMENT

VISION:

To be a premier and value based department committed to excellence in preparing students for success in Electrical Engineering and Technology professions.

MISSION:

To facilitate quality learning blended with practical engineering skills.

To prepare students to develop all round competitiveness.

To motivate Faculty and students to do impactful research on societal needs.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The Programme Educational Objectives of Electrical and Electronics Engineering Graduates will be able:

PEO1:

To excel in technological advancements in Electrical and Electronics Engineering and allied Fields.

PEO2:

To design electrical, electronic and computing systems that are innovative and socially acceptable.

PEO3:

- To exhibit professionalism, ethics, communication skills and team work in their career.
- To adapt to current trends through lifelong learning and involved in application oriented research.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. 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.
3. 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.
4. 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.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. 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.
7. 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.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. 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.
11. 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.
12. 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.

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMME SPECIFIC OUTCOMES (PSOs)

Electrical and Electronics Engineering Graduates will be able to:

PSO1: Apply the knowledge of Mathematics and Science in Electrical and Electronics Engineering and adapt to a challenging environment through individual and team work.

PSO2: Design, analyze and evaluate the performance of Electrical system using latest tools and gain sufficient competence to solve the problems in the electrical energy sector with future perspective considering socio-economic aspects.

PSO3: Develop the expertise in the emerging technologies for efficient operation and control of Electrical system with ethical responsibility and effective communication to engage in lifelong learning for a successful career.

GOVERNMENT COLLEGE OF TECHNOLOGY

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The Programme Educational Objectives of Electrical and Electronics Engineering Graduates will be able:

PEO1:

To excel in technological advancements in Electrical and Electronics Engineering and allied Fields.

PEO2:

To design electrical, electronic and computing systems that are innovative and socially acceptable.

PEO3:

- To exhibit professionalism, ethics, communication skills and team work in their career.
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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMME OUTCOMES (POs)

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. 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.
3. 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.
4. 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.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. 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.
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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PROGRAMME SPECIFIC OUTCOMES (PSOs)

Electrical and Electronics Engineering Graduates will be able to:

PSO1: Apply the knowledge of Mathematics and Science in Electrical and Electronics Engineering and adapt to a challenging environment through individual and team work.

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PSO3: Develop the expertise in the emerging technologies for efficient operation and control of Electrical system with ethical responsibility and effective communication to engage in lifelong learning for a successful career.

GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE – 641 013

B.E.ELECTRICAL AND ELECTRONICS ENGINEERING (FULL TIME)

FIRST SEMESTER

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week L	T	P	C
THEORY										
	22EMC1Z0	Induction Programme	MC	-	-	-	-	-	-	0
1	22EHS1Z1	தமிழர் மரபு Heritage of Tamils (Common to all Branches)	HSMC	40	60	100	1	0	0	1
2	22EHS1Z2	Professional English (Common to all Branches)	HSMC	40	60	100	2	1	0	3
3	22EBS1Z1	Linear Algebra and Calculus (Common to all Branches)	BS	40	60	100	3	1	0	4
4	22EBS1Z2	Engineering Physics (Common to all Branches)	BS	40	60	100	3	0	0	3
5	22EES101	Programming in C (Common to all Branches-Except MECH & PRODN)	ES	40	60	100	3	0	0	3
6	22EMC1Z1	Environmental Science and Engineering (Common to all Branches)	MC	40	60	100	3	0	0	0
PRACTICAL										
7	22EHS1Z3	Cambridge English (Common to all Branches)	HSMC	60	40	100	0	0	2	1
8	22EBS1Z3	Physics Laboratory (Common to all Branches)	BS	60	40	100	0	0	3	1.5
9	22EES1Z2	Workshop Practice (Common to all Branches)	ES	60	40	100	0	0	3	1.5
10	22EES103	Programming in C Laboratory (Common to all Branches-Except MECH & PRODN)	ES	60	40	100	0	0	3	1.5
TOTAL				**480**	**520**	**1000**	**15**	**2**	**11**	**19.5**

SECOND SEMESTER

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week L	T	P	C
THEORY										
1	22EHS2Z4	தமிழரும் தொழில்நுட்பமும் Tamils and Technology (Common to all Branches)	HSMC	40	60	100	1	0	0	1
2	22EHS2Z5	Values and Ethics (Common to all Branches)	HSMC	40	60	100	3	0	0	3
3	22EBS204	Differential Equations and Numerical Methods (Common to all Branches-Except CSE & IT)	BS	40	60	100	3	1	0	4
4	22EBS205	Applied Chemistry (Common to EEE,ECE,EIE,CSE & IT Branches)	BS	40	60	100	3	0	0	3
5	22EES204	Engineering Mechanics (Common to CIVIL,EEE & PRODN Branches)	ES	40	60	100	3	0	0	3
6	22EES205	Basics of Civil and Mechanical Engineering (Common to EEE & EIE Branches)	ES	40	60	100	3	0	0	3
		NCC Credit Course (Optional)					2	0	0	0
PRACTICAL										
7	22EBS2Z6	Chemistry Laboratory (Common to all Branches)	BS	60	40	100	0	0	3	1.5
8	22EES2Z6	Engineering Graphics (Common to all Branches)	ES	60	40	100	1	0	4	3
TOTAL				**360**	**440**	**800**	**17**	**1**	**7**	**21.5**

THIRD SEMESTER

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	22EES307	Data Structures (Common to EEE, ECE & CSE)	ES	40	60	100	3	0	0	3
2	22EPC301	Electric Circuit Theory	PC	40	60	100	3	1	0	4
3	22EPC302	Field Theory	PC	40	60	100	3	1	0	4
4	22EPC303	Electronic Devices and Circuits	PC	40	60	100	3	0	0	3
5	22EPC304	Electrical Machines-I	PC	40	60	100	3	0	0	3
6	22EPC305	Digital Circuits	PC	40	60	100	3	0	0	3
PRACTICAL										
7	22EPC306	Electric Circuits and Electronic Devices Laboratory	PC	60	40	100	0	0	3	1.5
8	22EPC307	Electrical Machines Laboratory – I	PC	60	40	100	0	0	3	1.5
TOTAL				**360**	**440**	**800**	**18**	**2**	**6**	**23**

FOURTH SEMESTER

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	22EBS407	Fourier Series and Transform Calculus (Common to EEE & EIE Branches)	BS	40	60	100	3	1	0	4
2	22EPC408	Linear Integrated Circuits	PC	40	60	100	3	0	0	3
3	22EPC409	Electrical Machines-II	PC	40	60	100	3	0	0	3
4	22EPC410	Power Generation, Transmissionand Distribution	PC	40	60	100	3	0	0	3
5	22EPC411	Principles of Signals and Systems	PC	40	60	100	3	0	0	3
THEORY WITH PRACTICAL COMPONENT										
6	22EPC412	Electrical and Electronic Measurements	PC	50	50	100	3	0	2	4
PRACTICAL										
7	22EES408	Engineering Exploration	ES	60	40	100	0	0	3	1.5
8	22EPC413	Analog Circuits and Digital IC Laboratory	PC	60	40	100	0	0	3	1.5
9	22EPC414	Electrical Machines Laboratory –II	PC	60	40	100	0	0	3	1.5
TOTAL				**430**	**470**	**900**	**18**	**1**	**11**	**24.5**

GOVERNMENT COLLEGE OF TECHNOLOGY,
COIMBATORE – 641 013

FIFTH SEMESTER											
Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22EES509	Control Systems	ES	40	60	100	3	1	0	4
2	22EPC515	Microprocessors, Microcontrollers and Applications	PC	40	60	100	3	1	0	4
3	22EPC516	Power Electronics	PC	40	60	100	3	0	0	3
4	22EPC517	Electrical Machine Design	PC	40	60	100	3	1	0	4
5	22EPE$XX	Professional Elective - I	PE	40	60	100	3	0	0	3
6	22EMC5Z2	Constitution of India (Common to all Branches)	MC	40	60	100	3	0	0	0
PRACTICAL										
7	22EPC518	Microprocessors, Microcontrollers and Applications Laboratory	PC	60	40	100	0	0	3	1.5
8	22EES510	Control Systems and Simulation Laboratory	ES	60	40	100	0	0	3	1.5
Total				**360**	**440**	**800**	**18**	**3**	**6**	**21**

SIXTH SEMESTER										
Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22EPC619	Power System Analysis	PC	40	60	100	3	1	0	4
2	22EPC620	Industrial Drives and Control	PC	40	60	100	3	0	0	3
3	22EPC621	Power System Protection	PC	40	60	100	3	0	0	3
4	22EPE$XX	Professional Elective - II	PE	40	60	100	3	0	0	3
5	22#OE$XX/ 22EPE$XX	Open Elective – I / Professional Elective-VII	OE/PE	40	60	100	3	0	0	3
PRACTICAL										
6	22EPC622	Power Electronics and Drives Laboratory	PC	60	40	100	0	0	3	1.5
7	22EEE601	Design Thinking for Electrical Engineering	ES	100	-	100	0	0	3	1.5
Total				**360**	**340**	**700**	**12**	**0**	**6**	**19**

SEVENTH SEMESTER

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22EPC723	Power System Operation and Control	PC	40	60	100	3	0	0	3
2	22EPE$XX	Professional Elective - III	PE	40	60	100	3	0	0	3
3	22EPE$XX	Professional Elective - IV	PE	40	60	100	3	0	0	3
4	22#OE$XX/ 22EPE$XX	Open Elective – II / Professional Elective VIII	OE/PE	40	60	100	3	0	0	3
5	22HS701	Project Management and Entrepreneurship	HSMC	40	60	100	3	0	0	3
PRACTICAL										
6	22EPC724	Power System Laboratory	PC	40	60	100	0	0	3	1.5
7	22EEE702	Engineering Projects In Community Service	EEC	60	40	100	0	0	4	2
8	22EEE703	Internship*	EEC	100	-	100	-			4
Total				**400**	**400**	**800**	**15**	**0**	**7**	**22.5**

EIGTH SEMESTER

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22EPE$X X	Professional Elective - V	PE	40	60	100	3	0	0	3
2	22EPE$XX	Professional Elective - VI	PE	40	60	100	3	0	0	3
PRACTICAL										
3	22EEE804	Capstone Project	EEC	60	40	100	0	0	16	8
Total				**140**	**160**	**300**	**6**	**0**	**16**	**14**

Note:

*** Internship of four consecutive weeks or two 2 consecutive weeks which are completed during the vacation of fourth (and/or) fifth (and/or) sixth semester shall be considered here.**

Total Credits	**165**

Credits Distribution

S.No.	CATEGORY		SEMESTER								Total
			I	II	III	IV	V	VI	VII	VIII	
1	**HSMC**	Humanities and Social Sciences / Management	5	4	-	-	-	-	3	0	**12**
2	**BS**	Basic Sciences	8.5	8.5	-	4	-	-	-	-	**21**
3	**ES**	Engineering Sciences	6	9	3	1.5	5.5	1.5	0	0	**26.5**
4	**PC**	Professional Core	-	-	20	19	12.5	11.5	4.5	-	**67.5**
5	**PE**	Professional Elective	-	-	-	-	3	3	6	6	**18**
6	**OE**	Open Elective	-	-	-	-	-	3	3	-	**6**
7	**EEC**	Employability Enhancement Courses	-	-	-	-	-	-	6	8	**15**
8	**MC**	Mandatory Courses	0	-	-	-	0	-	-	-	**0**
TOTAL			**19.5**	**21.5**	**23**	**24.5**	**21**	**19**	**22.5**	**14**	**165**

HUMANITIES AND SOCIAL SCIENCES / MANAGEMENT (HSMC)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22EHS1Z1	Heritage of Tamils	HSMC	40	60	100	1	0	0	1
2	22EHS1Z2	Professional English	HSMC	40	60	100	2	1	0	3
3	22EHS1Z3	Cambridge English	HSMC	60	40	100	0	0	2	1
4	22EHS2Z4	Tamils and Technology	HSMC	40	60	100	1	0	0	1
5	22EHS2Z5	Values and Ethics	HSMC	40	60	100	3	0	0	3
6	22EHS701	Project Management and Entrepreneurship	HSMC	40	60	100	3	0	0	3
TOTAL										**12**

BASIC SCIENCES(BS)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22EBS1Z1	Linear Algebra and Calculus	BS	40	60	100	3	1	0	4
2	22EBS1Z2	Engineering Physics	BS	40	60	100	3	0	0	3
3	22EBS1Z3	Physics Laboratory	BS	60	40	100	0	0	3	1.5
4	22EBS204	Differential Equation and Numerical Methods	BS	40	60	100	3	1	0	4
5	22EBS205	Applied Chemistry	BS	40	60	100	3	0	0	3
6	22EBS2Z6	Chemistry Laboratory	BS	60	40	100	0	0	3	1.5
7	22EBS407	Fourier Series and Transform Calculus (Common to EEE & EIE Branches)	BS	40	60	100	3	1	0	4
TOTAL										**21**

ENGINEERING SCIENCES(ES)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22EES101	Programming in C	ES	40	60	100	3	0	0	3
2	22EES1Z2	Workshop Practice	ES	60	40	100	0	0	3	1.5
3	22EES103	Programming in C Laboratory	ES	60	40	100	0	0	3	1.5
4	22EES204	Engineering Mechanics	ES	40	60	100	3	0	0	3
5	22EES205	Basics of Civil and Mechanical Engineering	ES	40	60	100	3	0	0	3
6	22EES2Z6	Engineering Graphics	ES	60	40	100	1	0	4	3
7	22EES307	Data Structures(Common to EEE,ECE,&CSE)	ES	40	60	100	3	0	0	3
8	22EES408	Engineering Exploration for Electrical Engineering	ES	60	40	100	0	0	3	1.5
9	22EES509	Control and Systems	ES	40	60	100	3	1	0	4
10	22EES510	Control Systems and Simulation Laboratory	ES	60	40	100	0	0	3	1.5
11	22EEE601	Design Thinking for Electrical Engineering	ES	100	-	100	0	0	3	1.5
TOTAL										**26.5**

PROFESSIONAL CORE(PC)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22EPC301	Electric Circuit Theory	PC	40	60	100	3	1	0	4
2	22EPC302	Field Theory	PC	40	60	100	3	1	0	4
3	22EPC303	Electronic Devices and Circuits	PC	40	60	100	3	0	0	3
4	22EPC304	Electrical Machines-I	PC	40	60	100	3	0	0	3
5	22EPC305	Digital Circuits	PC	40	60	100	3	0	0	3
6	22EPC306	Electric Circuits and Electronic Devices Laboratory	PC	60	40	100	0	0	3	1.5
7	22EPC307	Electrical Machines Laboratory – I	PC	60	40	100	0	0	3	1.5
8	22EPC408	Linear Integrated Circuits	PC	60	40	100	3	0	0	3
9	22EPC409	Electrical Machines-II	PC	40	60	100	3	0	0	3
10	22EPC410	Power Generation, Transmission and Distribution	PC	40	60	100	3	0	0	3

11	22EPC411	Principles of Signals and Systems	PC	40	60	100	3	0	0	3
12	22EPC412	Electrical and Electronic Measurements	PC	50	50	100	3	0	2	4
13	22EPC413	Analog Circuits and Digital IC Laboratory	PC	60	40	100	0	0	3	1.5
14	22EPC414	Electrical Machines Laboratory –II	PC	60	40	100	0	0	3	1.5
15	22EPC515	Microprocessors, Microcontrollers and Applications	PC	40	60	100	3	1	0	4
16	22EPC516	Power Electronics	PC	40	60	100	3	0	0	3
17	22EPC517	Electrical Machine Design	PC	40	60	100	3	1	0	4
18	22EPC518	Microprocessors, Microcontrollers and Applications Laboratory	PC	60	40	100	0	0	3	1.5
19	22EPC619	Power System Analysis	PC	40	60	100	3	1	0	4
20	22EPC620	Industrial Drives and Control	PC	40	60	100	3	0	0	3
21	22EPC621	Power System Protection	PC	40	60	100	3	0	0	3
22	22EPC622	Power Electronics and Drives Laboratory	PC	60	40	100	0	0	3	1.5
23	22EPC723	Power System Operation and Control	PC	40	60	100	3	0	0	3
24	22EPC724	Power System Laboratory	PC	40	60	100	0	0	3	1.5
TOTAL										**67.5**

PROFESSIONAL ELECTIVES										
Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
POWER ENGINEERING – V1										
1	22EPE$01	Power System Economics	PE	40	60	100	3	0	0	3
2	22EPE$02	Power System Stability	PE	40	60	100	3	0	0	3
3	22EPE$03	HVDC Transmission Systems	PE	40	60	100	3	0	0	3
4	22EPE$04	Facts Controllers	PE	40	60	100	3	0	0	3
5	22EPE$05	Energy Auditing and Management	PE	40	60	100	3	0	0	3
6	22EPE$06	Digital Protective Relays	PE	40	60	100	3	0	0	3
7	22EPE$07	Restructured Power Systems	PE	40	60	100	3	0	0	3
8	22EPE$08	High Voltage Engineering	PE	40	60	100	3	0	0	3
DRIVES AND ENERGY TECHNOLOGIES – V2										
9	22EPE$09	Special Machines and Controllers	PE	40	60	100	3	0	0	3
10	22EPE$10	Power Quality Engineering	PE	40	60	100	3	0	0	3
11	22EPE$11	Energy Storage Technology	PE	40	60	100	3	0	0	3
12	22EPE$12	Microgrid Technology	PE	40	60	100	3	0	0	3
13	22EPE$13	Renewable Energy Sources and Technology	PE	40	60	100	3	0	0	3
14	22EPE$05	Energy Auditing and Management	PE	40	60	100	3	0	0	3
15	22EPE$14	Design of Motors and Power Converters for Electric Vehicles	PE	40	60	100	3	0	0	3
INSTRUMENTATION AND CONTROL – V3										
16	22EPE$15 / 22NPE$10	Thermal Power Plant Instrumentation (Common to EEE & EIE)	PE	40	60	100	3	0	0	3
17	22EPE$16	Principles of Virtual Instrumentation	PE	40	60	100	3	0	0	3
18	22EPE$17	MEMS and NEMS	PE	40	60	100	3	0	0	3
19	22EPE$18	Logic and Distributed Control Systems	PE	40	60	100	3	0	0	3
20	22EPE$19	Modern Control Theory	PE	40	60	100	3	0	0	3

21	22EPE$20	Electronic Circuit Design (Common to EEE, ECE & EIE)	PE	40	60	100	3	0	0	3
22	22EPE$21	Electronic System Design and Productization (Common to EEE, ECE & EIE)	PE	40	60	100	3	0	0	3
23	22EPE$22	Adaptive Control (Common to EEE & EIE)	PE	40	60	100	3	0	0	3

ELECTRIC VEHICLE SYSTEMS – V4

24	22EPE$23	Electric Vehicle Architecture	PE	40	60	100	3	0	0	3
25	22EPE$14	Design of Motors and Power Converters for Electric Vehicles	PE	40	60	100	3	0	0	3
26	22EPE$24	Hybrid Electric and Fuel Cell Vehicles	PE	40	60	100	3	0	0	3
27	22EPE$25	Design of Electric Vehicle Charging System	PE	50	50	100	2	0	2	3
28	22EPE$26	Testing of Electric Vehicles	PE	50	50	100	2	0	2	3
29	22EPE$27	Grid Integration of Electric Vehicles	PE	40	60	100	3	0	0	3
30	22EPE$28	Intelligent Control of Electric Vehicles.	PE	50	50	100	2	0	2	3

DIVERSIFIED COURSES – V5

31	22EPE$29	Optimization Techniques and Applications	PE	40	60	100	3	0	0	3
32	22EPE$30	Soft Computing Techniques	PE	40	60	100	3	0	0	3
33	22EPE$31	Automotive Electronics for Electrical Engineering	PE	40	60	100	3	0	0	3
34	22EPE$32	Digital Signal Processing and Processors	PE	40	60	100	3	0	0	3
35	22EPE$33	Principles of Embedded Systems	PE	40	60	100	3	0	0	3
36	22EPE$34	IoT for Electrical Engineering	PE	40	60	100	3	0	0	3
37	22EPE$35	Machine Learning for Electrical Engineering	PE	40	60	100	3	0	0	3

OPEN ELECTIVES (OE)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1.	22COE$01	Disaster Management and Mitigation	OE	40	60	100	3	0	0	3
2.	22COE$02	Water Sanitation and Health	OE	40	60	100	3	0	0	3
3.	22MOE$03	Nanotechnology and Surface Engineering	OE	40	60	100	3	0	0	3
4.	22MOE$04	Industrial Safety Management	OE	40	60	100	3	0	0	3
5.	22EOE$05	Renewable Power Generation Systems	OE	40	60	100	3	0	0	3
6.	22EOE$06	Smart Grid Technology	OE	40	60	100	3	0	0	3
7.	22LOE$07	CMOS VLSI Design	OE	40	60	100	3	0	0	3
8.	22LOE$08	Mobile Communication	OE	40	60	100	3	0	0	3
9.	22POE$09	Rapid Prototyping	OE	40	60	100	3	0	0	3
10	22POE$10	Managerial Economics	OE	40	60	100	3	0	0	3
11.	22NOE$11	Measurement and Control	OE	40	60	100	3	0	0	3
12.	22NOE$12	Industrial Automation	OE	40	60	100	3	0	0	3
13.	22SOE$13	Programming in Java	OE	40	60	100	3	0	0	3
14.	22SOE$14	Network Essential	OE	40	60	100	3	0	0	3
15.	22I0E$15	Video creation and editing	OE	40	60	100	3	0	0	3
16.	22IOE$16	Digital marketing	OE	40	60	100	3	0	0	3
17.	22BOE$17	Principles Of Food Technology	OE	40	60	100	3	0	0	3
18.	22BOE$18	Biology For Engineers	OE	40	60	100	3	0	0	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)										
Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22CEE705	Engineering Projects In Community Service	EEC	60	40	100	0	0	4	2
2	22EEE703	Internship / Industrial Training	EEC	100	-	100	-	-	-	4
3	22EEE804	Capstone Project	EEC	40	60	200	0	0	16	8
TOTAL				**200**	**100**	**400**	**0**	**0**	**20**	**16**

MANDATORY COURSES (MC)										
Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22EMC1Z0	Induction Programme (3 Weeks)	MC	-	-	-	-	-	-	0
2	22EMC1Z1	Environmental Science and Engineering (Common to all Branches)	MC	40	60	100	3	0	0	0
3	22EMC5Z2	Constitution of India (Common to all Branches)	MC	40	60	100	3	0	0	0
TOTAL				180	120	300	6	0	0	0

VALUE ADDED COURSES (VA)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22ZVA$01	Microsoft Diversity Skilling Program	EEC	100	-	100	1	0	2	2
4	22EVA$02	Electrical Safety	EEC	100	-	100	1	0	0	1
5	22EVA$03	Embedded Systems	EEC	100	-	100	1	0	0	1
7	22EVA$04	Electrical Wiring and Maintenance of Household Appliances	EEC	100	-	100	0	0	2	1
9	22EVA$05	PCB Design and Fabrication	EEC	100	-	100	0	0	2	1
10	22EVA$06	Employability Skill Training	EEC	100	-	100	1	0	0	1

GOVERNMENT COLLEGE OF TECHNOLOGY
(An Autonomous Institution Affiliated to Anna University)
Coimbatore–641013.
ELECTRICAL AND ELECTRONICS ENGINEERING

22EMC1Z0	INDUCTION PROGRAMME	SEMESTER I

Details of the Programme:
Day 0: College Admission
Day 1: Orientation Programme
Day 2 Onwards: Induction Programme

Activities:
Physical activity,
Playground
Events,
Yoga Practices,
Literary,
Proficiency modules,
Team Building,
Lectures by Eminent people,
Familiarization to department,
Branch oriented information,
Motivational speakers,
Talent exposure,
Quiz completion,
Visit to local areas….etc.

22EHS1Z1	தமிழர் மரபு **Heritage of Tamils** (Common to all Branches)	**SEMESTER I**

PREREQUISITES	CATEGORY	L	T	P	C
NIL	HSMC	1	0	0	1

UNIT – I	**LANGUAGE AND LITERATURE**	**3 Periods**
Language Families in India - Dravidian Languages – Tamil as a Classical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature- Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.		
UNIT – II	**HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE**	**3 Periods**
Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.		
UNIT – III	**FOLK AND MARTIAL ARTS**	**3 Periods**
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.		
UNIT – IV	**THINAI CONCEPT OF TAMILS**	**3 Periods**
Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature- Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.		
UNIT – V	**CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE**	**3 Periods**
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.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOK:

1	தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித்தமிழ் – முனைவர் இல.சுந்தரம் . (விகடன் பிரசுரம்).
3	கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

REFERENCES:

1	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by:International Institute of Tamil Studies).
3	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by:International Institute of Tamil Studies.)
5	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)
6	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
7	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
8	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) –Reference Book.

22EHS1Z1	தமிழர் மரபு **Heritage of Tamils** (Common to all Branches)	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	HSMC	1	0	0	1

அலகு I	மொழி மற்றும் இலக்கியம்	3 Periods

இந்திய மொழிக் குடும்பங்கள்- திராவிட மொழிகள்- தமிழ் ஒரு செம்மொழி- தமிழ் செவ்விலக்கியங்கள் –சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை-சங்க இலக்கியத்தில் பகிர்தல் அறம்-திருக்குறளில் மேலாண்மைக் கருத்துக்கள்- தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்தசமயங்களின் தாக்கம்-பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள்-சிற்றிலக்கியங்கள்-தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி-தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II	மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை–சிற்பக் கலை	3 Periods

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள்-பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம் , பறை, வீணை, யாழ் , நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III	நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்	3 Periods

தெருக்கூத்து, கரகாட்டம்-வில்லுப்பாட்டு-கணியான் கூத்து-ஒயிலாட்டம்-தோல்பாவைக் கூத்து-சிலம்பாட்டம் –வளரி-புலியாட்டம் -தமிழர்களின் விளையாட்டுகள்.

அலகு IV	தமிழர்களின் திணைக் கோட்பாடுகள்	3 Periods

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு –சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு	3 Periods

இந்திய விடுதலைபோரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.

Contact Periods:
Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods

TEXT BOOK:

1	தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித்தமிழ் – முனைவர் இல.சுந்தரம் . (விகடன் பிரசுரம்).
3	கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
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REFERENCES:

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4	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by:International Institute of Tamil Studies.)
5	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)
6	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
7	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
8	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) –Reference Book.

22EHS1Z2	**PROFESSIONAL ENGLISH** (Common to all Branches)	**SEMESTER I**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**HSMC**	**2**	**1**	**0**	**3**

Course Objectives	1. To engage learners in meaningful language activities to improve their LSRW skills 2. To enhance learners' awareness of general rules of writing for specific audiences 3. To help learners understand the purpose, audience, contexts of different types of writing 4. To develop analytical thinking skills for problem solving in communicative contexts 5. To demonstrate an understanding of job applications and interviews for internship and placements	
UNIT – I	**FUNDAMENTALS OF COMMUNICATION**	**9 Periods**
Listening –Listening to Personal Introduction and Filling a form Speaking - Self Introduction; Introducing someone in a formal context Reading -Reading Biographies/ Autobiographies and E-mails relevant to technical contexts. Writing - Writing Biographies/ Autobiographies; Drafting Professional E-mails. Grammar - Present Tense (Simple Present, Present Progressive, Present Perfect, Present Perfect Continuous); Parts of Speech Vocabulary - Word Formation with Prefixes; Antonyms; Portmanteau Words		
UNIT – II	**SUMMATION AND PROBLEM SOLVING**	**9 Periods**
Listening - Listening to Short-Stories / Personal Experiences/Watching Movies. Speaking - Narrating Personal Experiences / Events and Short Stories Reading - Reading Travelogues and Books. Writing - Report on an event (Field Trip, Industrial Visit, Educational Tours etc.), Review on Books and Movies. Grammar –Past Tense (Simple Past, Past Progressive, Past Perfect, Past Perfect Continuous); Impersonal Passive Vocabulary - Word Formation with suffixes; Synonyms; Phrasal Verbs.		
UNIT – III	**DESCRIPTION OF A PROCESS / PRODUCT**	**9 Periods**
Listening - Listening to Digital Marketing Advertisements for Product /Process Descriptions Speaking –Describing/Interpreting a Picture; Giving instructions to use the product. Reading – Reading Advertisements, Gadget Reviews; User Manuals. Writing - Writing Definitions; Product /Process Description; Transcoding; Content Writing Grammar -Future Tense(Simple Future, future continuous, Future Perfect, Future Perfect Continuous); If Clauses Vocabulary - Homonyms; Homophones, One Word Substitutes.		
UNIT – IV	**EXPRESSION**	**9 Periods**
Listening – Listening to/Watching Formal Job interviews or Celebrity Interviews Speaking – Participating in a Face to Face or Virtual Interview (Job/Celebrity Interview), virtual interviews Reading – Company profiles, Statement of Purpose, (SOP), Excerpts of interview with professionals from Newspaper, Magazine and other Resources Writing – Job / Internship Application – Cover letter & Resume Grammar – Question types: 'Wh' / Yes or No/ and Tags; Subject- Verb Agreement. Vocabulary – Idiomatic Expressions		
UNIT – V	**PUBLIC SPEAKING**	**9 Periods**
Listening – Listening to Ceremonious Speeches on You Tube and Jotting down phrases Speaking – Delivering Welcome Address; Introducing the Chief-Guest; Proposing Vote of Thank and Felicitation Reading – Excerpts of Speeches from Newspaper, Magazines and Motivational Books Writing – Drafting a Welcome Address, Introduction to the Chief-Guest, Vote of Thanks and Felicitation Grammar –Common Errors Vocabulary – Commonly Confused Words		
Contact Periods: **Lecture: 30 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	***"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.*
2	***"Communicative English",*** *Global Publishers, Chennai 2017 by Dr.J.Anbazhagan Vijay*

REFERENCES:

1	*Raman.Meenakshi,Sharma.Sangeeta(2019). "****Professional English".*** *Oxford University Press. New Delhi.*
2	***"Learning to Communicate"*** *– Dr. V. Chellammal, Allied Publishing House, New Delhi,2003*
3	***"Using English"****, Orient Blackswan, Chennai, 2017 by Board of Editors*
4	***"OER"*** *(Authentic Open Educational Resources)*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Participate in a basic communicative task.	K3
CO2	Analyse problems in order to arrive at feasible solutions and communicate them orally and in the written format.	K3
CO3	Describe a product or process or mechanism.	K2
CO4	Present their opinions in a planned and logical manner, and draft effective resumes in context of job search.	K3
CO5	Deliver speeches at formal functions.	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	1	-	-	2	-	-	3	3	-	-	-	1	1
CO2	-	1	1	-	-	2	-	-	1	3	-	1	-	1	1
CO3	-	-	-	1	-	-	-	-	-	3	-	-	-	1	1
CO4	-	-	1	-	-	-	-	-	2	3	-	-	-	-	1
CO5	-	-	-	-	-	-	-	-	2	2	-	-	-	-	1
22EHS1Z2	-	**1**	**1**	**1**	-	**1**	-	-	**2**	**3**	-	**1**	-	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	3.3.2, 6.1.1, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2
CO2	2.1.1, 2.2.3, 2.2.4, 3.1.2, 6.2.1, 9.2.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 12.3.1, 12.3.2
CO3	4.1.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2
CO4	3.3.2, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2
CO5	9.2.2, 9.2.3, 9.2.4, 10.1.1, 10.1.3, 10.2.1, 10.2.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	12	88	-	-	-	100
CAT2	-	18	82	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	100	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	100	-	-	-	100
ESE	-	20	80	-	-	-	100

22EBS1Z1	**LINEAR ALGEBRA AND CALCULUS** (Common to all Branches)	**SEMESTER I**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**BS**	**3**	**1**	**0**	**4**

Course Objectives	1. To acquire knowledge of system of equations, eigenvalues, eigenvectors, diagonalization of matrices and reduction of quadratic forms to canonical forms. 2. To obtain the knowledge of analyze the functions using Limits and derivative recognize the appropriate tools of differential calculus to solve applied problems. 3. To obtain the knowledge of definite and improper integration and recognize the appropriate tools of Integral Calculus to solve applied problems. 4. To develop the skills in solving the functions of several variables by partial derivatives. 5. To acquire knowledge of multiple integration and related applied problems in various geometry	
UNIT – I	**LINEAR ALGEBRA**	**9+3 Periods**
Consistency of System of Linear Equations - Eigen values and eigenvectors - Diagonalization of matrices by orthogonal transformation - Cayley-Hamilton Theorem - Quadratic to canonical forms.		
UNIT – II	**DIFFERENTIAL CALCULUS**	**9+3 Periods**
Limit and continuity of function - Rolle's theorem - Mean value theorems - Taylor's and Maclaurin's theorems. Application of Differential Calculus: Radius of curvature, Centre of curvature, Circle of curvature and Evolutes of a curve.		
UNIT – III	**INTEGRAL CALCULUS**	**9+3 Periods**
Evaluation of definite integral by trigonometric substitution - Convergence and Divergence of improper integrals - Beta & Gamma functions and their properties - Applications of definite integrals to evaluate surface areas and volume of revolution (Cartesian coordinates only).		
UNIT – IV	**PARTIAL DERIVATIVES AND ITS APPLICATIONS**	**9+3 Periods**
Partial derivatives - total derivative - Taylor's series – Jacobians - Maxima, minima and saddle points - Method of Lagrange multipliers.		
UNIT – V	**MULTI VARIABLE INTEGRAL CALCULUS**	**9+3 Periods**
Double integral - Area as double integral - change of order of integration in double integrals - Triple Integrals - Volume as Triple Integral. Change of variables: Cartesian to polar, Spherical polar coordinates, Cylindrical polar coordinates.		
Contact Periods : **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

TEXT BOOK

1	*Veerarajan T.,* ***"Engineering Mathematics I"****, Tata McGraw-Hill Education(India)Pvt. Ltd, New Delhi,2015.*
2	*David C.Lay,* ***"Linear Algebra and Its Application"****, Pearson Publishers, 6th Edition, 2021.*

REFERENCES

1	*B.S.Grewal,* ***"Higher Engineering Mathematics"****, Khanna Publishers, 44th Edition, 2017.*
2	*Howard Anton,* ***"Elementry Linear Algebra"****, 11th Edition, Wiley Publication, 2013.*
3	*Narayanan.S and Manicavachagom Pillai. T.K. –* ***"Calculas Vol I and Vol II",*** *S.chand & Co, Sixth Edition, 2014.*
4	*H.K. Dass,* ***"Advance Engineering Mathematics"****, S. Chand and company, Eleventh Edition, 2015.*
5	*Jain R.K. and Iyengar S.R.K.,* ***"Advanced Engineering Mathematics"****, Narosa Publicaitons, Eighth Edition, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Solve the linear system of equations, diagonalize matrix by orthogonal transformation and reduce quadratic form to canonical form.	K5
CO2	Compare and contrast the ideas of continuity and differentiability and use them to solve engineering problems.	K5
CO3	Acquire fluency in integration of one variable and apply them to find surface area and volumes.	K5
CO4	Apply the techniques of partial derivatives in functions of several variables.	K5
CO5	Use multiple integration for finding area, surface and volume of different geometry.	K5

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	-	-	-	-	-	-	-	1	2	-	-
CO2	3	3	1	1	-	-	-	-	-	-	-	1	2	-	-
CO3	3	3	1	1	-	-	-	-	-	-	-	1	2	-	-
CO4	3	3	1	1	-	-	-	-	-	-	-	1	2	-	-
CO5	3	3	1	1	-	-	-	-	-	-	-	1	2	-	-
22EBS1Z1	**3**	**3**	**1**	**1**	-	-	-	-	-	-	-	**1**	**2**	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.1.2, 2.1.1, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.2.1, 3.3.1, 4.1.1, 4.1.2, 12.2.1
CO2	1.1.1, 1.1.2, 2.1.1, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.2.1, 3.3.1, 4.1.1, 4.1.2, 12.2.1
CO3	1.1.1, 1.1.2, 2.1.1, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.2.1, 3.3.1, 4.1.1, 4.1.2, 12.2.1
CO4	1.1.1, 1.1.2, 2.1.1, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.2.1, 3.3.1, 4.1.1, 4.1.2, 12.2.1
CO5	1.1.1, 1.1.2, 2.1.1, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.2.1, 3.3.1, 4.1.1, 4.1.2, 12.2.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	30	10	-	-	100
CAT2	20	40	30	10	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	30	10	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40	30	10	-	-	100
ESE	20	40	30	10	-	-	100

22EBS1Z2	**ENGINEERING PHYSICS** (Common to all Branches)	**SEMESTER I**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**BS**	**3**	**0**	**0**	**3**

Course Objectives	1.To understand the basics about crystal systems and defects. 2.To understand the principle, characteristics, working and applications of laser and optical fiber. 3.To solve problems in bending of beams. 4.To solve quantum mechanical problems with the understanding of Quantum Principles. 5.To understand the properties, production and applications of ultrasonic waves.	
UNIT – I	**CRYSTAL PHYSICS**	**9 Periods**
Introduction – Crystalline and amorphous materials – Lattice – Unit Cell –Crystal system - Bravais lattices – Miller indices – Reciprocal lattice - d spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC, and HCP structures – Crystal defects – Point, line and surface defects.		
UNIT – II	**LASER PHYSICS AND FIBER OPTICS**	**9 Periods**
Introduction- Principle of laser action - characteristics of laser - Spontaneous emission and Stimulated emission –Einstein's coefficients - population inversion – methods of achieving population inversion –Optical Resonator -Types of Lasers – Principle, construction and working of CO_2 Laser - applications of laser. Introduction – Basic Principles involved in fiber optics- Total internal reflection–Propagation of light through optical fiber –Derivation for Numerical Aperture and acceptance angle - fractional index change.		
UNIT – III	**PROPERTIES OF MATTER**	**9 Periods**
Elasticity- Hooke's law- stress-strain diagram - Factors affecting elasticity – Moment (Q) - Couple (Q) – Torque (Q) – Beam - Bending moment - Depression of a cantilever –Twisting Couple- Young's modulus by uniform bending - I shaped girders.		
UNIT – IV	**QUANTUM PHYSICS AND APPLICATIONS**	**9 Periods**
Limitations of classical Physics - Introduction to Quantum theory - Dual nature of matter and radiation- de-Broglie wavelength in terms of voltage, energy, and temperature –Heisenberg's Uncertainty principle – verification – physical significance of a wave function- Schrödinger's Time independent and Time dependent wave equations –- Particle in a one dimensional potential well - Scanning Electron Microscope (SEM)-Transmission Electron Microscope (TEM).		
UNIT – V	**ULTRASONICS**	**9 Periods**
Introduction - properties of ultrasonic waves - production of ultrasonic waves -Magnetostriction effect- Magnetostriction generator- Piezoelectric effect- Piezoelectric generator- Acoustic grating - Determination of wavelength and velocity of ultrasonic waves-cavitation - applications- ultrasonic drilling- ultrasonic welding- ultrasonic soldering and ultrasonic cleaning-Non- destructive Testing- Pulse echo system.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*K. Rajagopal, **"Engineering Physics"**, PHI Learning Private Limited, 2015.*
2	*P. K. Palanisamy, "**Engineering Physics-I",** Scitech publications Private Limited, 2015.*
3	*M. Arumugam, "**Engineering Physics"**, Anuradha Publishers, 2010.*

REFERENCES:

1	*Arthur Beiser, "**Concepts of Modern Physics"**, Tata McGraw-Hill, 2010.*
2	*D. Halliday, R. Resnick and J. Walker,"**Fundamentals of Physics"**, 6th Edition, John Wiley and Sons, 2001.*
3	*William T. Silfvast, "**Laser Fundamentals"**, 2nd Edition, Cambridge University Press, New York 2004.*
4	*M. N. Avadhanulu and P.G. Kshirsagar, "**A Textbook of Engineering Physics"**, S. Chand and Company Ltd, 2010.*
5	*R. K. Gaur and S. L. Gupta, "**Engineering Physics",**Dhanpat Rai Publishers, 2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret the crystal structure and analyse the type of defect	K4
CO2	Explain the principle, characteristics, working and applications of laser and optical fiber Analyse and solve problems in laser and optical fiber	K4
CO3	Solve problems in bending of beams Apply the knowledge in construction of buildings	K3
CO4	Explain the importance of quantum mechanics Solve problems in basic quantum physics Apply the wave equations in real time problems	K3
CO5	Explain the properties and production of ultrasonic waves Apply ultrasonic waves for industrial problems	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-	2	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-	1	-	-
CO5	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
22EBS1Z2	**3**	**2**	-	-	-	-	-	-	-	-	-	-	**2**	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.2.3, 2.3.1, 2.4.1
CO2	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.3.1, 2.4.1
CO3	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.1, 2.2.3, 2.2.4, 2.3.1, 2.4.1
CO4	1.1.1, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.2.3, 2.3.1, 2.4.1
CO5	1.1.1, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.3.1, 2.4.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	15	15	10	-	100
CAT2	30	30	15	15	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	40	20	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	40	40	20	-	-	-	100
ESE	30	30	15	15	10	-	100

22EES101	**PROGRAMMING IN C** (Common to all Branches - Except MECH & PRODN)	**SEMESTER I**

PREREQUISITES	CATEGORY	L	T	P	C
NIL	**ES**	**3**	**0**	**0**	**3**

Course Objectives	1. To study the basic concepts of computer and programming fundamentals. 2. To understand the data types in C, flow control statements, Arrays, Functions Pointers, Structures, Unions and File concepts in C.	
UNIT – I	**COMPUTER AND PROGRAMMING FUNDAMENTALS**	**9 Periods**
Computer fundamentals – Evolution, classification, Anatomy of a computer: CPU, Memory, I/O – Introduction to software –Classification of programming languages – Compiling –Linking and loading a program – Introduction to OS – Types of OS.		
UNIT – II	**DATA TYPES AND FLOW OF CONTROL**	**9 Periods**
Structured programming – Algorithms – Structure of a C program – Variables – Data types – Operators and expressions – Input and Output statements – Tokens –Type Conversion – Control statements.		
UNIT – III	**ARRAYS AND FUNCTIONS**	**9 Periods**
1D Arrays– 2D Arrays – Multidimensional Arrays – Strings – String handling functions – Functions – Recursion – Array as function arguments – Storage Classes – Enumerations.		
UNIT – IV	**POINTERS**	**9 Periods**
Introduction to pointers – Pointers arithmetic – call by reference – Relationship between Array and Pointers – Relationship between String and pointers – pointers to pointers – array of pointers – pointers to an array – Dynamic memory allocation – Arguments to main().		
UNIT – V	**STRUCTURES AND UNIONS, FILE OPERATIONS**	**9 Periods**
Preprocessor directives – Structures – Unions – Bit fields – Opening and closing a file – Working with file of records – Random access to file of records.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK

1	*Pradip Dey, Manas Ghosh, **"Computer Fundamentals and Programming in C",** Second Edition, Oxford University Press, 2018.*

REFERENCES

1	*Al Kelley, Ira Pohl **,"A Book on C- Programming in C** ",Fourth Edition, Addison Wesley, 2001.*
2	*Herbert Schildt , "**C: The Complete Reference**", Fourth Edition, McGraw Hill Education, 2017*
3	*Yashavant P.Kanetkar,**" Let Us C",**15^{th}edition,BPB Publications,2016.*
4	*Brian W. Kernighan and Dennis Ritchie, **"The C Programming Language",** Second Edition, Prentice Hall Software Series, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Articulate the basics of computer and evolution of programming languages.	K1
CO2	Write simple C programs using appropriate data types and control statements	K3
CO3	Write C programs using arrays , functions and enumerations	K3
CO4	Use pointers effectively to develop programs	K3
CO5	Create user defined data types using structures & union and effectively manipulate them in file operations.	K6

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	3	1	-	-	-	-	-	-	-	-	1	2	1	-
CO2	1	3	1	-	-	-	-	-	-	-	-	1	2	1	-
CO3	1	3	1	-	-	-	-	-	-	-	-	1	2	1	-
CO4	1	3	1	-	-	-	-	-	-	-	-	1	2	1	-
CO5	1	3	1	-	-	-	-	-	-	-	-	1	2	1	-
22EES101	**1**	**3**	**1**	-	-	-	-	-	-	-	-	**1**	**2**	**1**	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.3, 12.2.1
CO2	1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.3, 3.2.3, 3.3.1, 12.1.2
CO3	1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.3, 3.2.3, 3.3.1, 12.1.2
CO4	1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.3, 3.2.3, 3.3.1, 12.1.2,
CO5	1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.3, 3.2.3, 3.3.1, 12.1.2

ASSESSMENT PATTERN - THEORY

Test / Bloom's Category*	Remembering (K1)%	Understanding (K2)%	Applying (K3)%	Analyzing (K4)	Evaluating (K5)%	Creating (K6)%	Total %
CAT1	50	20	30	-	-	-	100
CAT2	20	30	50	-	-	-	100
Individual Assessment 1 / Case Study 1 / Seminar 1 / Project 1	50	-	50	-	-	-	100
Individual Assessment 2 / Case Study 2 / Seminar 2 / Project 2	-	-	100	-	-	-	100
ESE	20	30	50	-	-	-	100

22EMC1Z1	**ENVIRONMENTAL SCIENCE AND ENGINEERING** (Common to all Branches)	**SEMESTER I**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**MC**	**3**	**0**	**0**	**0**

Course Objectives	1. To study the modern agriculture related problems, natural resources and its harnessing methods. 2.To study the interrelationship between living organism and environment. 3. To educate the people about causes of pollutions and its controlling methods. 4. To impart the knowledge of various environmental threats and its consequences. 5. To study the various water conservation methods, Act, Population policy, Welfare programs.	
UNIT – I	**ENVIRONMENTAL ENERGY RESOURCES**	**9 Periods**
Food-effects of modern agriculture, fertilizers, pesticides, eutrophication & biomagnifications-Energy resources: renewable resources - Hydro Energy, Solar & Wind. Non-renewable resources – Coal and Petroleum - harnessing methods.		
UNIT – II	**ECO SYSTEM AND BIODIVERSITY**	**9 Periods**
Eco system and its components - biotic and abiotic components. Biodiversity: types and values of biodiversity, hot spots of biodiversity, endangered and endemic species, conservation of biodiversity: In situ and ex situ conservation. Threats to biodiversity-destruction of habitat, habit fragmentation, hunting, over exploitation and man-wildlife conflicts. The IUCN red list categories.		
UNIT – III	**ENVIRONMENTAL POLLUTION**	**9 Periods**
Air pollution, classification of air pollutants – sources, effects and control of gaseous pollutants SO_2, NO_2, H_2S, CO, CO_2 and particulates. Water pollution - classification of water pollutants, organic and inorganic pollutants, sources, effects and control of water pollution. Noise pollution - decibel scale, sources, effects and control.		
UNIT – IV	**ENVIRONMENTAL THREATS**	**9 Periods**
Global warming-measure to check global warming - impacts of enhanced Greenhouse effect, Acid rain-effects and control of acid rain, ozone layer depletion- effects of ozone depletion, disaster management - flood, drought, earthquake and tsunami.		
UNIT – V	**SOCIAL ISSUES AND ENVIRONMENT**	**9 Periods**
Water conservation, rain water harvesting, e-waste management, Pollution Control Act, Wild life Protection Act. Population growth- exponential and logistic growth, variation in population among nations, population policy. Women and Child welfare programs. Role of information technology in human and health, COVID-19 - effects and preventive measures.		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

TEXT BOOK:

1	*Sharma J.P., **"Environmental Studies"**, 4th Edition, University Science Press, New Delhi 2016.*
2	*Anubha Kaushik and C.P.Kaushik, **"Environmental Science and Engineering"**, 7th Edition, New Age International Publishers, New Delhi, 2021.*

REFERENCES:

1	*A K De, **"Environmental Chemistry"**, 8th Edition, New Age International Publishers, 2017.*
2	*G. Tyler Miller and Scott E. Spoolman, **"Environmental Science"**, Cengage Learning India Pvt, Ltd, Delhi, 2014.*
3	*Erach Bharucha, **"Textbook of Environmental Studies"**, Universities Press(I) Pvt, Ltd, Hyderabad, 2015.*
4	*Gilbert M.Masters, **"Introduction to Environmental Engineering and Science"**, 3rd Edition, Pearson Education, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Recognize and understand about the various environmental energy resources and the effective utility of modern agriculture.	K2
CO2	Acquire knowledge about the interaction of biosphere with environment and conservation methods of bio diversity.	K2
CO3	Be aware of the sources of various types of pollution, their ill effects and preventive methods.	K2
CO4	Identify and take the preventive measures to control the environmental threats and effects of Global warming, Ozone depletion, Acid rain, and natural disasters.	K2
CO5	Demonstrate an idea to save water and other issues like COVID -19.	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	1	-	-	3	-	-	-	-	-	1	-	-
CO2	-	-	1	-	-	-	3	-	-	-	-	-	-	-	-
CO3	2	1	1	1	-	-	3	-	-	-	-	-	1	-	-
CO4	2	1	1	1	-	-	3	-	-	-	-	-	-	-	-
CO5	-	1	1	1	-	2	3	-	-	-	-	-	-	-	-
22EMC1Z1	**2**	**1**	**1**	**1**	-	**1**	**3**	-	-	-	-	-	**1**	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.2.1, 1.4.1, 2.1.2, 2.3.1, 3.1.5, 3.2.1, 4.3.1, 7.1.1, 7.1.2, 7.2.1
CO2	3.1.5, 7.1.1, 7.1.2, 7.2.1
CO3	1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.3.1, 3.1.5, 3.2.1, 4.1.3, 4.3.1, 7.1.1, 7.1.2, 7.2.1
CO4	1.2.1, 1.4.1, 2.1.2, 2.3.1, 3.1.5, 4.1.3, 4.3.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2
CO5	2.1.2, 2.2.2, 3.1.5, 4.1.3, 4.3.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	20	20	-	-	100
CAT2	20	40	20	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	20	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40	20	20	-	-	100
ESE	20	40	20	20	-	-	100

22EBS1Z3	**PHYSICS LABORATORY** (Common to all Branches)	**SEMESTER I**

PREREQUISITES	CATEGORY	L	T	P	C
NIL	**BS**	**0**	**0**	**3**	**1.5**

Course Objectives	1. To impart practical knowledge on the concept of properties of matter and utilize the experimental techniques to measure the properties 2. To impart practical knowledge on the modulii of elasticity 3. To analyze the properties of semiconductors 4. To learn practically the basic electronic concepts of transistor and logic gates 5. To realize the principle, concepts and working of a solar cell and study the properties of ferromagnetic material 6. To understand the concept of quantum physics
S. No.	**LABORATORY EXPERIMENTS**
1.	Determination of refractive index of the glass and given liquid – Spectrometer diffraction method
2.	Determination of Planck's constant
3.	Determination of Young's Modulus of the material in the form of bar – Cantilever Bending -Koenig's Method
4.	a) Particle size determination using diode laser b) Determination of numerical aperture and acceptance angle in an optical fiber
5.	Hall effect - Determination of semiconductor parameters
6.	Determination of band gap of semiconductor material
7.	Determination of velocity of sound and compressibility of the given liquid-Ultrasonic Interferometer
8.	Determination of moment of inertia of disc and rigidity modulus of a wire-Torsional pendulum
9.	Transistor characteristics
10.	Solar cell characteristics
11.	Determination of Hysteresis losses in a Ferromagnetic material-B-H curve unit
12.	Logic Gates – Verification and Construction

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Determine refractive index and compressibility of liquids, micro size of particles and numerical aperture of an optical fibre	K5
CO2	Measure the Young's and rigidity modulii of the given material	K5
CO3	Determine the bandgap of a given semiconductor material and identify the type of semiconductor and its carrier concentration through Hall measurement	K5
CO4	Analyze the characteristics of transistor and verify the truth table of logic gates	K4
CO5	Measure the efficiency of a solar cell and energy loss associated with the ferromagnetic material by plotting B-H curve	K5
CO6	Determine the Planck's constant and work function	K5

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO6	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
22EBS1Z3	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.4.1, 2.4.2, 2.4.3, 2.4.4
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.4.1, 2.4.2, 2.4.3, 2.4.4
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.4.1, 2.4.2, 2.4.3, 2.4.4
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.4.1, 2.4.2, 2.4.3, 2.4.4
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.4.1, 2.4.2, 2.4.3, 2.4.4
CO6	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.4.1, 2.4.2, 2.4.3, 2.4.4

22EES1Z2	**WORKSHOP PRACTICE** (Common to all Branches)	**SEMESTER I**

PREREQUISTES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**ES**	**0**	**0**	**3**	**1.5**

Course Objectives	1. To make various basic prototypes in the carpentry trade such as Half Lap joint, Lap Tee joint, Dovetail joint, Mortise & Tenon joint. 2. To make various welding joints such as Lap joint, Lap Tee joint, Edge joint, Butt joint and Corner joint. 3. To make various moulds in foundry such as Cube, Straight pipe, Vpulley, and Conical bush. 4. To make various components using sheet metal such as Tray, Frustum of cone and Square box. 5. To understand the working and identify the various components of CNC Machines

LIST OF EXPERIMENTS
1. Introduction to use of tools and equipment's in Carpentry, Welding, Foundry and Sheet metal 2. Safety aspects in Welding, Carpentry, Foundry and sheet metal. 3. Half Lap joint and Dovetail joint in Carpentry. 4. Welding of Lap joint and Butt joint and T-joint. 5. Preparation of Sand mould for Cube, Conical bush, Pipes and V pulley 6. Fabrication of parts like Tray, Frustum of cone and Square box in sheet metal 7. CNC Machines demonstration and lecture on working principle. 8. Electrical wiring and simple house wiring.
Contact periods: **Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Safely Use tools and equipment's used in Carpentry, Welding, Foundry and Sheet metal to create basic joints.	K2
CO2	Prepare sand mould for various basic pattern shapes.	K3
CO3	Fabricate parts like Tray, Frustum of cone and Square box in sheet metal.	K3
CO4	Practice on the Welding and Carpentry	K3
CO5	Demonstrate the working of CNC Machines.	K2

COURSE ARTICULATION MATRIX:															
a) CO and PO Mapping															
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	3	2	1	3	1	2	3	3	2	3	-	-	2
CO2	2	2	3	2	1	3	3	2	3	3	2	3	1	-	2
CO3	2	2	3	2	1	3	3	2	3	3	2	3	2	-	2
CO4	2	2	3	2	1	3	3	2	3	3	2	3	3	2	3
CO5	2	2	3	2	3	-	-	2	3	3	2	2	2	3	2
22EES1Z2	**2**	**2**	**3**	**2**	**2**	**3**	**2**	**2**	**3**	**3**	**2**	**3**	**2**	**1**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.1, 4.1.4, 4.2.1, 4.3.1, 5.2.2, 5.3.2, 6.1.1, 6.2.1, 7.1.2, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.3.1, 12.1.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.1, 4.1.4, 4.2.1, 4.3.1, 5.2.2, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.2, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.3.1, 12.1.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.1, 4.1.4, 4.2.1, 4.3.1, 5.2.2, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.2, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.3.1, 12.1.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.1, 4.1.4, 4.2.1, 4.3.1, 5.2.2, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.2, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.3.1, 12.1.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.1, 4.1.4, 4.2.1, 4.3.1, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.2, 7.1.1, 7.2.2, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.3.1, 12.2.2, 12.3.1, 12.3.2

22EES103	**PROGRAMMING IN C LABORATORY** (Common to all Branches - Except MECH & PRODN)	**SEMESTER I**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**ES**	**0**	**0**	**3**	**1.5**

Course Objectives	To understand the concepts like Data types, Flow control statements, Functions, Arrays, command line arguments, Pointer, Dynamic memory allocation, Preprocessor Directives, Structures ,Unions and Files in C

EXERCISES ILLUSTRATING THE FOLLOWING CONCEPTS:	
1	Operators, Expressions and IO formatting
2	Decision Making and Looping
3	Arrays and Strings
4	Functions and Recursion
5	Pointers
6	Dynamic Memory Allocation
7	Command line arguments
8	Preprocessor Directives
9	Structures
10	Unions
11	Files
12	Mini Project

Contact periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Use appropriate data types and flow control statements to write C programs	K6
CO2	Write C programs using arrays , functions and command line arguments	K6
CO3	Write C programs using pointers, dynamic memory allocation and preprocessor directives	K6
CO4	Implement user defined data types using structures & union and effectively manipulate them in file operations.	K6
CO5	Develop simple applications using C	K6

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	1	1	-	-	-	-	-	-	-	-	2	1	-
CO2	2	3	1	1	-	-	-	-	-	-	-	-	2	1	-
CO3	2	3	1	1	-	-	-	-	-	-	-	-	2	1	-
CO4	2	3	1	1	-	-	-	-	-	-	-	-	2	1	-
CO5	2	3	2	1	-	-	-	-	3	3	-	-	2	1	-
22EES103	**2**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**	**2**	**1**	**-**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.2.3, 3.3.1, 4.1.1, 4.1.2, 4.2.1
CO2	1.1.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.2.3, 3.3.1, 4.1.1, 4.1.2, 4.2.1
CO3	1.1.1, 1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.2.3, 3.3.1, 4.1.1, 4.1.2, 4.2.1
CO4	1.1.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.2.3, 3.3.1, 4.1.1, 4.1.2, 4.2.1
CO5	1.1.1, 1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.5, 3.1.6, 3.2.3, 3.3.1

22EHS2Z4	தமிழரும் தொழில்நுட்பமும் **TAMILS AND TECHNOLOGY** (Common to all Branches)	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	HSMC	1	0	0	1

UNIT – I	WEAVING AND CERAMIC TECHNOLOGY	3 Periods
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW)– Graffiti on Potteries.		
UNIT – II	**DESIGN AND CONSTRUCTION TECHNOLOGY**	**3 Periods**
Designing and Structural construction House & Designs in household materials during Sangam Age- Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.		
UNIT – III	**MANUFACTURING TECHNOLOGY**	**3 Periods**
Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.		
UNIT – IV	**AGRICULTURE AND IRRIGATION TECHNOLOGY**	**3 Periods**
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.		
UNIT – V	**SCIENTIFIC TAMIL & TAMIL COMPUTING**	**3 Periods**
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.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOK:

1	தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித்தமிழ் – முனைவர் இல.சுந்தரம் . (விகடன் பிரசுரம்).
3	கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை
4	பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

REFERENCES:

1	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by:International Institute of Tamil Studies).
3	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by:International Institute of Tamil Studies.)
5	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)
6	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
7	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
8	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) –Reference Book.

22EHS2Z4	தமிழரும் தொழில்நுட்பமும் TAMILS AND TECHNOLOGY (Common to all Branches)	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	HSMC	1	0	0	1

அலகு I	நெசவு மற்றும் பானைத் தொழில்நுட்பம்	3 Periods
சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள்– பாண்டங்களில் கீறல் குறியீடுகள்.		
அலகு II	வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்	3 Periods
சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும்– சிலப்பதிகாரத்தில் மேடைஅமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும்-சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள்-மாதிரிகட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சிஅம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.		
அலகு III	உற்பத்தித் தொழில் நுட்பம்	3 Periods
கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் –நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள் , கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் –தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.		
அலகு IV	வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்	3 Periods
அணை, ஏரி, குளங்கள் , மதகு – சோழர்காலக் குமுழித்தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார்அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு –அறிவுசார் சமூகம்.		
அலகு V	அறிவியல் தமிழ் மற்றும் கணினித்தமிழ்	3 Periods
அறிவியல் தமிழின் வளர்ச்சி- கணினித்தமிழ் வளர்ச்சி- தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOK:

1	தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித்தமிழ் – முனைவர் இல.சுந்தரம் . (விகடன் பிரசுரம்).
3	கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

REFERENCES:

1	Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2	Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by:International Institute of Tamil Studies).
3	Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4	The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by:International Institute of Tamil Studies.)
5	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)
6	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
7	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
8	Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) –Reference Book.

22EHS2Z5	**VALUES AND ETHICS** (Common to all Branches)	**SEMESTER II**

PREREQUISITES	CATEGORY	L	T	P	C
NIL	HSMC	3	0	0	3

Course Objectives	1. To understand and appreciate the ethical issues faced by an individual in profession, society and polity. 2. To learn about Engineering Ethics and case studies. 3. To understand the negative health impacts of certain unhealthy behaviours. 4. To appreciate the need and importance of physical, emotional health and social health. 5. To get familiar with the global issues.	
UNIT – I	**BEING GOOD AND RESPONSIBLE**	**9 Periods**
Morals, Values and Ethics - Integrity - Work Ethics - Service Learning - Civic Virtue - Respect for Others - Living Peacefully - Caring - Sharing - Honesty - Courage - Valuing Time - Cooperation - Commitment - Empathy - Self-Confidence – Character.		
UNIT – II	**ENGINEERING AS SOCIAL EXPERIMENTATION**	**9 Periods**
Engineering Ethics: Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Models of Professional Roles. Engineering as Experimentation – Engineers as responsible Experimenters – Research Ethics - Codes of Ethics – Industrial Standards - A Balanced Outlook on Law – Case studies : Chernobyl disaster and Titanic disaster.		
UNIT – III	**ADDICTION AND HEALTH**	**9 Periods**
Peer pressure - Alcoholism: Ethical values, causes, impact, laws, prevention – ill effects of smoking - Prevention of Suicides; Sexual Health: Prevention and impact of pre-marital pregnancy and Sexually Transmitted Diseases. Drug Abuse: Abuse of different types of legal and illegal drugs: Ethical values, causes, impact, laws and prevention.		
UNIT – IV	**PROFESSIONAL ETHICS**	**9 Periods**
Abuse of Technologies**:** Hacking and other cyber crimes, Addiction to mobile phone usage, Video games and Social networking websites.		
UNIT – V	**GLOBAL ISSUES**	**9 Periods**
Multinational corporations - Environmental ethics - computer ethics - weapons development - engineers as managers - consulting engineers - engineers as expert witnesses and advisors - Code of Conduct – Corporate Social Responsibility.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Mike W Martin and Roland Schinzinger, **"Ethics in Engineering"**, 4 th Edition, McGraw-Hill, New York 2017.*
2	*Govindarajan M, Natarajan S and Senthil Kumar VS, **"Engineering Ethics"**, Prentice Hall of India, New Delhi, 2013.*

REFERENCES:

1	*Dhaliwal, K.K , **"Gandhian Philosophy of Ethics: A Study of Relationship between his Presupposition and Precepts",** Writers Choice, New Delhi, India,2016,.*
2	*Jayshree suresh, B.S.Raghavan, **"Human values and professional ethics"**, S.Chand & company Ltd, New Delhi, 2nd Edition, 2007.*
3	*L.A. and Pagliaro, A.M, **"Handbook of Child and Adolescent Drug and Substance Abuse: Pharmacological, Developmental and Clinical Considerations",** Wiley Publishers, U.S.A,2012.*
4	*Pandey, P. K(2012), **"Sexual Harassment and Law in India"**, Lambert Publishers, Germany,2012,.*
5	*Kiran D.R, **"Professional ethics and Human values",** Tata McGraw Hill, New Delhi, 2007.*
6	*Edmund G See Bauer and Robert L Barry, **"Fundamentals of Ethics for Scientists and Engineers"**, Oxford University Press, Oxford, 2001.*
7	*David Ermann and Michele S Shauf, **"Computers, Ethics and Society"**, Oxford University Press, 2003.*
8	*Govindarajan M, Natarajan S, Senthil Kumar V. S, **"Engineering Ethics"**, Prentice Hall of India, New Delhi, 2004.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Follow sound morals and ethical values scrupulously to prove as good citizens.	K3
CO2	Assess the relevance of ethics and morals in engineering and to learn case studies.	K3
CO3	Describe the concept of addiction and how it will affect the physical and mental health.	K2
CO4	Identify ethical concerns while using advanced technologies.	K2
CO5	Judge the code of conduct, Environmental ethics and computer ethics.	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	3	3	3	3	3	3	-	-	-	1
CO2	-	-	-	-	-	3	1	3	3	-	-	-	-	-	2
CO3	-	-	-	-	-	3	1	3	3	2	3	-	-	-	1
CO4	-	-	-	-	-	3	3	3	3	1	3	1	-	-	1
CO5	-	-	-	-	-	3	3	3	3	-	1	3	-	-	2
22EHS2Z5	-	-	-	-	-	**3**	**3**	**3**	**3**	**2**	**2**	**1**	-	-	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.2.1, 11.3.1
CO2	6.1.1, 6.2.1, 7.1.1, 8.1.1, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1
CO3	6.1.1, 6.2.1, 7.1.1, 8.1.1, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1 ,9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.2.1, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.2.1, 11.3.1
CO4	6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.2.1, 11.3.1, 11.3.2, 12.1.1
CO5	6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 11.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20	-	-	100
CAT2	30	30	20	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	30	20	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	30	20	20	-	-	100
ESE	30	30	20	20	-	-	100

22EBS204	DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS (Common to all Branches - Except CSE & IT)	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	BS	3	1	0	4

Course Objectives	1. To gain knowledge of methods to solve higher order differential equations with constant and variable coefficients. 2. To be familiar with forming partial differential equations and solving partial differential equations of standard types of first order and homogeneous linear differential equations. 3. To be familiar with numerical interpolation, numerical differentiation and numerical integration. 4. To acquire the knowledge of numerical solution to first order ordinary differential equations using single and multi step techniques. 5. To gain the knowledge of numerical solution to second order partial differential equations using explicit and implicit methods.

UNIT – I	**ORDINARY DIFFERENTIAL EQUATIONS**	**9+3 Periods**
Higher order linear differential equations with constant coefficients -variable coefficients: Cauchy-Euler equation, Cauchy-Legendre equation-Method of variation of parameters-Simultaneous first order linear equations with constant coefficients.		
UNIT – II	**PARTIAL DIFFERENTIAL EQUATIONS**	**9+3 Periods**
Formation of partial differential equations – First order partial differential equations – Standard types and Lagrange's type – Homogeneous linear partial differential equation of second and higher order with constant coefficients.		
UNIT – III	**INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION**	**9+3 Periods**
Solution of polynomial and transcendental equations: Newton-Raphson method-Interpolation with equal interval: Newton's forward and backward difference formulae-Interpolation with unequal intervals: Lagrange's formulae-Numerical Differentiation: Newton's formulae-Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.		
UNIT – IV	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**	**9+3 Periods**
First order ordinary differential equations: Taylor's series method-Euler and modified Euler's methods-Runge-Kutta method of fourth order -Milne's and Adam's predicator-corrector methods.		
UNIT – V	**NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS**	**9+3 Periods**
Partial differential equations: Finite difference method for two dimensional Laplace equation and Poisson equation- Implicit and explicit methods for one dimensional heat equation (Bender-Schmidt and Crank-Nicholson methods)-Finite difference explicit method for wave equation.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

TEXT BOOK

1	*Veerarajan.T,* ***"Engineering Mathematics"****, Revised Edition 2018, McGraw Hill Education (India) Private Limited*
2	*P. Kandasamy, K. Thilagavathy, K. Gunavathi,* ***" Numerical Methods"****, S. Chand & Company, 3rd Edition, Reprint 2013.*

REFERENCES

1	*B.S.Grewal, "* ***Higher Engineering Mathematics****", Khanna Publishers, New Delhi, 44th Edition, 2018.*
2	*SrimantaPal,* ***"Numerical Methods Principles, Analyses and Algorithms"****, Oxford University Press, New Delhi, 1st Edition 2009.*
3	*Raisinghania.M..D,* ***"Ordinary And Partial Differential Equations"****, 20th Edition, S. Chand Publishing,2020*
4	*S.S. Sastry,* ***"Introductory methods of numerical analysis"****, PHI, New Delhi, 5th Edition, 2015.*
5	*Ward Cheney, David Kincaid,* ***"Numerical Methods and Computing,*** *Cengage Learning,* ***,*** *Delhi, 7th Edition 2013.*
6	*S. Larsson, V. Thomee,* ***"Partial Differential Equations with Numerical Methods"****, Springer, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Solve higher order linear differential equation with constant and variable coefficients and simultaneous differential equation.	K5
CO2	Form partial differential equations and find solutions of first and higher order partial differential equations.	K5
CO3	Obtain approximate solutions for transcendental equations and problems on interpolation, differentiation, integration.	K5
CO4	Find the numerical solutions of first order ordinary differential equations using single and multi step techniques.	K5
CO5	Solve second order partial differential equations using explicit and implicit methods.	K5

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	1	-	-	-	-	-	-	-	1	2	-	-
CO2	3	3	-	1	-	-	-	-	-	-	-	1	2	-	-
CO3	3	3	-	1	-	-	-	-	-	-	-	1	2	-	-
CO4	3	3	-	1	-	-	-	-	-	-	-	1	2	-	-
CO5	3	3	-	1	-	-	-	-	-	-	-	1	2	-	-
22EBS204	3	3	-	1	-	-	-	-	-	-	-	1	**2**	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 4.1.1, 12.2.1
CO2	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 4.1.1, 12.2.1
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 4.1.1, 12.2.1
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 4.1.1, 12.2.1
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 4.1.1, 12.2.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	20	20	-	-	100
CAT2	20	40	20	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	20	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40	20	20	-	-	100
ESE	20	40	20	20	-	-	100

22EBS205	APPLIED CHEMISTRY (Common to EEE, ECE, EIE, CSE & IT Branches)	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	BS	3	0	0	3

Course Objectives	1. To know about the second law of thermodynamics and its various functions. 2. To understand the concept of electrochemistry, primary, secondary batteries, construction and its uses. 3. To understand the basic principles of corrosion, mechanism and its protection methods. 4. To acquire basic knowledge about the nanoparticles, its preparations, properties, types and applications in various field. 5. To impart the knowledge of preparations of single crystal, wafer preparation, P-N junction formation by various methods.	
UNIT – I	**CHEMICAL THERMODYNAMICS**	**9 Periods**
The Second law of thermodynamics-Concepts of entropy, Work and free energy functions - Maxwell's relationships for reversible and irreversible process - Gibbs Helmholtz equation – Partial molar free energy-Chemical potential-Gibb's Duhem Equation, Clausius - Clapeyron equation.		
UNIT – II	**ELECTRO CHEMISTRY AND STORAGE DEVICES**	**9 Periods**
Cells–Electro chemical cell and electrolytic cell – electrodes– electrode potentials – standard oxidation and reduction potentials-Hydrogen and Calomel electrodes- EMF series and its significance. Batteries - Types of batteries- Primary - Zn/MnO_2 and Li/$SOCl_2$ - Construction, working and applications. Secondary batteries- Lead acid battery and lithium-ion battery – Li-TiS_2- Construction, working and Applications.		
UNIT – III	**CORROSION**	**9 Periods**
Corrosion-Definition -Classifications: Chemical Corrosion and Electro chemical corrosion mechanism-Pilling Bedworth rule–Galvanic series and its importance- preventing methods-Cathodic protection (sacrificial anode and impressed current conversion method). Protective Coatings-Inorganic coating-surface preparation-Electro plating method applied to Cr and Ni, Organic coating- paints - constituents and its functions.		
UNIT – IV	**NANO MATERIALS**	**9 Periods**
Nanomaterials and bulk materials; Size-dependent properties (Optical, Electrical and Mechanical); Types of nanomaterials: Definition- properties and uses of nanoparticle, nanorod and nanotube. Preparation of nanomaterials: chemical vapour deposition, electrochemical deposition. Applications of nanomaterials in medicine and electronics.		
UNIT – V	**FABRICATION**	**9 Periods**
Silicon for IC chips - single crystal – preparation by Czochralski and float zone processes- wafer preparation, P-N junction formation – Ion implantation. Diffusion and epitaxial growth techniques - Insulator layer by oxidation- Printing of circuits by photolithography – masking and electron beam methods- etching by chemical and electrochemical methods.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Jain. P.C. and Monica Jain,* ***"Engineering Chemistry"****, DhanpatRai Publications Pvt Ltd, New Delhi, 16th Edition,2017.*
2	*S.S. Dara****, "A text book of Engineering Chemistry"****, S. Chand Publishing, 12th Edition, 2018.*

REFERENCES:

1	*Dara. S.S, Umarae, **"Text book of Engineering Chemistry"**, S. Chand Publications, 2013.*
2	*M.S.Tyagi, **"Introduction to semiconductor materials and devices"**, WileyIndia, 2012.*
3	*B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday**, "Textbook of nanoscience and nanotechnology"**, Universities Press-IIM Series in Metallurgy and Materials Science, 2018.*
4	*B.R Puri, L.R Sharma & M. S. Pathania, **"Principles of Physical Chemistry" Nagin .S**Chand and Co., 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the applications of thermodynamics and its various functions.	K3
CO2	Implement the new ideas related to batteries which find uses in the society including engineering fields.	K3
CO3	Identify the corrosion mechanisms and its controlling methods.	K3
CO4	Applying the concepts of nanoscience and nanotechnology in the synthesis of nanomaterials for engineering applications.	K3
CO5	Construct the silicon chips and their fabrication methods and to apply in preparation of electrical and electronic instruments.	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	1	-	1	-	-	-	-	-	-	-	1	-	-
CO2	2	1	1	-	1	-	-	-	-	-	-	-	1	2	-
CO3	1	1	1	1	1	2	1	-	-	-	-	-	-	-	-
CO4	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-
CO5	1	1	1	1	1	-	-	-	-	-	-	-	1	1	-
22EBS205	**2**	**1**	**1**	**1**	**1**	**1**	**1**	-	-	-	-	-	**1**	**1**	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping:

CO1	1.1.1, 1.2.1, 2.1.2, 2.1.3, 2.3.1, 3.2.2, 5.1.1
CO2	1.1.2, 1.2.1, 2.3.1, 3.2.2, 5.1.1
CO3	1.2.1, 2.3.1, 3.2.2, 4.1.1, 4.3.1, 5.1.1, 6.1.1, 7.1.1
CO4	1.2.1, 2.2.2, 2.3.1, 3.2.2, 4.1.1, 4.3.1, 5.1.1, 5.1.2, 7.1.1
CO5	1.2.1, 2.3.1, 3.2.2, 4.1.2, 5.1.1

ASSESSMENT PATTERN – THEORY :

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	20	10	-	-	100
CAT2	30	40	20	10	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	40	20	10	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	40	20	10	-	-	100
ESE	30	40	20	10	-	-	100

22EES204	**ENGINEERING MECHANICS** (Common to CIVIL, EEE & PRODN Branches)	**SEMESTER II**

PREREQUISITES:	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**ES**	**3**	**0**	**0**	**3**

Course Objectives	1. To learn the basic principles and concepts of force system. 2. To gain knowledge on different kinds of friction. 3. To understand the concepts of centre of gravity and moment of inertia. 4. To understand the Kinematics and kinetics of rigid body motion. 5. To study the dynamics of particles, impulse and momentum Principles.	
UNIT – I	**BASIC CONCEPTS OF FORCES**	**9 Periods**
Basic Concepts and Principles of Forces– Laws of Mechanics – System of forces in Plane – Free body Diagrams- resultant of a force system – resolution and composition of forces – Lami's theorem – moment of a force – physical significance of moment-Varignon's theorem – resolution of a force and couple system– forces in space – addition of concurrent forces in space – equilibrium of a particle in space.		
UNIT – II	**STATIC AND DYNAMIC FRICTION**	**9 Periods**
Frictional resistance – classification of friction- laws of friction – coefficient of friction-angle of friction – angle of repose – cone of friction –advantages-equilibrium of a body on a rough inclined plane –ladder friction – rope friction – wedge friction.		
UNIT – III	**PROPERTIES OF SECTION**	**9 Periods**
Centroid and Centre of Gravity for simple & Composite sections– theorems of moment of inertia Determination of moment of inertia of various sections –Product of Inertia – Principal moment of inertia of plane areas - Mass moment inertia of circular plate, Cylinder, Cone, Sphere.		
UNIT – IV	**BASICS OF DYNAMICS - KINEMATICS**	**9 Periods**
Kinematics and kinetics – displacements, velocity and acceleration - Equations of motion –Rectilinear motion of a particle with uniform velocity, uniform acceleration, varying acceleration– motion under gravity – relative motion – curvilinear motion of particles – projectiles– angle of projection – range – time of flight and maximum height.		
UNIT – V	**BASICS OF DYNAMICS - KINETICS**	**9 Periods**
Newton's second law of motion – linear momentum – D'Alembert's principle, Dynamic equilibrium– equation of particles-principle of work and energy –law of conservation of energy –Principle of impulse and momentum – Equations of momentum – Laws of conservation of momentum. Impact – Time of compression, restitution, collision – Co-efficient of restitution – types of impact – collision of elastic bodies by direct central impact and oblique impact – collision of small body with a massive body – Kinetic energy of a particle.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*F.B. Beer and E.R. Johnson, **"Vector Mechanics for Engineers"**, Tata Mc.Graw Hill Pvt Ltd, 11^{th} Edition, 2013.*
2	*Rajasekaran S &Sankara Subramanian, **"Fundamentals of Engineering Mechanics"**, Vikas Publishing House Pvt Ltd. 3^{rd}Edition, 2017.*

REFERENCES:

1	*S. Timoshenko and Young, **"Engineering Mechanics"**, McGraw Hill, 4th Edition, 2017.*
2	*Bansal R.K, **"A Text Book of Engineering Mechanics"**, Laxmi Publications, 2015.*
3	*R.C. Hibbeller, **"Engineering Mechanics"**, Prentice Hall of India Ltd, 14th Edition, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Familiarize the principles and Concepts of Mechanics	K2
CO2	Calculate the friction force acting on a plane under various conditions.	K3
CO3	Determine the centre of gravity and moment of inertia for different sections.	K3
CO4	Predict the Rectilinear and curvilinear motion of particles.	K3
CO5	Evaluate the dynamics of particles using kinetic principles.	K4

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	-	-	2	-	-	-	-	-	-	1	2	2
CO2	3	2	1	-	-	2	-	-	-	-	-	1	-	2	3
CO3	3	3	1	-	-	2	-	-	-	-	-	-	-	2	3
CO4	3	3	1	-	-	2	-	-	-	-	-	1	1	2	3
CO5	3	3	1	-	-	2	-	-	-	-	-	1	1	2	3
22EES204	**3**	**3**	**1**	-	-	**2**	-	-	-	-	-	**1**	**1**	**2**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 2.4.3, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 6.1.1
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 6.1.1, 12.2.2
CO3	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 6.1.1
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 6.1.1, 12.2.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 6.1.1, 12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	30	10	-	-	100
CAT2	30	30	30	10	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	30	30	10	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	30	30	10	-	-	100
ESE	30	30	30	10	-	-	100

22EES205	BASICS OF CIVIL AND MECHANICAL ENGINEERING (Common to EEE & EIE Branches)	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	3	0	0	3

Course Objectives	1. To impart basic knowledge on building materials and construction practices. 2. To know the basics of Civil Engineering infrastructure development works. 3. To impart basic knowledge on Basic mechanical devices. Refrigeration and Air-conditioning systems. 4. To provide an insights to the basic conventional and non-conventional machining techniques.	
PART – A Civil Engineering		
UNIT – I	**BUILDING MATERIALS AND CONSTRUCTION**	**8 Periods**
Properties and applications: Stone, Bricks, Cement, Concrete, Steel, Timber – Basic surveying methods and surveying instruments – Building elements and its construction: Foundation, Flooring, Masonry and Roofing.		
UNIT – II	**WATER SUPPLY AND SANITARY ENGINEERING**	**7 Periods**
Sources of water – Hydrological cycle – Quality of water – Distribution of water – Methods of rain water harvesting. Sanitary Engineering – Systems of Sewerage – Collection, disposal of sewage.		
UNIT – III	**IRRIGATION AND TRANSPORTATION ENGINEERING**	**7 Periods**
Irrigation methods - Hydraulic Structures: Dams – Parts of the dam and their functions, Canals and Diversion headworks. Modes of transportation – Highways – Classification and geometrical features, components of track and its functions.		
PART – B Mechanical Engineering		
UNIT – IV	**BASICS OF MECHANICAL DEVICES**	**8 Periods**
Internal Combustion (IC) engines – Otto and Diesel Cycles - Working principle of Petrol and Diesel Engines – Four stroke and two stroke cycles – Comparison of four stroke and two stroke engines - Working principle of Boilers, Turbines, Reciprocating Pumps and Centrifugal Pumps - Concept of hybrid engines - Industrial safety practices and protective devices.		
UNIT – V	**REFRIGERATION AND AIR CONDITIONING SYSTEM**	**7 Periods**
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 - Properties of air-water mixture - Concepts of psychometric and its process.		
UNIT – VI	**METAL CUTTING PROCESSES**	**8 Periods**
Lathe components and theirs functions - Basic operations of Lathe - Introduction to CNC Lathe - Types of Drilling machine - Main parts and functions - Shaper and Planer machines - Components and functions - Non-conventional machining techniques - Basic principles and operations of Electrochemical Machining (ECM), Electrical Discharge Machining (EDM) and Laser Beam Machining (LBM).		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Shanmugam G., Palanichamy M S., **"Basic Civil and Mechanical Engineering"**, McGraw Hill Education, 2018.*
2	*Ramamrutham, **"Basic Civil Engineering"**, Dhanpat Rai Publishing Co.(P) Ltd. 2013.*
3	*VenugopalK, Prabu Raja V., **"Basic Mechanical Engineering"**, AnuradhaPublications, 2014.*
4	*DomkundwaS,Kothandaraman, C.P., Domkundwar A, **"Thermal Engineering"**,Dhanpat Rai &Co.Publishers, New Delhi, 2013.*
5	*SeropeKalpakjiam., Steven R Schmid., **"Manufacturing Engineering and Technology"**, Pearson Education, Seventh Edition, 2018*

REFERENCES:

1	*P.C.Varghese "**Building Materials**", PHI Learning pvt. Ltd, New Delhi, 2015.*
2	*Bhavikatti,S.S.,**"Basic Civil Engineering"**, New Age International, 2019.*
3	*Ganesan V., **"Internal Combustion Engines"**, Tata McGraw Hill, New Delhi, 2012.*
4	*Ananthanarayanan, P.N., **"Basic Refrigeration and Air Conditioning"**, McGraw-Hill Education (India), 2013.*
5	*Hajrachoudhury A K.,Hajrachoudhury S K.,**"Elements of Workshop Technology Vol-I: Manufacturing Processes"**, Media Promoters and Publishers Pvt Ltd, Mumbai, 2014.*
6	*Sharma P C., **"A Textbook of Production Technology (Manufacturing Processes)"**, S.Chand& Company Ltd., New Delhi, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	To know the properties and uses of building materials and types of foundation for green building.	K1
CO2	To identify various sources of water, rain water harvesting and sewage disposal methods.	K1
CO3	To indicate the importance of transportation and irrigation practices.	K2
CO4	To apply the knowledge on Basic mechanical devices and Refrigeration and Air-conditioning in their field of specialization.	K3
CO5	To apply the concept of different metal cutting techniques in their applications.	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	1	2	1	3	-	-	-	-	-	1	1	2	2
CO2	2	1	1	2	-	2	1	2	-	-	-	-	-	-	3
CO3	2	1	1	1	1	3	-	1	-	-	-	1	-	2	3
CO4	3	2	1	2	2	-	2	-	-	2	-	1	1	2	-
CO5	3	2	1	2	2	-	1	-	-	2	-	1	1	-	3
22EES205	**3**	**2**	**1**	**2**	**2**	**2**	**1**	**1**	-	**1**	-	**1**	**1**	**2**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.2.1, 1.3.1, 2.3.2, 3.3.1, 3.4.2, 4.1.2, 4.1.4, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 6.1.1, 6.2.1, 12.2.2, 12.3.2
CO2	1.2.1, 1.3.1, 2.2.2, 2.2.4, 3.4.2, 4.1.2, 4.3.1, 4.3.3, 6.1.1, 7.1.2, 8.1.1, 8.2.2
CO3	1.3.1, 1.4.1, 2.4.4, 3.2.1, 4.3.1, 4.3.3, 5.1.1, 6.1.1, 6.2.1, 8.1.1, 12.2.2, 12.3.2
CO4	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.2.2, 2.3.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.2.3, 3.3.1, 3.3.2, 4.1.1, 4.1.2, 4.1.3, 5.1.1, 5.1.2, 5.2.1, 5.3.1, 7.1.1, 7.2.1, 10.1.1, 10.1.2, 10.3.1, 12.3.1
CO5	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.2.2, 2.3.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.2.3, 3.3.1, 3.3.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 5.1.1, 5.1.2, 5.2.1, 5.3.1, 7.1.1, 10.1.1, 10.1.2, 10.3.1, 12.3.1

ASSESSMENT PATTERN – THEORY :

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	40	20	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	40	40	20	-	-	-	100
ESE	40	40	20	-	-	-	100

22EBS2Z6	**CHEMISTRY LABORATORY** (Common to all Branches)	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	BS	0	0	3	1.5

Course Objectives	To inculcate the practical applications of Chemistry to students and make them apply in the fields of engineering and technology.

LIST OF EXPERIMENTS	
1.	Estimation of hardness by EDTA method.
2	Conductometric titration of mixture of strong acid and weak acid using strong base.
3.	Estimation of chloride by Argentometric method.
4.	Potentiometric titration of ferrous iron by dichromate.
5.	Determination of Saponification value of an oil.
6.	Estimation of Iron by Spectrophotometry.
7.	Estimation of Dissolved Oxygen.
8.	Estimation of HCl by pH titration.
9.	Estimation of Copper in brass sample.
10.	Estimation of Manganese in Pyrolusite ore.
11.	Anodiziation of aluminium.
12.	Determination of corrosion rate and inhibitor efficiency of mild steel in acid media by weight loss method.

Contact Periods:			
Lecture: 0 Periods	**Tutorial: 0 Periods**	**Practical: 45 Periods**	**Total: 45 Periods**

REFERENCE BOOKS:

1	*A.O. Thomas, "**Practical Chemistry**", Scientific Book Centre, Cannanore, 2006.*
2	*Vogel's "**Text book of Quantitative Analysis**", Jeffery G H, Basset J. Menthom J, Denney R.C., 6th Edition, EBS, 2009.*

COURSE OUTCOMES: Upon the completion of the course, the student will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the quality of water samples with respect to their hardness and DO.	K3
CO2	Determine the amount of metal ions through potentiometric and spectroscopic techniques.	K3
CO3	Infer the strength of acid, mixtures of acids by pH meter and conductivity cell.	K3
CO4	Estimate the chloride, manganese and copper from various samples.	K3
CO5	Interpret the corrosion rate determination and anodizing method.	K2

COURSE ARTICULATION MATRIX:															
a) CO and PO Mapping															
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	1	-	1	-	-	-	-	-	-	-	-	-	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	2	1	1	1	-	-	1	-	-	-	-	-	1	1	-
22EBS2Z6	**2**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.2.1, 2.3.1, 3.1.5,
CO2	1.1.1, 1.2.1, 1.3.1, 2.1.2,
CO3	1.1.1, 1.2.1, 2.1.3, 4.1.3,
CO4	1.2.1, 1.3.1, 2.3.1,
CO5	1.1.1, 1.2.1, 1.3.1, 2.3.1, 3.1.5, 4.2.1, 7.1.1,

22EES2Z6	**ENGINEERING GRAPHICS** (Common to all Branches)	**SEMESTER II**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**ES**	**1**	**0**	**4**	**3**

Course Objectives	1. To Understand the geometrical constructions. 2. To Study the various types of projections. 3. To Identify different section of solids. 4. To Perform the development of surfaces and view of solids. 5. To Familiarize with CAD packages.	
UNIT – I	**GEOMETRICAL CONSTRUCTIONS AND PLANE CURVES**	**(3+12 Periods)**
Principles of Engineering Graphics and their significance - Basic geometrical constructions. Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Drawing of tangents and normal to the above curves.		
UNIT – II	**ORTHOGRAPHIC PROJECTIONS**	**(3+12 Periods)**
Introduction to Orthographic Projection - Conversion of pictorial views to orthographic views. Projection of points - Projection of straight lines with traces - Projection of planes (polygonal and circular surfaces) inclined to both the principal planes.		
UNIT – III	**PROJECTION AND SECTION OF SOLIDS**	**(3+12 Periods)**
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids, when the axis is inclined to both the principal planes by rotating object method. Sectioning of prisms, pyramids, cylinder and cone in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section.		
UNIT – IV	**DEVELOPMENT OF SURFACES AND ISOMETRIC PROJECTIONS**	**(3+12 Periods)**
Development of lateral surfaces of simple and sectioned solids – prisms, pyramids, cylinder and cone. Principles of isometric projection – isometric scale – isometric projections of simple solids and truncated solids - prisms, pyramids, cylinder, cone- combination of two solid objects in simple vertical positions.		
UNIT – V	**COMPUTER AIDED DRAFTING**	**(3+12 Periods)**
Introduction to computer aided drafting package to make 2D Drawings. Object Construction: Page layout – Layers and line types – Creating, editing and selecting the geometric objects. Mechanics: Viewing, annotating, hatching and dimensioning the drawing – Creating blocks and attributes. Drafting: Create 2D drawing. A number of chosen problems will be solved to illustrate the concepts clearly. (Demonstration purpose only, not to be included in examination)		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 60 Periods Total: 75 Periods**		

TEXT BOOKS:

1	*K.Venugopal, **"Engineering Graphics"**, New Age International (P) Limited, 2016.*
2	*K.V.Natarajan, **"A text book of Engineering Graphics"**, Dhanalakashmi Publishers, Chennai, 2016.*

REFERENCES:

1	*K.L.Narayana and P.Kannaiah, **"Text book on Engineering Drawing"**, 2nd Edition, SciTech Publications (India) Pvt. Ltd, Chennai, 2009.*
2	*N.S.Parthasarathy and Vela Murali, **"Engineering Graphics"**, Oxford University Press, New Delhi, 2015.*
3	*K.R.Gopalakrishna, **"Engineering Drawing" (Vol. I&II combined),** Subhas Publications, Bangalore, 2014.*
4	*Basant Agarwal and C.M.Agarwal, **"Engineering Drawing"**, Tata McGraw Hill Publishers, New Delhi, 2013.*
5	*Kevin Lang and Alan J.Kalameja, "**AutoCAD 2012 Tutor for Engineering Graphics"**, Cengage Learning Publishers, 1st Edition, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire on representing solids as per international standards.	K3
CO2	Impart knowledge on different types of projections.	K3
CO3	Generate and interrupt the true shape of section.	K3
CO4	Develop the various surfaces according to the standards.	K3
CO5	Know the concept of computers in drafting engineering diagrams.	K6

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	1	1	1	1	2	-	3	1	3	1	3	1	2	2
CO2	3	1	1	1	1	2	-	3	1	3	1	3	1	2	1
CO3	3	1	1	1	1	2	-	3	1	3	1	3	2	2	1
CO4	3	1	1	1	1	2	-	3	1	3	1	3	2	2	2
CO5	3	1	1	1	1	2	-	3	1	3	1	3	2	2	3
22EES2Z6	**3**	**1**	**1**	**1**	**1**	**2**	**-**	**3**	**1**	**3**	**1**	**3**	**2**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.3, 2.4.2, 3.1.2, 3.1.4, 3.2.1, 4.3.3, 5.1.1, 6.2.1, 8.1.1, 8.2.1, 8.2.2, 9.2.1, 9.2.4, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.1, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.3, 2.4.2, 3.1.2, 3.1.4, 3.2.1, 4.3.3, 5.1.1, 6.2.1, 8.1.1, 8.2.1, 8.2.2, 9.2.1, 9.2.4, 10.1.1, 10.1.2, 10.2.1, 10.3.1, 10.3.2, 11.3.1, 12.1.1, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.3, 2.4.2, 3.1.2, 3.1.4, 3.2.1, 4.3.3, 5.1.1, 6.2.1, 8.1.1, 8.2.1, 8.2.2, 9.2.1, 9.2.4, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.1, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.3, 2.4.2, 3.1.2, 3.1.4, 3.2.1 ,4.3.3, 5.1.1, 6.2.1, 8.1.1 , 8.2.1, 8.2.2, 9.2.1, 9.2.4, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.1, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.3, 2.4.2, 3.1.2, 3.1.4, 3.2.1, 4.3.3, 5.1.1, 6.2.1, 8.1.1, 8.2.1, 8.2.2, 9.2.1, 9.2.4, 10.1.1, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.1, 12.2.1, 12.2.2, 12.3.1, 12.3.2

22EES307	DATA STRUCTURES (Common to EEE, ECE & CSE Branches)	III SEMESTER

PREREQUISITES	CATEGORY	L	T	P	C
Programming In C	PC	3	0	0	3

Course Objectives	The objective of the course is to enable the students to analyze the time complexity of an algorithm, Understand and Use List, Stack, Queue, Tree and graph Data structures and effectively use sorting and searching Techniques.	
UNIT – I	**INTRODUCTION AND ABSTRACT DATA TYPES**	**(9 Periods)**
Algorithm Analysis: Calculation of Running Time – Abstract Data Type- List ADT: Array implementation of List, Linked Lists, Doubly Linked List, Circularly Linked Lists- Cursor implementation of Linked List		
UNIT – II	**STACK AND QUEUE ADT**	**(9 Periods)**
Stack ADT: Stack Model, Implementation of stacks, Applications: Balancing Symbols, Postfix expression evaluation, Infix to postfix conversion, Function Calls – Queue ADT: Queue Model, Implementation of Queues, Applications.		
UNIT – III	**TREE ADT**	**(9 Periods)**
Preliminaries – Implementation of Trees – Tree Traversals – Binary Tree: Implementation, Expression Tree – Search Tree ADT – AVL Trees - BTrees – Red Black Trees.		
UNIT – IV	**GRAPH ALGORITHMS**	**(9 Periods)**
Definitions – Representation of Graphs – Traversal- Topological sort – Shortest Path Algorithms: Dijkstra's Algorithm – Network Flow Problem – Minimum Spanning Tree: Prim's and Kruskal's algorithm.		
UNIT – V	**SORTING AND SEARCHING**	**(9 Periods)**
Sorting: Insertion Sort – Shell Sort – Heap Sort – Merge Sort – Quick Sort – Bucket Sort – External Sorting: Simple Algorithm, Multi way merge, Poly Phase Merge – Searching : Linear Search – Binary Search – Hashing : Hash Functions– Collision Resolution: Separate Chaining – Open Addressing – Linear Probing– Quadratic Probing – Double Hashing – Rehashing.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Mark Allen Weiss* ***"Data Structures and Algorithm Analysis in C"*** *Second Edition, Pearson Education Limited, 2002.*

REFERENCES:

1	*Thomas H. Cormen , Charles E. Leiseron, Ronald L.Rivest, Clifford Stein,* ***"Introduction to Algorithms",*** *Third Edition, PHI learning Pvt. Ltd., 2011.*
2	*Sartaj Sahni,* ***"Data Structures, Algorithms and applications in C++",*** *Second Edition, Universities Press, 2005.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the time complexity of various algorithms	K4
CO2	Define and use list, stack and queue Data Structures	K3
CO3	Define and use Tree Data Structure	K3
CO4	Define and use Graph Data Structure	K4
CO5	Use appropriate sorting and searching Techniques	K4

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

Cos/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	2	1	-	-	-	-	-	-	-	1	2	2	1
CO2	2	2	2	2	2	2	-	-	-	1	-	1	2	1	1
CO3	2	2	2	2	2	2	-	-	-	1	-	1	2	1	1
CO4	2	2	2	2	2	2	-	-	-	1	-	1	2	1	1
CO5	2	2	1	1	-	-	-	-	-		-	1	2	2	2
22EES 307	2	2	2	2	2	2	-	-	-	1	-	1	2	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.3.1,1.4.1,2.1.2,2.2.2,2.3.1,2.4.1,3.1.6,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,4.2.2,4.3.1,12.2.2.
CO2	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1.3,4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2
CO3	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1.3,4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2
CO4	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1.3,4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2
CO5	1.3.1,1.4.1,2.1.2.2.1,2.2.3,2.3.1,2.4.4,3.1.3,3.1.6, 3 .2.3, 3.3.2, 4.1.2, 4.2.1,4.3.1,6.1.1, 10.3.1,11.2.1, 12.1.1,12.2.2,12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	20	30	50	-	-	100
CAT2	-	10	80	10	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	80	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	80	20	-	-	100
ESE	-	30	50	20	-	-	100

22EPC301	ELECTRIC CIRCUIT THEORY	III SEMESTER

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	1	0	4

Course Objectives	To gain knowledge in basic concepts of circuit theory and finally be able to analyze and synthesize electric circuits	
UNIT – I	**DC AND AC CIRCUIT ANALYSIS**	**(12 Periods)**
Ohm's law and Kirchhoff's Laws – Waveform representation – Form Factor and Peak Factor derivation for alternating waveforms - R, L, C series-parallel circuits - Star-delta transformation - Source transformations - Mesh and nodal methods – Phase relation in R, L and C - Power factor - Real, reactive and apparent powers – Problems in AC and DC circuits.		
UNIT – II	**NETWORK THEOREMS AND POLYPHASE CIRCUITS**	**(12 Periods)**
Superposition theorem – Thevenin's and Norton's theorems - Maximum power transfer theorem - Reciprocity theorem. Three phase system – Interconnection of three- phase sources and loads - Balanced and unbalanced circuits - Power measurement		
UNIT – III	**RESONANCE, COUPLED CIRCUITS AND TRANSIENTS**	**(12 Periods)**
Resonance in series and parallel circuits – frequency response - derivation of bandwidth - Introduction to coupled circuits – Mutual inductance – Coefficient of coupling - Dot rule - Single and double tuned circuits - Problems. Transient response – DC response of RL, RC, R L C circuits – Sinusoidal response of RL, RC, RLC circuits.		
UNIT – IV	**TWO PORT NETWORKS**	**(12 Periods)**
Two port networks - Open circuit impedance and short circuit admittance parameters – Transmission and inverse transmission parameters – Hybrid and inverse hybrid parameters-Image parameters - Applications.		
UNIT – V	**FILTERS DESIGN AND SYNTHESIS OF CIRCUITS**	**(12 Periods)**
Classification of filters - Low pass and high pass filters - Band pass and Band stop filters-Constant K and m-derived filters. Hurwitz Polynomials – Positive Real Function – Synthesis of reactive one port RL, RC networks using Foster and Cauer methods.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

TEXT BOOK:

1	*Sudakar A. and Shyam Mohan S.Palli* ***"Circuits and Networks (Analysis and Synthesis)"*** *Tata Mc Graw Hill Book Co., New Delhi, III Ed., 2017*
2	*Charles K. Alexander, Matthew N.O. Sadiku* ***"Fundamentals of Electric Circuits"*** *McGraw Hill Book Co., 7 Ed. 2020*

REFERENCES:

1	*Hayt W.H and Kemmerley J.E,* ***"Engineering Circuit Analysis"****, Tata McGraw Hill Book Co., V Ed., 2019*
2	*C.P. Kuriakose* ***"Circuit Theory: Continuous and Discrete – time systems – Elements of Network Synthesis"*** *PHI, Delhi, 2018*
3	*Gangadhar K.A.,* ***"Circuit Theory"****, Khanna Publishers, II Ed., 2019*
4	*M.E.Van Valkenburg,* ***"Network Analysis"****, PHI, Delhi, 2019*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply electric circuit laws to DC and AC circuits and solve problems	K3
CO2	Analyze complex circuits using theorems and solve three phase circuits	K4
CO3	Understand the concepts of resonance, coupled circuits and transients and solve problems	K2
CO4	understand two port networks and solve the networks using different parameters	K2
CO5	Design filter circuits and Synthesize electric networks.	K6

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	1	3	-	-	-	-	-	-	-	-	2	1	1
CO2	3	3	1	3	-	-	-	-	-	-	-	-	3	3	1
CO3	3	3	1	3	-	-	-	-	-	-	-	-	3	3	1
CO4	3	3	1	3	-	-	-	-	-	-	-	-	3	2	2
CO5	3	3	1	3	-	-	-	-	-	-	-	-	2	2	2
22EP C301	3	3	1	3	-	-	-	-	-	-	-	-	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.2.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.2.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.2.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.2.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.2.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	40	-	30	-	100
CAT2	10	20	30	10	30	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	40	40	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	20	40	40	-	-	100
ESE	10	20	30	-	30	10	100

22EPC302	FIELD THEORY	III SEMESTER

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	1	0	4

Course Objectives	To learn the concepts of static and dynamics of charges, understand electromagnetic fields and work on problem solving and application of these ideas for design	
UNIT – I	**ELECTROSTATIC POTENTIAL AND FIELD**	**(12 Periods)**
Types of charges - Charge distribution - Coulomb's Law - Gauss' law - their applications - Potential - Electric field intensity - Boundary Conditions - Laplace and Poisson's equations – Dielectrics – Capacitance - Electrostatic energy- Problems		
UNIT – II	**MAGNETIC POTENTIAL AND FIELD**	**(12 Periods)**
Biot - Savart's law - Ampere's law - Their applications - Scalar and Vector magnetic potentials - Magnetic torque - Force - Boundary conditions – Energy density in magnetic field – Lifting power of electromagnet – Problems		
UNIT – III	**ELECTRO MAGNETIC FIELDS**	**(12 Periods)**
Problems in divergence and curl of vector fields in various coordinates - Faraday's laws - Maxwell's equations - Current densities - Time harmonics fields - Problems		
UNIT – IV	**ELECTROMAGNETIC WAVES**	**(12 Periods)**
Wave equations – Uniform plane waves in free space - Uniform plane waves in lossless dielectrics – Uniform plane waves in lossy dielectrics – Uniform plane waves in good conductor - Poynting's theorem - Problems.		
UNIT – V	**FIELD MODELING, EMI AND EMC**	**(12 Periods)**
Field plotting - Laplace equation in rectangular coordinates – Separation of variables - Finite difference method - Finite element method - Infinite square through with lid – Infinite square through with different potentials on four sides – Moment method – EMI and EMC – Sources – Conducted and Radiated EMI – Elimination methods - Problems.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

TEXT BOOK:

1	*John D. Kraus and Daniel A. Fleisch **"Electromagnetics with Applications"**, Mc Graw Hill International Ed., 2018.*
2	*William H.Hayt **"Engineering Electromagnetics"**, Mc Graw Hill Book Co., 2020.*

REFERENCES:

1	*AshutoshPramanik **"Electromagnetism"** Prentice Hall of India Pvt. Ltd, 2018.*
2	*Gangadhar K.A., **"Field Theory"**, Khanna Publishers, 2017.*
3	*Joseph Edminister, **"Electromagnetics"**, 2nd Ed., Tata McGraw Hill Book Co., 2019.*
4	*Mathew N.D Sadiku, **"Elements of Electromagnetics"**, Oxford university press, Fourth Edition., 2021.*
5	*Dr.Dhananjayan.P. **"Engineering Electromagnetics"**, Lakshmi Publications, 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the basics of electric field	K2
CO2	Ascertain the concepts of magnetic field	K3
CO3	Master the fundamentals of electromagnetic field	K3
CO4	Illustrate the knowledge gained to analyze electromagnetic waves	K3
CO5	Estimate the field parameters for a given problem based on field modeling	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	1	2	-	-	-	-	-	-	2	1	1
CO2	3	3	3	3	1	2	-	-	-	-	-	-	3	3	1
CO3	3	3	3	3	1	2	-	-	-	-	-	-	3	3	1
CO4	3	3	3	3	1	2	-	-	-	-	-	-	3	2	2
CO5	3	3	3	3	1	2	-	-	-	-	-	-	2	2	2
22EP C302	3	3	3	3	1	2	-	-	-	-	-	-	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,4.1.1,4.1.2,4.1.4, 4.2.1,4.3.1,5.1.1,5.1.2,6.1.1
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,4.1.1,4.1.2,4.1.4, 4.2.1,4.3.1,5.1.1,5.1.2,6.1.1
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,4.1.1,4.1.2,4.1.4, 4.2.1,4.3.1,5.1.1,5.1.2,6.1.1
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,4.1.1,4.1.2,4.1.4, 4.2.1,4.3.1,5.1.1,5.1.2,6.1.1
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,4.1.1,4.1.2,4.1.4, 4.2.1,4.3.1,5.1.1,5.1.2,6.1.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	40	-	30	-	100
CAT2	10	20	20	20	30	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	40	40	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	40	40	20	-	100
ESE	10	20	20	20	30	-	100

22EPC303	ELECTRONIC DEVICES AND CIRCUITS	III SEMESTER

PREREQUISITES :	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To impart knowledge about various electronic devices and circuits and to identify the suitability of electronic devices for real time applications.	
UNIT – I	**DIODES AND APPLICATIONS**	**(9 Periods)**
PNdiode: VIcharacteristics – transition and diffusion capacitance – reverse recovery time – diodemodels – Applications : Half-wave and Full-wave rectifiers and filters – power supply regulators – Clipping and clamping circuits – Avalanche and Zener break down – Zenerdiodes – varactor and optical diodes.		
UNIT – II	**BI-POLAR JUNCTION TRANSISTORS AND AMPLIFIERS**	**(9 Periods)**
BJT: Structure–operation and characteristics – as an amplifier and switch– DC operating point – base, emitter and voltage-divider bias –Miller's theorem –BJT amplifier : operation –AC equivalent circuits–CE, CC, CB configurations - multistage – RC coupled – transformer coupled– Darlington and differential amplifiers.		
UNIT – III	**FIELD-EFFECT TRANSISTOR AND BIASING**	**(9 Periods)**
JFET: Structure, operation and characteristics with parameters – biasing configurations – MOSFET: Structure – types (Depletion and Enhancement) – operation and characteristics– biasing configurations – V MOSFET – CMOS technology.		
UNIT – IV	**AMPLIFIERS ANALYSIS AND FEEDBACK TECHNIQUES**	**(9 Periods)**
BJT and FET amplifiers – basics of frequency response – Low–high and total Frequency response –Power amplifiers –operation – characteristics– parameters of Class A, AB, B and C amplifiers – Operational Amplifier : inverting and non inverting amplifiers –concepts of feedbacks –Negative feedback: shunt and series feedback- Positive feedback: WienBridge and RC phase shift oscillators.		
UNIT – V	**OTHER SEMICONDUCTOR DEVICES**	**(9 Periods)**
Basic constructions, characteristics curves, parameters and applications : SCR – DIAC – TRIAC - Unijunction Transistors - programmable Unijunction Transistors –IGBT –photo transistors and optical couplers–New semiconductor materials –SiliconCarbide- GalliumArsenide.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK :

1	*Thomas L.Floyd, **"Electronic Devices"**, 9th Edition. ,Prentice Hall Inc. 2012*
2	*Robert Boyle stad, **"Electronic Devices and Circuit Theory"**, 9th Edition, Pearson, 2010*

REFERENCES:

1	*Jacob Millman, Christos C Halkias and SatyabrataJIT ,**"Electron Devices and Circuits"**, 2nd Ed.,Tata Mc GrawHill, 2008.*
2	*Allen Mottershead, **"Electronic Devices and Circuits, An Introduction"**, Eastern Economy Ed.,Prentice-HallofIndia,2009*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the construction and working of semiconductor devices	K2
CO2	Analyze the characteristics of the devices and their equivalent circuit models	K4
CO3	Design of electronic circuits using devices and components	K3
CO4	Explore the suitability the device for various applications	K5
CO5	Study the special semiconductor and power electronic devices	K2

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	2	2	2	-	-	1	1	-	3	3	1
CO2	3	3	1	2	2	-	-	-	-	-	-	2	2	3	1
CO3	3	3	1	2	2	-	-	-	-	2	3	2	2	3	2
CO4	3	2	2	2	2	-	2	-	-	1	2	-	3	2	3
CO5	3	2	2	2	2	-	2	2	-	1	3	3	2	2	2
22EP C303	3	2	2	2	2	2	2	2	-	1	2	2	2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.2.1,1.3.1,1.4.1,2.3.1,2.3.2,2.4.4,3.1.3,3.1.6,3.2.1,4.1.4,4.2.1,4.3.4,5.1.1,5.3.1,6.1.1,7.1.1,7.2.2,10.1.1,10.3.1,11.1.1
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1,3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1,3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2,10.1.1,10.2.2,10.3.1,11.1.1,11.2.1,11.3.1,11.3.2,12.3.1,12.3.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.3,2.2.4,2.4.2,2.4.3,2.4.4,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.3.1,4.1.2,4.1.4,4.2.1,5.1.2,5.2.2,5.3.2,7.1.1,7.2.2,10.1.1,10.3.1,11.2.1,11.1.2, 11.3.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.3,2.2.4,2.4.2,2.4.3,2.4.4,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.3.1,4.1.2,4.1.4,4.2.1,5.1.2,5.2.2,5.3.2,7.1.1,7.2.2,10.1.1,10.3.1,11.2.1,11.1.2, 11.3.2,8.2.1,8.2.2,11.1.1,11.1.2,11.2.1,12.1.2,12.2.1,12.3.1,12.3.2

ASSESSMENT PATTERN							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	20	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

22EPC304	ELECTRICAL MACHINES-I	SEMESTER III

PREREQUISITES :	CATEGORY	L	T	P	C
Engineering Physics, Field theory	PC	3	0	0	3

Course Objectives	To obtain knowledge about energy in the magnetic system, the working principle of DC generators, DC motors and Transformers. Also to perform testing in various DC machines and transformers.	
UNIT – I	**PRINCIPLES OF ELECTROMECHANICAL ENERGY CONVERSION**	**(9 Periods)**
Energy in magnetic system – Field energy- co energy - Force -torque equations- eddy currents - eddy current losses – flux distribution curve in the air gap – Singly-multiply excited magnetic field systems - mmf of distributed ac windings – Winding Inductances - Rotating Magnetic Field-mmf waves - Magnetic saturation - leakage fluxes.		
UNIT – II	**DC GENERATORS**	**(9 Periods)**
Constructional details- principle of operation – Armature winding -Emf equation – Types of dc generators - Armature reaction: Effects of armature reaction - demagnetizing & cross magnetizing ampere-turns – compensating windings – interpoles : commutation – Characteristics of DC generators - losses - efficiency - Parallel operation of dc generators-applications.		
UNIT – III	**DC MOTORS**	**(9 Periods)**
Constructional details - principle of operation- back emf – Types -Torque equation losses - efficiency – power flow diagram – Electrical - mechanical characteristics of different types of DC motors – Starters – Speed control methods – Types of Electric braking		
UNIT – IV	**TRANSFORMERS**	**(9 Periods)**
Principle of operation – Types-constructional features of single phase -three phase transformers –EMF equation - Phasor diagram – Transformers on load - Equivalent circuit – Voltage Regulation - efficiency- All day efficiency Three phase transformer connections – Scott connection – Parallel operation of three phase transformers – Inrush current phenomenon - its prevention - Auto transformers, Off-load - on-load tap changing transformer-Isolation Transformer.		
UNIT – V	**TESTING OF DC MACHINES AND TRANSFORMERS**	**(9 Periods)**
DC machines: Brake test, field test, Retardation test - Swinburne's test - Hopkinson's test. Transformers: Open Circuit -Short Circuit Tests-- Phasing, Identification -Polarity of transformer winding - Sumpner's test.		
Contact Periods: **Lecture:45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK:

1	*Nagrath J. and D. P. Kothari, **"Theory of Electric Machines"**, Tata McGraw Hill, 2006*
2	*Fitzgerald A. E., C. Kingsley and S. Umans, **"Electric Machinery"**, 7/e, McGraw Hill, 2020*

REFERENCES:

1	*Bimbra P. S., **"Electrical Machinery"**, 7/e, Khanna Publishers, 2021.*
2	*BL. Theraja, AK, Theraja, **"A Textbook of Electrical Technology"** Volume II : AC And DC Machines", S.Chand Publications, Multicolour Illustrative Edition, 2005.*
3	*Abhijith Chakrabarti, Sudipta Debnath, **"Electrical Machines"**, McGraw Hill Education, NewDelhi 2015.*
4	*Deshpande M. V., **"Electrical Machines"**, Prentice Hall India, New Delhi, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply basic laws of electromagnetic principles for static and dynamic electric machines.	K1
CO2	Analyze the performance of electrical machines for the different level of utilization in Industries.	K4
CO3	Identify suitable machines for any specific application.	K6
CO4	Perform testing of the electrical machines.	K3
CO5	Evaluate the performance of electrical machines.	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping															
COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	2	1	-	-	-	-	1	1	2	3	2	2
CO2	3	3	3	3	1	-	-	-	-	1	1	1	3	3	3
CO3	3	2	2	2	2	-	-	-	-	-	1	1	3	2	2
CO4	2	2	2	3	1	-	-	-	-	1	1	1	2	2	2
CO5	2	2	1	3	1	-	-	-	-	-	1	2	2	2	1
22EPC 304	3	2	2	3	1	-	-	-	-	1	1	1	3	2	2
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.4,2.4.1,2.4.2,3.1.1,3.1.3,3.1.6,3.2.2,3.2.3,3.3.1,3.4.1,4.1.1,4.1.2,4.2.2,4.3.4,5.1.2,5.3.2,10.1.3,10.3.2,11.1.2,12.1.1,12.2.1,12.3.1,
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.2.1,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.3.1,3.3.2,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,4.3.1,4.3.2,4.3.4,5.1.1,5.3.1,10.2.1,10.3.2,11.1.1,12.1.2,
CO3	1.1.1,1.1.2,1.2.1,1.3.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.3,2.4.4,3.1.2,3.1.4,3.1.5,3.2.1,3.2.3,3.3.1,3.3.2,3.4.2,4.1.1,4.2.1,4.2.2,5.1.1,5.2.1,5.2.2,11.3.1,12.2.1,12.2.2,
CO4	1.1.1,1.3.1,2.1.2,2.2.1,2.2.3,2.2.4,2.3.1,3.1.3,3.1.6,3.2.1,3.2.2,3.4.1,4.1.1,4.1.2,4.1.3,4.2.1,4.3.1,4.3.2,4.3.4,5.1.2,10.1.2,10.3.1,11.3.1,12.1.1,12.3.1,
CO5	1.1.2,1.2.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.4,3.3.2,3.4.1,4.1.1,4.1.2,4.1.4,4.2.2,4.3.3,4.3.4,5.3.2,11.1.2,12.1.1,12.2.1,12.3.2,

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	20	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

22EPC305	DIGITAL CIRCUITS	SEMESTER III

PREREQUISITES :	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To learn the concepts and design techniques used in digital electronics and also to familiarize the Hardware description language in the design of digital circuits	
UNIT – I	**NUMBER SYSTEMS AND DIGITAL LOGIC FAMILIES**	**(9 Periods)**
Number system- error detection, corrections & codes conversions- Boolean Algebra and Logic gates – Boolean functions - Canonical and Standard Forms - Digital Logic gates – Gate level minimization - NAND and NOR Implementation- minimization using K-maps & Quine McCluskey Digital Logic Families - comparison of RTL, DTL, TTL, ECL and MOS families - operation, characteristics of digital logic family.		
UNIT – II	**COMBINATIONAL CIRCUITS**	**(9 Periods)**
Combinational circuits - Analysis and Design Procedure- Binary adder subtractor - Decimal adder – Binary multiplier – Magnitude comparator – Multiplexers - Demultiplexers - code converters- Encoders and Decoders.		
UNIT – III	**SYNCHRONOUS SEQUENTIAL CIRCUITS**	**(9 Periods)**
Sequential circuits- Latches – Flip flops - Analysis of Clocked Sequential Circuits – State Reduction and Assignment - Design Procedure- Moore and Mealy models - Registers, Shift Registers, Ripple Counters, Synchronous Counters.		
UNIT – IV	**ASYNCHRONOUS SEQUENTIAL CIRCUITS AND PROGRAMMABLE LOGIC DEVICES**	**(9 Periods)**
Asynchronous Circuits - Analysis Procedure - Circuits with Latches – Reduction of State Flow Tables – Race Free State Assignment – Hazards - Design Example. Programmable Logic Devices: PROM – PLA –PAL, CPLD-FPGA.		
UNIT – V	**HARDWARE DESCRIPTION LANGUAGE**	**(9 Periods)**
Introduction to Verilog: Structure of Verilog module, Operators, data types, Styles of description- Data flow description, Implement logic gates, half adder and full adder using Verilog data flow description. Behavioral description: Structure, variable assignment statement, sequential statements, Verilog behavioral description of Multiplexers (2:1,4:1,8:1) and De-multiplexers - Encoders (8 to 3), Decoders (2 to 4). Latches - flip flops.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK:

1	*Morris Mano.M **"Digital Design"** Pearson Education, New Delhi, 6^{th} Ed., 2018.*
2	*Samir Palnitkar, **"Verilog HDL- A guide to Digital Design and Synthesis"** Pearson Education, New Delhi, 2ndEd., 2003.*

REFERENCES :

1	*Ronald J. Tocci, Neal S Widmer, Gregory L Moss, **"Digital Systems: Principles and Applications",** Prentice Hall, 12thEd., 2017*
2	*Floyd Thomas L.,**"Digital fundamentals"** Pearson Education, New Delhi, 11thEd.,2015.*
3	*Charles H.Roth, **"Fundamentals of Logic Design"** 7^{th} Ed., Cl-Engineering, 2013.*
4	*Nazeih M. Botros , **"HDL Programming VHDL and Verilog",** Dreamtech press ,2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the fundamentals of digital electronics and logic families.	K2
CO2	Illustrate reduction of logical expressions using Boolean algebra and k-map.	K4
CO3	Use the procedures for the analysis and design of combinational circuits	K3
CO4	Analyze the design capability in synchronous and asynchronous sequential circuits	K4
CO5	Design digital logic circuits in different types of modeling using HDL	K6

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	-	-	-	-	-	-	-	2	3	2	2
CO2	3	3	2	3	-	-	-	-	-	-	-	-	2	2	2
CO3	3	3	3	3	-	-	-	-	-	-	-	1	3	3	3
CO4	3	3	3	3	-	-	-	-	-	-	-	2	3	3	2
CO5	3	3	3	3	3	-	-	-	-	-	-	2	3	3	3
22EPC 305	3	3	3	3	3	-	-	-	-	-	-	2	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping		
CO1	1.1.1,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.4,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.1.3,3.1.6,3.2.1,3.2.3,4.1.1,4.1.4,4.2.2,4.3.4,12.2.1,12.2.2,12.3.1,12.3.2	
CO2	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.3, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.3, 4.3.4	
CO3	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.4, 3.1.1, 3.1.3, 3.1.3, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.3, 4.3.4, 12.1.2	
CO4	1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.3,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.3,4.3.4,12.1.2,12.2.2,12.3.2	
CO5	1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.3,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.3,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,12.1.2,12.2.2,12.3.2	

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	40	30	-	-	100
CAT2	10	20	30	30	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	50	50	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	40	40	20	-	100
ESE	10	20	30	30	-	10	100

22EPC306	ELECTRIC CIRCUITS AND ELECTRONIC DEVICES LABORATORY	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objectives	To enable the students to gain experimental skill.on the concepts learned in Electrical and Electronic circuits

List of Experiments:

1. Study of measuring instruments
2. Verification of Ohm's Law and Kirchhoff's laws.
3. Verification of network theorems.
4. Analysis of First order R-L and R-C Circuits/.Second order RLC Circuits
5. Measurement of average, rms, form and peak factor of time varying signals
6. Study of Fluorescent lamp circuit
7. Three phase power measurement
8. Semiconductor diode characteristics.
9. Zener diode characteristics and voltage regulation.
10. Transistor characteristics - common emitter mode and common base mode.
11. Characteristics of UJT and generation of sawtooth waveforms.
12. Characteristics of FET.
13. Circuit analysis using technical software
14. IV and PV characteristics of PV panel.

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Verify the basic laws of circuit theory and various network theorems.	K4
CO2	Infer the characteristics of basic semiconductor devices.	K4
CO3	Measure the real and reactive power in three phase network	K4
CO4	Analyze the circuits and devices using simulation tool.	K4
CO5	Determine the parameters of electronic circuits.	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
CO2	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
CO3	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
CO4	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
CO5	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
22EPC306	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1

22EPC307	ELECTRICAL MACHINES LABORATORY – I	SEMESTER III

PREREQUISITES :	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objectives	To give hands on training for evaluating the performance and characteristics of DC Machines and Transformers.

List of Experiments:

1. Swinburne's test and Speed control of d.c. shunt motor.
2. Open circuit characteristics and load test on d.c. shunt generator.
3. Open circuit characteristics and load test on d.c. compound generator.
4. Open circuit characteristics and load test on separately excited d.c. generator
5. Load test on d.c. shunt motor.
6. Load test on d.c. series motor.
7. Load test on d.c. compound motor.
8. Hopkinson's Test
9. OC and SC tests on single phase transformers.
10. Load test on single phase transformer.
11. Sumpner's test.
12. Separation of losses in transformers.
13. Separation of losses in dc machines
14. Three phase transformer connections.

Contact Periods:
Lecture: 0 Periods **Tutorial:0 Periods** **Practical: 45 Periods** **Total: 45 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the electrical / mechanical / performance characteristics of DC machines/transformers.	K4
CO2	Illustrate the different speed control methods for DC Motors..	K4
CO3	Develop the transformer model and analyze the performance.	K5
CO4	Interpret component of iron loss of DC machine / transformer.	K5
CO5	Study practically the losses occurring in DC machines and transformers.	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	-	-	-	3	3	-	-	2	1	1
CO2	3	3	3	3	3	-	-	-	3	3	-	-	3	3	1
CO3	3	3	3	3	3	-	-	-	3	3	-	-	3	3	1
CO4	3	3	3	3	3	-	-	-	3	3	-	-	3	2	2
CO5	3	3	3	3	3	-	-	-	3	3	-	-	2	2	2
22EPC 307	3	3	3	3	3	-	-	-	3	3	-	-	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1, 4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1, 6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.2.4,9.3.1,10.1.1,10.1.2,10.1.3, 10.2.1,10.2.2,10.3.1,10.3.2	
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1, 4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1, 6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.2.4,9.3.1,10.1.1,10.1.2,10.1.3, 10.2.1,10.2.2,10.3.1,10.3.2	
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1, 4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1, 6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.2.4,9.3.1,10.1.1,10.1.2,10.1.3, 10.2.1,10.2.2,10.3.1,10.3.2	
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1, 4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1, 6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.2.4,9.3.1,10.1.1,10.1.2,10.1.3, 10.2.1,10.2.2,10.3.1,10.3.2	
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1, 4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1, 6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.2.4,9.3.1,10.1.1,10.1.2,10.1.3, 10.2.1,10.2.2,10.3.1,10.3.2	

22EBS407	FOURIER SERIES AND TRANSFORM CALCULUS (Common to branches EEE & EIE)	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	BS	3	1	0	4

Course Objectives	The main objective of this course is to provide students with the foundations of Fourier series and transforms methods and analysis techniques mostly used in various applications in engineering and technology.	
UNIT – I	**FOURIER SERIES**	**(9+3 Periods)**
Dirichlet's Conditions – General Fourier series –Odd and even functions- Half range Sine and Cosine series – Parseval's Identity on Fourier series–Harmonic Analysis.		
UNIT – II	**BOUNDARY VALUE PROBLEMS**	**(9+3 Periods)**
Classification of partial differential equations – Method of separation of variables–One dimensional wave equation–One dimensional heat equation–Transient and Steady state conditions–Fourier series solution.		
UNIT–III	**LAPLACE TRANSFORMS**	**(9+3 Periods)**
Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions. Inverse Laplace transform. Convolution theorem. Evaluation of integrals by Laplace transform, solving ordinary differential equations by Laplace Transform method		
UNIT – IV	**FOURIER TRANSFORMS**	**(9+3 Periods)**
Statement of Fourier integral Theorem–Fourier transform pair–Fourier Sine and Cosine Transforms–Properties –Transforms of Simple functions-Convolution Theorem–Parseval's Identity-Finite Fourier transforms.		
UNIT – V	**Z-TRANSFORMS**	**(9+3 Periods)**
Z-transforms - Elementary properties-Inverse Z-transforms - Initial and Final value theorems - Convolution theorem – Formation of difference equations-Solution to difference equations of second order with constant coefficients using Z- transform.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 15 Periods** **Practical: 0 Periods** **Total: 60 Periods**		

TEXT BOOK:

1	*Kandasamy, Thilagavathy and Gunavathy., **"Engineering Mathematics"**, for III Semester, S.Chand&Co, Ramnagar, New Delhi. Revised edition 2017.*
2	*Veerarajan.T.,**"Transforms and partial Differential equations"**, Tata Mc Graw Hill Publishing Co.,New Delhi.2015*

REFERENCES:

1	*J.Ray Hanna And John H. Rowland, **"Fourier Series, Transforms and Boundary Value Problems"**, Dover Publication Inc, Mineola, New York, Second Edition , 2008.*
2	*B.S.Grewal, **"Higher Engineering Mathematics"**, Khanna Publishers, New Delhi, 44th Edition, 2018.*
3	*Ray Wylie C and Louis C Barrett, **"Advanced Engineering Mathematics"**, McGraw Hill Education(India)Pvt Ltd., New Delhi, 6th Edition 2014.*
4	*N.P.Bali and Manish Goyal., **"Transforms and partial Differential equations"**, University Science Press, New Delhi, 2010.*
5	*S. Larsson, V. Thomee, **"Partial Differential Equations with Numerical Methods"**, Springer, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Express the periodic functions arising in the study of engineering problems as trigonometric series.	K5
CO2	Solve the partial differential equation arising in engineering problems as wave and heat flow in steady state (Cartesian coordinate) using Fourier series.	K5
CO3	Apply Laplace Transform technique to solve the given integral equation s and ordinary differential equations.	K5
CO4	Find Fourier transforms, finite and infinite Fourier sine and cosine transforms.	K5
CO5	Apply the Z transform methods to find solutions of difference equations in engineering problem.	K5

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	3	-	-	-	-	-	-	-	1	2	-	-
CO2	3	2	2	3	-	-	-	-	-	-	-	1	2	-	-
CO3	3	2	2	3	-	-	-	-	-	-	-	1	2	-	-
CO4	3	2	2	3	-	-	-	-	-	-	-	1	2	-	-
CO5	3	2	2	3	-	-	-	-	-	-	-	1	2	-	-
22EBS407	3	2	2	3	-	-	-	-	-	-	-	1	2	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.1, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.2 4.1.1, 4.1.2, 4.1.4, 4.2.2, 4.3.2, 4.3.3, 4.3.4, 11.2.1, 11.3.1, 12.1.2, 12.3.2.
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.1, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.2 4.1.1, 4.1.2, 4.1.4, 4.2.2, 11.2.1, 11.3.1, 12.1.2, 12.3.2.
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.1, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.2 4.1.1, 4.1.2, 4.1.4, 4.2.2, 4.3.2, 4.3.3, 4.3.4, 11.2.1, 11.3.1, 12.1.2, 12.3.2.
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.1, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.2 4.1.1, 4.1.2, 4.1.4, 4.2.2, 4.3.2, 4.3.3, 4.3.4, 11.2.1, 11.3.1, 12.1.2, 12.3.2.
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.1, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.2 4.1.1, 4.1.2, 4.1.4, 4.2.2, 4.3.2, 4.3.3, 4.3.4, 11.2.1, 11.3.1, 12.1.2, 12.3.2.

ASSESSMENT PATTERN							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	45	35	-	-	-	100
CAT2	15	45	40	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	45	35	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	25	40	35	-	-	-	100
ESE	25	40	35	-	-	-	100

22EPC408	LINEAR INTEGRATED CIRCUITS	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
Electronic Devices and Circuits	PC	3	0	0	3

Course Objectives	1.To learn the concept of IC fabrication technology and applications. 2.To study the OPAMP characteristics. 3.To design and develop real time OPAMP applications.	
UNIT – I	**IC FABRICATION AND REALIZATION**	**(9 Periods)**
IC Classification - fundamental of monolithic IC technology: epitaxial growth, masking and etching, diffusion of impurities - Realization of monolithic ICs and packaging - Fabrication of diodes, capacitance, resistance and FETs.		
UNIT – II	**OPERATIONAL AMPLIFIERS CHARACTERISTICS**	**(9 Periods)**
Functional block diagram - Ideal op-amp - Open loop and closed loop operation – CMRR - Input bias and offset currents - Input and output offset voltages - Compensation techniques - Frequency response of op-amp – Transfer characteristics - Slew rate - Bandwidth.		
UNIT – III	**APPLICATIONS OF OPERATIONAL AMPLIFIERS**	**(9 Periods)**
Inverting and Non Inverting amplifiers – Differential amplifiers - Integrator and differentiator - V/I & I/V converters - Log and Antilog Amplifiers - Active Filters – Voltage to frequency converters – Sample and Hold circuits – Instrumentation amplifiers – Comparators – Clippers - Clampers - Zero crossing detectors – Square and triangular waveform generator		
UNIT – IV	**555 TIMERS, A/D AND D/A CONVERTERS**	**(9 Periods)**
555 timer – Functional block diagram - Astable and monostable operation of 555 timer – Applications – Frequency counters – A/D converters(Flash and successive approximation types) - D/A converters(R- 2R ladder and weighted resistor types		
UNIT – V	**APPLICATION ICs**	**(9 Periods)**
Positive and negative voltage regulators (IC723) Adjustable voltage regulators (LM117/LM317) – Dual tracking regulators (78xx & 79xx Series) – Phase Locked loop (IC565)- Programmable supply – SMPS - LM 380 power amplifier - ICL 8038 function generator IC.		
Contact Periods : **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Roy Choudhry D. and Shail Jain "**Linear Integrated Circuits**" New Age international, New Delhi,4th Ed., 2017*
2	*David A.Bell "**Op-amp & Linear ICs**'" Oxford, 3rd Ed., 2021*

REFERENCES:

1	*RamakantA.Gayakwad, "**OPAMPs and Linear Integrated Circuits**", Prentice Hall of India Pvt.Ltd. New Delhi, 4th Ed. 201*
2	*Jacob Millman, Christos C.Halkias, Integrated Electronics - Analog and Digital circuits.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the fabrication of semiconductor devices and circuits	K2
CO2	Analyze working of circuits in practical conditions	K4
CO3	Identification of suitable solutions to real time problems	K2
CO4	Application of circuits for interfacing and generation of waveforms	K3
CO5	Use of general purpose circuits to specific applications and Utility of devices in regulated supply for electronic circuits	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	1	1	1	-	2	-	-	-	-	-	1	2	1	1
CO2	3	2	1	2	-	2	-	-	-	-	-	1	3	3	1
CO3	3	3	3	2	-	-	-	-	-	-	-	2	3	3	1
CO4	3	2	3	2	-	-	-	-	-	-	-	2	3	2	2
CO5	2	2	3	2	-	2	-	-	-	-	-	2	2	2	2
22EP C408	3	2	2	2	-	2	-	-	-	-	-	2	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping

CO1	1.2.1, 1.3.1, 2.2.2, 2.2.4, 2.3.1, 2.4.4, 3.1.5, 3.1.6, 3.2.3, 4.1.2, 6.1.1, 12.1.1, 12.3.1,
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.3, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.4, 6.1.1, 12.1.1,
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.3.2, 2.4.1,2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.4, 4.2.1, 4.2.2, 12.1.1, 12.1.2, 12.2.1
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 3.1.2, 3.1.3, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.3, 4.2.1, 4.2.2, 4.3.1, 7.2.2, 12.2.1, 12.2.2, 12.3.2
CO5	1.1.1, 1.1.2, 1.3.1, 2.1.3, 2.2.2, 2.2.4, 2.3.1, 2.4.2, 3.1.2, 3.1.3, 3.1.4, 3.1.6, 3.3.1, 3.3.2, 3.4.2, 4.1.3, 4.2.1, 4.2.2, 4.3.1, 6.2.1, 7.1.1, 7.2.2, 12.2.1, 12.2.2, 12.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	30	30	-	-	100
CAT2	-	20	30	30	20	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	20	40	40	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	20	40	40	-	-	100
ESE	10	20	30	30	-	10	100

22EPC409	ELECTRICAL MACHINES-II	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
Concept of Electromechanical Energy Conversion	PC	3	0	0	3

Course Objectives	To acquire the knowledge of working principles and performance of rotating AC machinery and special machines.	
UNIT – I	**SYNCHRONOUS GENERATOR**	**(9 periods)**
Construction – Rotor types – emf equation – Synchronous reactance – Armature reaction-Voltage regulation – EMF, MMF, ZPF –Synchronizing and parallel operation – Synchronizing torque-Change of excitation and mechanical input – Two reaction theory – Determination of direct and quadrature axis synchronous reactance using slip test – Operating characteristics.		
UNIT – II	**SYNCHRONOUS MOTOR**	**(9 periods)**
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 - Necessity of Damper windings - Applications.		
UNIT – III	**THREE PHASE INDUCTION MOTOR**	**(10 periods)**
Construction – Principle –Rotor types – Slip – Equivalent circuit – Slip-torque characteristics - Condition for maximum torque – Losses and efficiency – Load test - No load and blocked rotor tests -Separation of no load losses – Double cage rotors – Induction generator – Synchronous induction motor. Types of starters – Rotor resistance, Autotransformer and Star-delta starters – Speed control - Voltage control, Frequency control and pole changing – Cascaded Connection-V/f control – Slip power recovery Scheme-Braking of three phase induction motor: Plugging, dynamic braking and regenerative braking.		
UNIT – IV	**SINGLE PHASE INDUCTION MOTOR AND STARTING METHOD**	**(9 periods)**
Constructional details of single phase induction motor – Double revolving field theory and operation – Equivalent circuit – No load and blocked rotor test – Performance analysis – Starting methods of single-phase induction motors - Shaded pole induction motor - Capacitor-start capacitor run induction motor.		
UNIT – V	**SPECIAL MACHINES**	**(8 periods)**
Linear induction motor - Hysteresis motor - AC series motor-Switched Reluctance Motor-Stepper motor –Permanent magnet A.C motor (BLDC and PMSM) (Qualitative treatment only)- Magnetic levitation.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOKS :

1	*Kothari D. P. and Nagrath I. J., "**Electric Machines**" Tata McGraw Hill, 5th Ed., 2017.*
2	*Fitzgerald A.E., Charles Kingsly C. Stephen D. Umans., "**Electric Machinery**" Tata McGrawHill, 6th Ed., 2013.*

REFERENCES :

1	*Sahdev, S. K.. "**Electrical Machines**", Cambridge University Press, United Kingdom, 2017.*
2	*Melkebeek, Jan A., "**Electrical Machines and Drives: Fundamentals and Advanced Modelling**", Springer International Publishing, Germany, 2018.*
3	*E.G. Janardanan, "**Special electrical machines**", PHI learning Private Limited, Delhi, 2014.*
4	*Ghosh, Smarajit, "**Electrical Machines**", Pearson Education India,, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the operating principle of rotating AC machines.	K2
CO2	Familiarize the characteristics of synchronous and induction machines.	K2
CO3	Apply the knowledge of Induction and Synchronous machines for specific applications	K3
CO4	Execute speed control and starting methods for various AC motors.	K3
CO5	Familiarize special electrical machines and their applications	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	2	-	-	-	-	-	-	2	2	3	2
CO2	3	3	3	3	3	-	-	-	-	-	-	2	2	3	3
CO3	3	3	3	2	2	-	-	-	-	-	-	1	3	3	3
CO4	3	3	3	2	2	-	-	-	-	-	-	2	1	3	1
CO5	3	3	3	2	2	-	-	-	-	-	-	1	1	2	3
22EPC409	3	3	3	2	2	-	-	-	-	-	-	2	2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.4,2.3.1,2.4.1,2.4.2,2.4.3,2.4.4, 3.1.1,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.4,4.2.1,4.3.1,4.3.3, 5.1.1,5.1.2,5.2.2,12.1.1,12.2.1, 12.2.2,12.3.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.2,2.4.1,2.4.2,2.4.3,3.1.1, 3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.2,4.1.2,4.1.4,4.2.1,4.3.1,4.3.2,4.3.3,5.1.2, 5.2.1,5.2.2,5.3.1,5.3.2,12.2.1,12.2.2,12.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3, 3.1.1,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.3,4.2.1,4.2.2,4.3.1,4.3.3,5.1.1, 5.2.2,5.3.1,12.2.2,12.3.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.4.1,2.4.2,2.4.3, 3.1.1,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.2,4.1.2,4.2.1,4.3.1,4.3.3,5.2.1,5.2.2, 5.3.1,12.1.1, 12.2.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3, 2.4.4,3.1.1,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.2.1,4.3.1,4.3.3, 5.2.1,5.2.2, 5.3.1,12.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	40	30	-	-	100
CAT2	10	30	30	30	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	50	40	10	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	40	40	20	-	100
ESE	10	20	30	40	-	-	100

22EPC410	POWER GENERATION, TRANSMISSION AND DISTRIBUTION	SEMESTER: IV

PREREQUISITES :	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To know the various components of Power Systems and design an electric power network in electrical and mechanical point of view.	
UNIT – I	**GENERATION OF ELECTRICAL ENERGY**	**(9 Periods)**
Structure of electric power system – Working and Site Selection of: Conventional Energy Generation- Thermal, Hydro, Pumped storage plant, Nuclear, Diesel and Gas turbine power plant- Non-Conventional Energy Generation- Wind, Tidal, Solar, GeoThermal, Biogas and Fuel Cell. Comparison of different types of power plants.		
UNIT – II	**TRANSMISSION LINE PARAMETERS AND DESIGN**	**(9 Periods)**
Types of conductor- conductor materials, Line Resistance, inductance and capacitance of solid, stranded and bundled conductors-configuration –Symmetrical and unsymmetrical spacing – Transposition of lines – Concept of GMR and GMD –Skin and proximity effect – Interference with neighboring communication circuits. Mechanical design of transmission line-Line supports- Sag and tension calculations considering the effect of ice and wind loading-stringing chart		
UNIT – III	**MODELLING AND PERFORMANCE OF TRANSMISSION LINES**	**(9 Periods)**
Classification of Transmission lines-regulation and efficiency-short Transmission lines effect of load power factor on transmission efficiency and regulation of line-Medium Transmission line: end condenser method, nominal-T and π methods. Ferranti effect-Long Transmission line: Analysis by Rigorous method, Surge Impedance Loading- Power flow through a Transmission line- Concept of Power circle diagram- Corona: Phenomenon-Corona loss –methods of reducing Corona		
UNIT – IV	**LINE INSULATORS AND POWER CABLES**	**(9 Periods)**
Insulator materials-types of insulators- potential distribution across string of suspension insulators- string efficiency and methods of improving string efficiency. Cables: general construction of cables-insulation resistance of power cables-capacitance and insulation stress in cables, sheathing-grading of cables, tan δ and power factor- heating of cable-breakdown of cables.		
UNIT – V	**SUBSTATION AND DISTRIBUTION SYSTEM**	**(9 Periods)**
Substation: Classification-Bus-Bar Arrangements in substation. Distribution system: Design consideration-classification of DS. DC distributor fed at one end, both ends, ring main- 3-wire DC distribution system A.C. Distribution: A.C. Distributors with concentrated loads- 3-phase 4-wire star connected load circuits- consequence of disconnecting neutral in a 3-phase 4- wire system.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*S.N.Singh "**Electric Power Generation, Transmission and Distribution**" Prentice Hall of India Pvt.Ltd, New Delhi, second edition, 2011.*
2	*D.P.Kothari and I.J.Nagrath, "**Power System Engineering**", 2nd edition, Tata McGraw Hill, Third edition, 2019*
3	*C.L.Wadwa, "**Electrical Power Systems**", New Age International, Seventh Edition, 2022.*

REFERENCES :

1	*J.B.Gupta, **"Transmission and Distribution of Electrical Power"**, S.R.Kataria & Sons, 2014*
2	*Luces M. Fualkenberry, Walter Coffer, **"Electrical Power Distribution and Transmission"**, Pearson Education, 2007*
3	*A. Chakrabarti, Soni Ml, P. V. Gupta, U.S. Bhatnagar, **"A Text Book On Power System Engineering"** , Dhanpat Rai Publishing Company, 2008.*
4	*Mehta V.K., Rohit Mehta.,**"Principles of Power Systems"**, S.Chand and Co., 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the structure of the power system and different energy sources.	K2
CO2	Evaluate the parameters of the transmission line for different configurations.	K4
CO3	Develop a model and assess the performance of overhead lines.	K3
CO4	Classify different types of distribution systems and evaluate the performance of the Distribution network.	K5
CO5	Analyze transmission and distribution network with respect to electrical and mechanical aspects.	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	2	2	3	3	-	-	-	-	-	2	1	-	-
CO2	3	3	2	2	3	3	-	-	-	-	-	2	2	2	-
CO3	3	3	2	2	3	3	-	-	-	-	-	2	2	2	2
CO4	3	3	2	2	3	3	-	-	-	-	-	2	2	2	-
CO5	3	3	2	2	3	3	-	-	-	-	-	2	2	2	-
22EPC410	3	3	2	2	3	3	-	-	-	-	-	2	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 12.1.1, 12.1.2, 12.2.1
CO2	1.1.2, 1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 12.1.1, 12.1.2, 12.2.1
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.4, 3.1.5, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.4, 4.2.2, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 12.1.1, 12.1.2, 12.2.1
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.4, 3.1.5, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.4, 4.2.2, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 12.1.1, 12.1.2, 12.2.1
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.4, 3.1.5, 3.1.6, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.4, 4.2.2, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 12.1.1, 12.1.2, 12.2.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	25	40	25	-	-	100
CAT2	10	20	40	30	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	40	30	30	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	35	35	30	-	100
ESE	10	20	35	25	10	-	100

22EPC411	PRINCIPLES OF SIGNALS AND SYSTEMS	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To understand the basic properties of signal and systems and characterization of systems in time and frequency domains and to analyze continuous, linear time-invariant systems using state variable formulation and solve the resulting state equations.	
UNIT – I	**CLASSIFICATION OF SIGNALS AND SYSTEMS**	**(9 Periods)**
Standard signals : Step – Ramp –Pulse –Impulse – Sinusoids –Classification of signals : Continuous time (CT) and Discrete Time (DT) signals–Periodic and Aperiodic signals – Deterministic and Random signals –Energy and Power signals –Classification of systems :CT systems and DT systems –Linear and Nonlinear –Time-variant and Time-invariant –Causal and Non-causal –Stable and Unstable.		
UNIT – II	**ANALYSIS OF CONTINUOUS TIME SIGNALS**	**(9 Periods)**
Fourier series : Spectrum of Continuous Time signals – Properties -Fourier transform: continuous time aperiodic signals and periodic signals- properties– Fourier and Laplace Transform in signals Analysis		
UNIT – III	**LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS**	**(9 Periods)**
Differential Equation :CT system representations– Frequency response of systems characterized by Differential Equations -Block diagram representation – Impulse response, convolution integrals – State space representation		
UNIT – IV	**ANALYSIS OF DISCRETE TIME SIGNALS**	**(9 Periods)**
Z transforms – Properties - Inverse Z transforms - Initial and final value theorems - Convolution theorem Baseband Sampling of CT signals – Aliasing, Reconstruction of signal from DT signal, Discrete Time Fourier series representation of DT periodic signals – Properties – Representation of DT aperiodic signals by Discrete Time Fourier Transform (DTFT) – Fast Fourier Transform (FFT)– Properties		
UNIT – V	**LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS**	**(9 Periods)**
Difference Equations – Block diagram representation – Impulse response – Convolution sum – DTFT and Z Transform analysis of Recursive and Non-Recursive systems – Frequency response of systems characterized by Difference Equations – State space representation		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOKS:

1	*Alan V. Oppenheim, Alan S. Willsky and S. Hamid Nawab, "**Signals and Systems**", Pearson Publication, 2015*
2	*Simon Haykin and Barry Van Veeh, "**Signals and Systems**", Wiley India, New Delhi, 2021*

REFERENCES :

1	*H P Hsu, Rakesh Ranjan, "**Signals and Systems**", Schaum's Outlines, Tata McGraw Hill, 7th Reprint, 2010*
2	*John Alan Stuller, "**An Introduction to Signals and Systems**", Thomson, 2008*
3	*Edward W Kamen & Bonnie's Heck, "**Fundamentals of Signals and Systems**",Pearson Education, 2007.*
4	*Rodger E. Ziemer, William H. Tranter, D. Ronald Fannin. "**Signals & systems**", Fourth Edition, Pearson Education, 2002.*
5	*S.Salivahanan, A. Vallavaraj, C. Gnanapriya, "**Digital Signal Processing**", McGraw Hill International/TMH, 2007.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire knowledge about various test signals	K2
CO2	Investigate properties of signals and corresponding systems	K4
CO3	Review of mathematical concepts for analyzing systems	K2
CO4	Analyze continuous and discrete time signals in frequency domain	K4
CO5	Modelling of time invariant systems using different methodologies	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
CO2	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
CO3	3	3	2	2	3	-	-	-	3	1	1	-	3	3	2
CO4	3	3	2	2	3	-	-	-	3	1	1	-	3	3	2
CO5	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3
22EPC 411	3	3	2	2	3	-	-	-	3	1	1	-	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping		
CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1	
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1	
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1	
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1	
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1	

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	30	20	-	-	100
CAT2	20	25	35	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	25	25	25	25	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	25	25	25	25	-	-	100
ESE	25	25	20	30	-	-	100

22EPC412	ELECTRICAL AND ELECTRONIC MEASUREMENTS	SEMESTER IV

PREREQUISITES :	CATEGORY	L	T	P	C
NIL	PC	3	0	2	4

Course Objectives	To learn the construction, operation and its importance of instruments in measurements and provide practical experience to supplement the theoretical knowledge gained in the field of measurements.	
UNIT – I	**MEASUREMENTS OF ELECTRICAL QUANTITIES AND ERROR ANALYSIS**	**(9 Periods)**
Functional elements of Instruments, -Standards and calibrations - Principle of operation of permanent magnet moving coil, moving iron, dynamometer, induction, thermal and rectifier instruments - Extension of instrument ranges Limiting errors of instruments - Combination of limiting errors – Gross, systematic and random errors in measurements - Statistical analysis of errors		
UNIT – II	**MEASUREMENTS USING BRIDGES**	**(9 Periods)**
Wheatstone, Kelvin, Wein, Hay's, Maxwell, Anderson and Schering bridges - Q meter - Measurement of self and mutual inductances - Wagner earthing device - Megger.		
UNIT – III	**MEASUREMENTS OF MAGNETIC QUANTITIES AND INSTRUMENT TRANSFORMERS**	**(9 Periods)**
Flux meters – B-H curve and permeability measurements on ring and bar specimens – Iron loss measurement by magnetic squares – Instrument transformers - types and errors - Instruments for measurement of frequency and power factor - maximum demand Indicator		
UNIT – IV	**ELECTRONIC INSTRUMENTATION**	**(9 Periods)**
Sensors and Transducers – Signal Conditioning - Digital voltmeter – DMM – Digital Clamp meter - True RMS meter - Standard signal generators - Function generator - Spectrum analyzer - Power Quality analyzer- Introduction to virtual Instrumentation		
UNIT – V	**DISPLAY DEVICES AND RECORDERS**	**(9 Periods)**
Digital storage oscilloscope – Active and passive probes - Errors in measurement – calibration of probes - Seven segment display – Dot matrix, LED, LCD - Concepts of Smart meters – Net metering - Data logger.		
LIST OF EXPERIMENTS		**(30 Periods)**
1. Calibration of Ammeter, Voltmeter, Wattmeter and Energy meter. 2. Measurement of High Resistance by Loss of Charge method. 3. Burden Characteristics of Current Transformers. 4. Measurement of Sequence Impedances of Synchronous Machines. 5. Instrumentation Amplifier. 6. Study of DSO. 7. Study of smart meter and data logging. 8. Creating Virtual Instrumentation for simple applications.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 30 Periods Total: 75 Periods**		

TEXT BOOKS :

1	*Sawhney A.K., "**A Course in Electrical and Electronics Measurements and Instrumentation**" DhanpatRai & Sons, 19th edition 2015*
2	*David A Bell, "**Electronic Instrumentation and Measurements**", Third Edition, Ox for University Press, 2013*

REFERENCES:

1	*Golding E.W. and Widdis F.G., **"Electrical Measurements and Measuring Instruments"**, A.H. Wheeler & Co., Ahmedabad , 2003*
2	*A.D. Helfrick and W.D. Cooper, **"Modern Electronic Instrumentation and Measurement Techniques"**, Prentice Hall India Private Ltd., New Delhi, 2010*
3	*H.S. Kalsi, **"Electronic Instrumentation"**, Tata McGraw-Hill, New Delhi, 2010.*
4	*Jovitha Jerome **"Virtual Instrumentation Using LabVIEW"** PHI Learning Pvt. Ltd 1st Ed., 2010*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the standards, characteristics and errors of measurements	K2
CO2	Demonstrate the operation of electrical and electronics measuring instruments	K3
CO3	Identify the kind of instrument for measurement of different quantities.	K3
CO4	Test and measure electrical and electronic parameters using instruments.	K4
CO5	Analyse and calculate all the parameters related to measurements	K4

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	2	1	2	1	2	1	-	-	2	3	3	3
CO2	3	3	3	2	2	-	-	-	1	-	-	-0	3	2	2
CO3	3	2	2	2	2	-	-	-	1	-	-	1	3	3	2
CO4	3	3	3	3	3	2	2	2	2	-	-	2	3	3	3
CO5	3	3	3	3	2	-	1	2	1	-	-	2	3	3	3
22EPC412	3	3	3	2	2	2	1	2	1	-	-	2	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping		
CO1	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.3,2.2.2,2.3.1,2.3.2,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.3,4.1.2,4.1.3,4.1.4,4.2.2,4.3.2,5.3.1,5.3.2,6.2.1,7.1.2,8.1.1,8.2.1,9.2.1,12.2.1,12.2.2,12.3.1,12.3.2	
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.5,3.1.6,3.2.1,3.2.3,3.3.1,3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,5.1.1,5.1.2,5.2.1,9.2.1,	
CO3	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.4,2.3.1,2.3.2,2.4.3,3.1.2,3.1.3,3.1.4,3.1.6,3.2.1,3.2.3,3.3.1,3.3.2,3.4.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,5.1.1,5.1.2,5.2.1,5.2.2,9.2.1,12.1.2	
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.2,6.2.1,7.1.1,7.1.2,8.1.1,8.2.1,9.1.1,9.1.2,9.2.1,9.3.1,12.1.2,12.2.2,12.3.2	
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.3,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,5.1.1,5.1.2,5.2.1,7.1.1,8.1.1,8.2.1,9.2.1,9.3.1,12.1.2,12.2.2,12.3.2	

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	40	30	20	-	-	100
CAT2	10	40	30	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	40	20	10	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	-	40	30	-	100
ESE	10	40	30	20	-	-	100

22EES408	ENGINEERING EXPLORATION	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	0	0	3	1.5

Course Objectives	The objective of the course is to provide an introduction to the engineering field. It is designed to help the student to learn about engineering and how it is useful in our everyday life.	
UNIT – I	**INTRODUCTION**	**(15 periods)**
Introduction to Engineering and Engineering study: Difference between science and engineering, scientist and engineer needs and wants, various disciplines of engineering, some misconceptions of engineering, expectation for the 21st century engineer and Graduate Attributes.		
UNIT – II	**ENGINEERING DESIGN**	**(15 periods)**
Engineering Requirement, Knowledge within Engineering disciplines, Engineering advancements, Problem definition, Idea generation through brain storming and researching, solution creation through evaluating and communicating, text/analysis, final solution and design improvement.		
UNIT – III	**ENGINEERING DISCIPLINES**	**(15 periods)**
Reading analog multimeter, measuring current, voltage and resistance, electricity from chemicals, solar cells, magnets. Ohms law and Watts law, circuit identification and circuit calculation, resister colour code, continuity.		
Contact Periods: **Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods**		

REFERENCES :

1	*Ryan A Brown, Joshua W. Brown and Michael Berkihiser: "**Engineering Fundamentals: Design, Principles, and Careers**", Goodheart-Willcox Publisher, Second edition, 2014.*
2	*Saeed Moaveni, "**Engineering Fundamentals: An Introducton to Engineering**", Cengage learning, Fourth Edition, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain technological and engineering development , change and impacts of engineering	K2
CO2	Complete initial steps (Define a problem list criteria and constrains , Brainstorm potential solutions and document ideas) in engineering designs	K3
CO3	Communicate possible solutions through drawings and prepare project report.	K3
CO4	Draw sketches to a Design problem.	K3
CO5	Apply the concept of engineering fundamentals in Civil, Mechanical, Electrical and Computer Engineering.	K3

COURSE ARTICULATION MATRIX

a)CO/PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	1	3	1	2	-	1	2	1	1	1	2	1	1
CO2	2	-	1	3	1	2	-	1	2	1	1	1	2	1	1
CO3	2	-	1	3	1	2	-	1	2	1	1	1	2	1	-
CO4	2	-	1	3	1	2	-	1	2	1	1	1	2	1	1
CO5	2	-	1	3	1	2	-	1	2	1	1	1	2	1	1
22EES408	2	-	1	3	1	2	-	1	2	1	1	1	2	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators mapping

CO1	1.2.1, 1.3.1, 3.1.1, 3.1.4, 3.1.6, 4.1.1, 4.1.3, 4.1.4, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 6.2.1, 8.1.1, 9.1.1, 9.2.2, 9.2.3, 9.3.1, 10.1.2, 10.1.3, 11.3.1, 12.1.2, 12.3.1
CO2	1.2.1, 1.3.1, 3.1.1, 3.1.4, 3.1.6, 4.1.1, 4.1.3, 4.1.4, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 6.2.1, 8.1.1, 9.1.1, 9.2.2, 9.2.3, 9.3.1, 10.1.2, 10.1.3, 11.3.1, 12.1.2, 12.3.1
CO3	1.2.1, 1.3.1, 3.1.1, 3.1.4, 3.1.6, 4.1.1, 4.1.3, 4.1.4, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 6.2.1, 8.1.1, 9.1.1, 9.2.2, 9.2.3, 9.3.1, 10.1.2, 10.1.3, 11.3.1, 12.1.2, 12.3.1
CO4	1.2.1, 1.3.1, 3.1.1, 3.1.4, 3.1.6, 4.1.1, 4.1.3, 4.1.4, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 6.2.1, 8.1.1, 9.1.1, 9.2.2, 9.2.3, 9.3.1, 10.1.2, 10.1.3, 11.3.1, 12.1.2, 12.3.1
CO5	1.2.1, 1.3.1, 3.1.1, 3.1.4, 3.1.6, 4.1.1, 4.1.3, 4.1.4, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 6.2.1, 8.1.1, 9.1.1, 9.2.2, 9.2.3, 9.3.1, 10.1.2, 10.1.3, 11.3.1, 12.1.2, 12.3.1

22EPC413	ANALOG CIRCUITS AND DIGITAL IC LABORATORY	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
Electron Devices and circuits, Digital circuits	PC	0	0	3	1.5

Course Objectives	To illustrate the different electronic circuits and their application in practice. To get practice in doing projects related to analog and digital systems.

LIST OF EXPERIMENTS:

1. Design of Rectifier for Filters.
2. Design of Oscillator circuits.
3. Design of Transistor amplifiers.
4. Instrumentation amplifier.
5. Applications of Operational Amplifiers.
6. Realization of a V-to-I & I-to-V converter using Op-Amps.
7. A/D and D/A Converters.
8. Study of VCO and PLL ICs.
9. Simulation of above circuits using software packages.
10. Design of Logic and Arithmetic Circuits.
11. Design of Registers ,Counters.
13. Multiplexer and Demultiplexer, Encoder and Decoder.
14. Synchronous / Asynchronous circuit design.
16. PAL / PLA implementation.
17. Design Entry and simulation of combinational and Sequential logic circuits (4 bit adders, Sequential Counter) using HDL.

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Test various waveform generation circuits using Op Amps, Comparators and IC 's	K4
CO2	Realize the electronic circuit depends on applications	K3
CO3	Design and test various digital logic circuits.	K3
CO4	Build and debug analog and digital circuits implemented on breadboards	K4
CO5	Develop and demonstrate troubleshooting ability in real time applications	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	3	-	1	-	-	-	-	-	3	3	2
CO2	3	3	3	2	2	2	-	-	-	-	-	2	3	3	3
CO3	3	3	3	2	2	-	-	-	-	-	-	2	3	3	3
CO4	3	2	2	3	2	-	-	-	-	-	-	-	2	3	2
CO5	2	2	2	3	2	2	2	-	-	-	-	2	2	3	2
22EPC413	3	3	2	3	2	2	2	-	-	-	-	2	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.3,3.1.1,3.1.6,3.2.1,3.2.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.2.2,4.3.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,7.1.1
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.4,3.1.1,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.4,4.2.1,4.2.2,4.3.1,5.1.2,5.2.1,5.3.2,6.1.1,12.1.2,12.2.2,12.3.1
CO3	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.4,3.1.1,3.1.3,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.4,4.2.1,4.2.2,4.3.1,5.1.2,5.2.1,5.3.2,12.1.2,12.2.2,12.3.1
CO4	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.4.2,2.4.3,3.1.1,3.1.3,3.1.5,3.1.6,3.2.3,3.3.1,3.3.2,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.2.2,4.3.1,4.3.2,4.3.4,5.1.2,5.2.1,5.2.2,5.3.1
CO5	1.1.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.4.2,2.4.3,3.1.1,3.1.3,3.1.5,3.1.6,3.2.3,3.3.1,3.3.2,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.3.1,4.3.2,4.3.4,5.1.2,5.2.1,5.2.2,5.3.1,6.1.1,7.1.1,7.2.1,12.1.2,12.2.2,12.3.1

22EPC414	ELECTRICAL MACHINES LABORATORY – II	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objectives	To provide hands-on training for evaluating the performance and characteristics of AC Machines and to identify the suitability of its applications.

LIST OF EXPERIMENTS:

1. Regulation of Alternator by EMF and MMF Methods.
2. Load test on three phase Alternator.
3. Regulation of salient pole Alternator by Slip Test.
4. Regulation of Alternator by ZPF method.
5. V and Inverted V curves of Synchronous Motor.
6. Equivalent Circuit of three phase Induction Motor.
7. Load Test on three phase Induction Motor.
8. Load Test and V curves of Synchronous Induction motor.
9. Performance characteristics of three phase Induction Motor by Circle Diagram.
10. Load Test on single phase Induction Motor.
11. Speed control of Slip Ring Induction Motor.
12. Study of different types of starters for Induction Motors.
13. Load test on three phase induction motor with eddy current loading.
14. Analysis of electromagnet parameters such as Electromagnetic force and Electromagnetic Induction using simulation softwares.

Contact Periods:
Lecture: 0 Periods **Tutorial:0 Periods** **Practical: 45 Periods** **Total: 45 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the performance characteristics of different types of AC Machines.	K2
CO2	Suggest suitable test for performance determination of Rotating AC Machines.	K3
CO3	Analyze and evaluate the performance of A.C. rotating machines.	K5
CO4	Identify suitable speed control methods for rotating machines.	K2
CO5	Evaluate the electrical apparatus to identify the suitability for different applications.	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	1	2	1	1	1	-	-	2	3	2	1
CO2	3	2	1	2	1	2	1	-	1	-	-	2	2	2	3
CO3	2	2	2	2	2	-	2	1	-	-	-	1	2	3	2
CO4	2	2	2	3	1	2	1	-	1	-	-	2	1	2	3
CO5	3	2	2	2	1	-	3	1	-	-	-	1	2	3	2
22EPC 414	3	2	2	3	2	2	2	1	1	-	-	2	2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.3.1,2.1.2,2.2.1,2.2.4,2.3.1,2.4.2,2.4.4,3.1.1,3.1.3,3.1.5,3.2.1,3.2.2,3.2.3,3.3.2,4.1.1,4.2.1,4.3.1,4.3.2,4.3.3,5.1.1,5.2.2,6.2.1,7.1.2,8.1.1,9.2.2,12.1.1,12.2.1,12.3.1,
CO2	1.1.2,1.2.1,1.3.1,1.4.1,2.1.3,2.2.3,2.3.1,2.4.1,2.4.2,2.4.3,3.1.2,3.3.1,3.4.2,4.1.3,4.2.1,4.2.2,4.3.1,4.3.3,5.3.1,6.1.1,7.2.1,9.1.1,12.2.1,12.3.1,12.3.2,
CO3	1.1.1,1.3.1,2.1.1,2.2.1,2.2.2,2.4.2,2.4.4,3.1.1,3.1.4,3.1.6,3.2.2,3.3.2,3.4.1,4.1.1,4.1.4,4.3.1,4.3.4,5.1.2,5.2.2,5.3.2,7.1.2,7.2.1,8.1.1,12.1.2,12.2.2,
CO4	1.1.2,1.4.1,2.1.1,2.1.2,2.2.2,2.2.4,2.3.1,2.4.1,2.4.2,2.4.3,3.1.2,3.1.4,3.2.1,3.2.3,3.3.2,3.4.2,4.1.2,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,5.1.1,5.3.1,6.2.1,7.2.1,9.2.1,12.1.1,12.2.2,12.3.2,
CO5	1.1.1,1.2.1,1.3.1,1.4.1,2.1.2,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.2,2.4.4,3.1.2,3.1.4,3.1.5,3.2.1,3.3.1,3.4.1,4.1.4,4.2.2,4.3.3,5.2.1,5.3.2,7.1.1,7.2.1,7.2.2,8.2.1,12.1.1,12.3.1,

V SEMESTER

22EES509	CONTROL SYSTEMS	SEMESTER V

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	3	1	0	4

Course Objectives	To understand the different ways of system representations, to assess the system dynamics and to design appropriate controllers and compensators.	
UNIT – I	**CONTROL SYSTEM MODELING**	**(9+3) Periods**
Basic Elements of Control System - Open loop and Closed loop systems - Transfer function models of linear time - invariant systems - Modelling of Electric systems, Mechanical systems - Block diagram reduction Techniques - Signal flow graph		
UNIT – II	**TIME DOMAIN ANALYSIS**	**(9+3) Periods**
Transient response-steady state response-Measures of performance of the standard first order and second order system-effect on an additional zero and an additional pole-steady error constant and system- type number.		
UNIT – III	**FREQUENCY DOMAIN ANALYSIS**	**(9+3) Periods**
Relationship between time and frequency response, Bode plots, Polar plots, Nichols chart, Nyquist plot - gain and phase margin, Construction of M&N circles - Closed loop frequency response.		
UNIT – IV	**DESIGN OF FEEDBACK CONTROL SYSTEM**	**(9+3) Periods**
Design specifications - Lead, Lag and Lag-lead compensators using Root Locus and Bode Plot techniques - PID controller- PR controller - Design using reaction curve and Zeigler-Nichols technique - PID control in State Feedback form.		
UNIT – V	**STATE SPACE ANALYSIS OF CONTINUOUS SYSTEMS**	**(9+3) Periods**
Concepts of state variables - State space model – Decomposition of transfer function – Canonical state model – Transfer function from state model – Solution of state equations – State transition matrix – Eigen values - Eigen vectors - Concept of Controllability and Observability.		
Contact Periods: **Lecture:45 Periods** **Tutorial:15 Periods** **Practical: 0 Periods** **Total: 60 Periods**		

TEXT BOOK:

1	Nagarath, I.J. and Gopal, M., "Control Systems Engineering",Nagarath, I.J. and Gopal, M., New Age International Publishers, 2017.
2	S.K. Bhattacharya, "Control Systems Engineering", Sheffield Hallam University, 2017.

REFERENCES:

1	*Nise, Norman S., "**Control systems engineering**", Wiley, 2020.*
2	*B.C. Kuo& Farid Golnaraghi, "**Automatic Control System**", McGraw Hill, 2018.*
3	*S. Salivahanan, "**Control Systems Engineering**", Pearson, India, 2015.*
4	*Manke, B. S, "**Control System Design**", Mercury Learning & Information, 2017.*
5	*K. Ogata, "**Modern Control Engineering**", 5th edition, PHI, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	**Model** linear-time-invariant systems using transfer function and state space forms.	K3
CO2	**Compare** various feedback control strategies.	K2
CO3	**Analyze** the system stability in time-domain and frequency domain.	K4
CO4	**Apply and Design** different types of compensators for time-domain and frequency domain specifications.	K5
CO5	**Evaluate** the system stability using the state space model.	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs /POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	2	-	-	-	-	-	-	2	2	3	3
CO2	3	3	2	3	2	-	-	-	-	-	-	2	2	2	3
CO3	3	3	3	3	2	-	-	-	-	-	-	2	3	3	2
CO4	3	3	3	3	2	-	-	-	-	-	-	3	3	3	3
CO5	3	3	3	3	3	-	-	-	-	-	-	3	3	3	3
22EES 509	3	3	3	3	2	-	-	-	-	-	-	2	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.4,2.3.1,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.1,5.1.1,5.1.2,5.3.2,12.1.1,12.2.1,12.2.2,12.3.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.2,2.4.1,2.4.2,2.4.3,3.1.1,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.1,5.1.1,5.1.2,5.2.1,5.3.1,12.1.1,12.2.1,12.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,3.1.1,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,5.1.1,5.1.2,5.2.1,5.2.2,12.1.1,12.2.1,12.2.2,12.3.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.4.1,2.4.2,2.4.3,3.1.1,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.1,4.3.3,5.1.1,5.1.2,5.2.1,5.3.1,12.1.1,12.2.1,12.2.2,12.3.1,12.3.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.3,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,12.1.1,12.2.1,12.2.2,12.3.1,12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	20	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	20	-	100
ESE	20	30	30	20	-	-	100

22EPC515	MICROPROCESSORS, MICROCONTROLLERS AND APPLICATIONS	SEMESTER V

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	1	0	4

Course Objectives	Tolearn the basic concepts of microprocessor and microcontroller hardware and assembly language programming and to demonstrate interfacing techniques and applications.	
UNIT – I	**8085 AND ARM ARCHITECTURE**	**9 Periods**
Architecture and Addressing modes of 8085 processors - Instruction set of 8085 - ARM architecture – ARM organization and implementation – The ARM instruction set - Basic ARM Assembly language program.		
UNIT – II	**PIC18 MICROCONTROLLER FRAMEWORK**	**9 Periods**
Architecture - Instruction set - Memory organizations - Register file structure - CPU registers - Addressing modes - Assembly language programming.		
UNIT – III	**REAL TIME CONTROL**	**9 Periods**
Timers –Prescaler and generating a large time delay- Timer 0,1,2,3 and Counter programming – PWM Generation - Interrupts-Interrupt Service Routine-Sources of interrupts – Programming timer interrupts, external hardware interrupts, serial communication interrupt – Interrupt priority.		
UNIT – IV	**PERIPHERALS OF PIC MICROCONTROLLER**	**9 Periods**
ADC characteristics- ADC programming in PIC – DAC interfacing – Sensor interfacing and signal conditioning – Basics of serial communication – PIC connection to RS232 – Serial port programming		
UNIT – V	**ARM AND MICROCONTROLLER APPLICATIONS**	**9 Periods**
MICROCONTROLLER APPLICATIONS: LEDs, push buttons, relays and latch connection - Keyboard interfacing-interfacing 7 segment displays – LCD interfacing - ADC/DAC Interfacing - Measurement applications - Automation and control applications. **ARM APPLICATIONS**: Smart phones, Set top boxes, digital television, digital cameras.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

TEXT BOOK (Maximum 2):

1	*Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey, "**PIC Microcontroller and Embedded Systems – Using Assembly and C for PIC18**", Pearson International 2nd Edition, 2021.*
2	*SteaveFurber,**"ARM system – on – chip architecture"**,Addison Wesley, 2nd Edition,2001*

REFERENCES (Minimum 4 and Maximum 6):

1	*Ramesh. S. Gaonkar, "**Microprocessor Architecture, Programming and Applications of 8085**", Penram International Pvt. Ltd., 2004*
2	*Muhammad AliMazidi, Janice GillispieMazidi, Rolin D. M CKinlay "**The 8051 Microcontroller and Embedded Systems**", Second Ed., Pearson Education 2009*
3	*Deshmhmukh L M, "**Microcontrollers (Theory and applications)**", Tata McGraw-Hill Publishing Co. Ltd, New Delhi, 2008*
4	*Vijayendran.V, "**Fundamentals of Microprocessor-8085: Architecture, Programming & Interface**", Vijay Nicole Pvt. Ltd, 2004*
5	*John Crisp, "**Introduction to Microprocessors and Microcontrollers**", Newnes publications (Imprint of Elsevier), 2nd Ed., 2004*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explore the architecture of 8085, ARM and PIC microcontrollers.	K2
CO2	Illustrate the File Registers, Memory and employ assembly language programming	K2
CO3	Create interface between digital system and input/output devices	K2
CO4	Design and develop microcontroller based real-time applications	K3
CO5	Design and Develop skill in simple program writing for 8085, ARM and PIC microcontroller-based control applications	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	1	2	2	-	-	-	-	-	1	2	1	1
CO2	2	3	1	2	2	2	-	-	-	-	-	1	3	3	1
CO3	3	3	3	2	0	0	-	-	-	-	-	2	3	3	1
CO4	3	2	3	2	0	0	-	-	-	-	-	2	3	2	2
CO5	3	1	3	2	2	2	-	-	-	-	-	2	2	2	2
22EPC515	3	2	2	2	2	2	-	-	-	-	-	2	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.3.1, 2.1.1, 2.1.1, 2.2.2,2.2.4, 2.3.1, 2.4.4, 3.1.6, 3.2.3, 4.2.2, 4.3.1, 5.1.1, 5.1.2, 5.2.1, 5.3.2, 6.1.1, 12.1.1, 12.3.1
CO2	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.4, 4.2.2, 4.3.1, 5.1.1, 5.1.2, 5.2.1, 5.3.2, 6.1.1, 12.1.1
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.3,2.2.4, 2.3.1, 2.3.2, 2.4.1,2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.4, 4.2.1, 4.2.2, 12.1.1, 12.1.2, 12.2.1
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.4, 2.3.2, 2.4.1, 2.4.2, 3.1.2, 3.1.3, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 12.2.1, 12.2.2, 12.3.2
CO5	1.1.1, 1.1.2, 1.3.1, 2.1.3, 2.2.2, 2.2.4, 2.3.1, 2.4.2, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.2, 4.1.3, 4.2.1, 4.2.2, 4.3.1, 5.1.1, 5.1.2, 6.2.1, 7.1.1, 7.2.2, 8.1.1, 12.2.1, 12.2.2, 12.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	40	40	10	-	-	100
CAT2	10	40	40	10	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	20	40	40	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	20	40	40	-	-	100
ESE	10	40	40	10	-	-	100

22EPC516	POWER ELECTRONICS	SEMESTER V

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To learn about the operation of different types of power semiconductor devices and circuits and identify the more efficient circuit for specific applications.	
UNIT – I	**POWER SEMICONDUCTOR DEVICES**	**9 Periods**
Basic structure and switching characteristics of Power diode - Power transistor - SCR- TRIAC – GTO - MOSFET and IGBT- Ratings of SCR - Series Parallel operation of SCR - di/dt and dv/dt protection - Gate driving circuits - Introduction to wide bandgap devices.		
UNIT –II	**CONTROLLED RECTIFIERS**	**9 Periods**
Operation and analysis of 1Φ half and fully controlled rectifiers with R- RL and RLE load (Fully controlled and Half controlled) and analysis of rectifiers - Operation of 3Φ Half and Fully controlled Rectifier with R and RL loads - Operation of Vienna Rectifiers-Effect of source impedance in 1Φ and 3Φ Full converters - 1Φ and 3Φ Dual Converters.		
UNIT – III	**DC CHOPPERS**	**9 Periods**
Classification and operation of different types of choppers - Control strategies – Forced commutation- Operation of voltage, current and load commutated choppers - Cuk and SEPIC converters - SMPS.		
UNIT – IV	**INVERTERS**	**9 Periods**
Types of inverters - Operation of 1Φ - 3Φ bridge inverters (120 and 180 degree modes) – Current Source Inverter - 1Φ ASCSI, 1Φ and 3Φ PWM inverters – types of PWM (single pulse, multiple pulse and sine PWM) - Modulation Index-Fourier analysis of PWM inverter output voltage. Introduction to Multilevel inverter – Types – Operation – Applications.		
UNIT – V	**AC VOLTAGE CONTROLLERS**	**9 Periods**
Types of control (Phase and Integrated cycle control) - Operation of 1Φ voltage regulator with R- RL loads - Operation of 3Φ AC voltage controller with R load - 1Φ step up and step down cyclo converters - Concept of matrix converter		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK :

1	*Muhammad H. Rashid "**Power Electronics - Circuits- Devices and Applications**" Prentice Hall of India- New Delhi- Fourth Ed.- 2014*
2	*Ned Mohan "**Power Electronics-Converter Applications and Design Wiley**", 3rd Ed., Reprint 2009.*
3	*Dr. P.S.Bhimbra "**Power Electronics**" Khanna Publishers, 5th Ed., Reprint 2014*

REFERENCES :

1	*Singh. M.D and Khanchandani. K.B "**Power Electronics**" Tata McGraw Hill Publishing Co. Ltd,New Delhi- 3rd Reprint 2012*
2	*Dubey- G.K., Doradla.S.R., Joshi.A., Sinha.R.M.K- "**Thyristorised Power Controllers**"- New Age International Publishers Ltd.-1st Ed., Reprint 2012*
3	*Vedam Subramaniam- "**Power Electronics**"- New Age International (P) Publishers Ltd. - 2nd Ed., Reprint, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Acquire knowledge about fundamental concepts and techniques used in power electronics.	K2
CO2	Illustrate and compare performance of various power semiconductor devices and switching circuits	K3
CO3	Demonstrate the operation of power electronic converters.	K2
CO4	Select suitable devices by assessing the circuits for various applications.	K4
CO5	Analyze and evaluate the performance of a power electronic circuit.	K5

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	2	1	1	-	-	-	1	2	3	2
CO2	3	2	2	2	1	2	2	-	-	-	-	2	3	2	1
CO3	3	2	2	2	1	-	-	1	-	-	-	1	1	3	2
CO4	3	2	1	2	2	3	1	1	-	-	-	2	3	1	2
CO5	2	3	2	2	2	-	2	-	-	-	-	1	2	1	3
22EPC516	3	3	2	3	2	3	2	1	-	-	-	1	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,2.1.2,2.1.3,2.2.1,2.2.3,2.2.4,2.3.1,2.4.1,2.4.2,2.4.4,3.1.1,3.1.3,3.1.5,3.1.6,3.2.2,3.3.2,4.1.1,4.1.3,4.2.1,4.3.3,5.1.1,5.2.1,5.3.1,5.3.2,6.2.1,7.2.2,8.2.1,12.3.1,
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.4.1,2.4.3,3.1.2,3.1.4,3.2.1,3.3.1,3.4.2,4.1.3,4.1.4,4.3.1,4.3.3,5.2.1,5.3.1,6.1.1,7.1.1,7.2.1,12.1.2,12.2.1,12.3.1,
CO3	1.1.1,1.1.2,1.2.1,1.3.1,2.1.1,2.1.3,2.2.1,2.2.2,2.3.2,2.4.2,2.4.4,3.1.1,3.1.2,3.1.4,3.1.6,3.2.1,3.2.2,3.3.2,4.1.1,4.1.3,4.2.1,4.3.1,4.3.4,5.1.2,5.3.2,8.2.1,12.1.2,12.2.2,
CO4	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.3,2.2.2,2.2.4,2.3.1,2.4.1,2.4.3,3.1.4,3.2.3,3.4.2,4.1.2,4.1.4,4.3.2,5.1.1,5.2.1,5.3.1,6.1.1,6.2.1,7.2.2,8.2.2,12.1.1,12.1.2,12.2.2,12.3.2,
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.3,2.4.4,3.1.2,3.1.4,3.1.5,3.1.6,3.2.1,3.3.1,3.4.1,4.1.1,4.1.3,4.1.4,4.2.2,4.3.3,5.1.2,5.2.1,5.2.2,5.3.2,7.1.1,7.2.2,12.3.1,12.3.2,

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	20	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

22EPC517	ELECTRICAL MACHINE DESIGN	SEMESTER V

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	1	0	4

Course Objectives	To impart knowledge on designing static and Rotating machines based upon fundamental theories.	
UNIT – I	**FUNDAMENTALS OF ELECTRICAL MACHINE DESIGN**	**9 Periods**
Major considerations in Electrical Machine Design - Electrical Engineering Materials - Space factor - Choice of Specific Electrical and Magnetic loadings- Concept of magnetic circuit- MMF calculation for various types of electrical machines - Thermal considerations - Heat flow - Temperature rise and Insulating Materials - Rating of machines - IE3,IE4,NEMA Standard specifications.		
UNIT – II	**DESIGN OF DC MACHINES**	**9 Periods**
Output Equations - Main Dimensions - Choice of Specific Electric and Magnetic Loading - Magnetic Circuits Calculations - Carter's Coefficient - Net length of Iron - Selection of number of poles - Design of Armature, commutator, air gap, field poles, field coil and brushes - Performance prediction using design values		
UNIT – III	**DESIGN OF TRANSFORMERS**	**9 Periods**
Output Equations - Main Dimensions - KVA output for single and three phase transformers - Window space factor - Design of core, yoke and winding - Overall dimensions - Operating characteristics - No load current - Temperature rise in Transformers - Design of Tank and cooling tubes of transformers- Introduction to Resin type and Oil less Transformer.		
UNIT – IV	**DESIGN OF INDUCTION MOTORS**	**9 Periods**
Output equation of Induction motor - Main dimensions - Design of stator - Choice of Average flux density- Length of air gap- Rules for selecting rotor slots of squirrel cage machines- Design of rotor bars, slots and end rings - Design of wound rotor - Magnetic leakage calculations - Leakage reactance of poly phase machines - Magnetizing current - Short circuit current - Operating characteristics - Losses and Efficiency.		
UNIT – V	**DESIGN OF SYNCHRONOUS MACHINES**	**9 Periods**
Output equations - Choice of Electrical and Magnetic Loading - Design of salient pole machines - Short circuit ratio - Shape of pole face - Armature design - Estimation of air gap length - Design of rotor and damper winding - Determination of full load field - Design of field winding - Design of turbo alternators - Rotor design.		
Contact Periods: **Lecture: 45 Periods** **Tutorial:15 Periods** **Practical: 0 Periods** **Total: 60 Periods**		

TEXT BOOK :

1	*Pyrhonen, Juha, et al.,"**Design of Rotating Electrical Machines**", Wiley, United Kingdom, 2013.*
2	*Sawhney A.K, "**A course in Electrical Machine Design**", Dhanpat Raj & Co, 2016*

REFERENCES:

1	*Gray, Alexander, "**Electrical Machine Design: The Design and Specification of Direct and Alternating Current Machinery"**, N.p., Creative Media Partners, LLC, 2018.*
2	*Lipo, Thomas A. "**Introduction to AC Machine Design**", Wiley, United Kingdom, 2017.*
3	*Vishnu Murthy, K M. "**Computer Aided Design of Electrical Machines**", BS Publications, India, 2015.*
4	*V Rajini, V.S Nagarajan, "**Electrical Machine Design**", Pearson, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	**Illustrate the basics** of design considerations for rotating and static electrical machines.	K2
CO2	**Design** DC machines as per requirements.	K3
CO3	**Create** Transformers as per requirements.	K2
CO4	**Develop** Induction machines as per requirements.	K5
CO5	**Formulate** and analyze synchronous machines.	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**P O8**	**P O9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	1	-	-	-	-	-	-	2	2	3	1
CO2	3	2	3	3	2	-	-	-	-	-	-	1	3	3	2
CO3	3	3	3	3	2	-	-	-	-	-	-	2	2	2	3
CO4	3	3	3	3	2	-	-	-	-	-	-	2	3	3	2
CO5	3	3	3	3	2	-	-	-	-	-	-	1	3	3	3
22EPC 517	3	3	3	3	2	-	-	-	-	-	-	2	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1, 3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1, 4.3.3,4.3.4,5.1.2,5.2.1,12.1.2,12.2.1,12.3.2
CO2	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.2,2.4.1,2.4.2,2.4.3,3.1.1,3.1.3,3.1.4, 3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.2.2,4.3.1,4.3.3,4.3.4,5.1.2, 5.2.1,5.3.1,12.1.2,12.3.2
CO3	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,3.1.1, 3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.2.2,4.3.1,4.3.3, 4.3.4,5.1.2,5.2.1,5.3.1,12.1.2,12.2.1,12.3.2
CO4	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.4.1,2.4.2,2.4.3,3.1.1,3.1.3, 3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.2.2,4.3.1,4.3.3,4.3.4, 5.1.2,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2
CO5	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4, 3.1.1,3.1.3,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.2.2,4.3.1, 4.3.3,4.3.4,5.1.2,5.2.1,5.3.1,12.2.1,12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	20	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

22EMC5Z2	CONSTITUTIONOFINDIA (Common to all Branches)			SEMESTERIV			
PREREQUISITES			**CATEGORY**	**L**	**T**	**P**	**C**
NIL			**MC**	**3**	**0**	**0**	**0**
Course Objectives	The objective of the course is to familiarize the students on the role, powers and functions of Indian government. Also understand the recent acts in India.						
UNIT-I	**INTRODUCTIONANDEMERGENCYPROVISIONS**			**9 Periods**			
Historical Background: The Company rule, The Crown rule - Constituent Assembly: Composition, Objectives –Preamble and Salient features of the Indian Constitution-Fundamental Rights, Fundamental Duties, Directive Principles of state policy, Emergency Provisions-National Emergency, President Rule, Financial Emergency.							
UNIT-II	**SYSTEMOFGOVERNMENT**			**9 Periods**			
Parliamentary system: merits, demerits, reasons for adopting parliamentary system – Federal system: Evaluation of federal features– Centre-State relations: Legislative, Administrative and Financial relations –Local Government :Panchayati Raj and urban local government.							
UNIT-III	**UNIONANDSTATEGOVERNMENT**			**9 Periods**			
President of India: Election, Powers and functions-Prime Minister and Cabinet: Structure and functions–Governor: Powers and functions- Chief Minister and Council of Ministers: Functions.							
UNIT-IV	**ORGANSOFGOVERNANCEANDRECENTACTS**			**9 Periods**			
Parliament: Lok Sabha and Rajya Sabha, Composition and powers –State Legislative Assembly and Legislative Council: Composition and powers – Judicial System in India: Structure and features –Supreme Court and High Court: Composition, Jurisdiction, Recent acts in significance - RTI, Citizenship act, POCSO Act.							
UNIT-V	**POLITICALDYNAMICS**			**9 Periods**			
Political parties: Party system, Recognition of National and State parties – Elections: Electoral system and reforms – Pressure groups – National Integration: Obstacles, National Integration Council – Foreign Policy: Principles and Objectives.							
Contact Periods: **Lecture: 45Period Tutorial: 0Period Practical:0Period Total : 45Periods**							

TEXT BOOKS:

1	*National portal of India, "**The Constitution of India**" (Full Text), https://legislative.gov.in/constitution-of- india*
2	*Dr.B.R.Ambedkar, "**The Constitution of India",** Sudhir Prakashan, 2020.*

REFERENCES:

1	*Durga Das Basu, "**Introduction to the Constitution of India**, LexisNexis, 2022*
2	*P.M.Bakshi, "**The Constitution of India"**, LexisNexis, 2020*
3	*Subash C Kashyap, "**Our Parliament"**, National Book Trust, 2021*
4	*Subash C Kashyap, "**Our Political System**", National Book Trust, 2011*

COURSE OUTCOMES: Upon completion of the course, the students will be able to		Bloom's Taxonomy Mapped
CO1	Know the evolution of Indian Constitution and its basic premises.	K1
CO2	Explain the system of governance in India.	K2
CO3	Describe the structure of Union and State Governments	K2
CO4	Obtain the knowledge of functions of Legislature and Judiciary	K1
CO5	Know the political system of India	K1

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
CO2	-	-	-	-	-	1	-	1	1	-	-	-	-	-	1
CO3	-	-	-	-	-	2	-	1	1	-	-	-	-	-	1
CO4	-	-	-	-	-	1	-	1	2	-	-	-	-	-	1
CO5	-	-	-	-	-	2	-	2	1	-	-	-	-	-	-
22EMC5Z2	-	-	-	-	-	2	-	1	2	-	-	-	-	-	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	6.1.1,6.2.1,8.1.1,8.2.1,8.2.2,9.1.2
CO2	6.1.1,6.2.1,8.1.1,8.2.1,8.2.2,9.1.2
CO3	6.1.1,6.2.1,8.1.1,8.2.1,8.2.2
CO4	6.1.1,6.2.2,9.1.2,9.2.1
CO5	6.2.2,8.1.1,8.2.2,9.1.2,9.2.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	50	50	-	-	-	-	100
CAT2	50	50		-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50	50	-	-		-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	50	50	-	-		-	100
ESE	50	50	-	-	-	-	100

22EPC518	MICROPROCESSORS, MICROCONTROLLERS AND APPLICATIONS LABORATORY	SEMESTER: V

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objectives	To learn the programming and interfacing aspects of Microprocessors and micro controller and to apply microcontrollers in real time control applications.

LIST OF EXPERIMENTS: **45 Periods**

1. Programming of 8085 Microprocessor
2. Programming of ARM processors
3. Programming of PIC microcontroller
4. Interfacing of switches and display devices using microcontrollers
5. Interfacing of D/A and A/D converters using microcontrollers
6. Interfacing of keyboard and display using microcontrollers
7. Interfacing of stepper motor using Microcontrollers.
8. Interfacing of analog and digital sensors using microcontrollers
9. MPPT algorithms for solar photovoltaic system using microcontrollers

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Familiarize with the Assembly Level Programming.	K2
CO2	Employ Programming To interface various I/O devices	K3
CO3	Apply the Concepts to Acquire In Depth Knowledge on real time applications.	K3
CO4	Analyze abstract problems and apply a combination of hardware and software to address the problem.	K4
CO5	Explore the various programming platforms and controllers	K6

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	2	2	2	2	2	-	-	1	1	-	3	3	3
CO2	3	3	1	2	2	-	-	-	-	-	-	2	2	3	2
CO3	3	3	1	2	2	-	-	-	-	2	3	2	3	2	3
CO4	3	2	2	2	2	-	2	-	-	1	2	-	3	2	3
CO5	3	2	2	2	2	-	2	2	-	1	3	3	3	3	3
22EPC 518	3	2	2	2	2	2	2	2	-	1	2	2	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1,1.3.1,1.4.1,2.3.1,2.3.2,2.4.4,3.1.3,3.1.6,3.2.1,4.1.4,4.2.1,4.3.4,5.1.1,5.3.1,6.1.1,7.1.1,7.2.2,10.1.1,10.3.1,11.1.1
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1,3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1,3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2,10.1.1,10.2.2,10.3.1,11.1.1,11.2.1,11.3.1,11.3.2,12.3.1,12.3.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.3,2.2.4,2.4.2,2.4.3,2.4.4,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.3.1,4.1.2,4.1.4,4.2.1,5.1.2,5.2.2,5.3.2,7.1.1,7.2.2,10.1.1,10.3.1,11.2.1,11.1.2, 11.3.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.3,2.2.4,2.4.2,2.4.3,2.4.4,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.3.1,4.1.2,4.1.4,4.2.1,5.1.2,5.2.2,5.3.2,7.1.1,7.2.2,10.1.1,10.3.1,11.2.1,11.1.2, 11.3.2,8.2.1,8.2.2,11.1.1,11.1.2,11.2.1,12.1.2,12.2.1,12.3.1,12.3.2

22EES510	CONTROL SYSTEMS AND SIMULATION LABORATORY	SEMESTER V

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	0	0	3	1.5

Course Objectives	To impart practical experience on the theoretical knowledge gained in the field of control systems and to provide adequate exposure in the design of closed loop systems.

LIST OF EXPERIMENTS **45 Periods**

1. Open loop and closed loop speed control system.
2. Digital position control system.
3. Transfer function of armature-controlled DC motor.
4. Transfer function of field-controlled DC motor.
5. Transfer function of separately excited DC generator
6. Root locus design for DC motor digital position control.
7. Frequency response design method for DC motor speed control.
8. Design and Simulation of PI and PID controllers for a first and second order system with dead time.
9. Design and Simulation of Lag and Lead compensators.
10. Study of PLC programming- Ladder Logic: Speed control of DC motor using industrial PLC.
11. Control logic design for BLDC motor.

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze and synthesize open loop and closed loop control systems from the theory of Control System Engineering	K3
CO2	Evaluate the behavioral performance of various control systems with respect to stability	K3
CO3	Design feedback compensators/controllers to achieve a set of desired closed loop system characteristics and design a compensator in the frequency domain to meet specific design requirements using a lead compensator, lag compensator, or lead-lag compensator.	K3
CO4	Develop a PLC program for an automatic control system of a medium degree of complexity and select the right hardware for a given application	K6
CO5	Perform root locus of a system to determine the range of values for which the system will be stable and analyze the stability with the addition of pole or zero.	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO 3
CO1	3	3	2	2	3	0	0	0	3	1	1	0	3	3	3
CO2	3	3	2	2	3	0	0	0	3	1	1	0	3	3	3
CO3	3	3	2	2	3	0	0	0	3	1	1	0	3	3	3
CO4	3	3	2	2	3	0	0	0	3	1	1	0	3	3	3
CO5	3	3	2	2	3	0	0	0	3	1	1	0	3	3	3
22EES 510	3	3	2	2	3	0	0	0	3	1	1	0	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.22.4.1,2.4.2,2.4.3,2.4.4,3.2.1,3.2.2,3.2.3,3.4.1,3.4.2,4.1.3,4.1.4,4.2.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.19.2.2,9.2.3,9.2.4,9.3.1,10.3.1,10.3.2,11.1.1

SEMESTER VI

22EPC619	POWER SYSTEM ANALYSIS	SEMESTER VI

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	1	0	4

Course Objectives	To model and analyze the electric power network under normal and abnormal operating conditions for the design of protective and control apparatuses through the analysis results	
UNIT – I	**POWER SYSTEM MODELLING**	**9+3 Periods**
Need for system planning and operational studies – Basic components of a power system - Single line diagram – Per phase and per unit analysis – Generator – Transformer – Transmission line and load representation for different power system studies - Primitive network – Construction of Y-bus using inspection and singular transformation methods.		
UNIT – II	**POWER FLOW ANALYSIS**	**9+3 Periods**
Importance of power flow analysis in planning and operation of power systems – Statement of power flow problem – Classification of buses – Development of power flow model in complex variables form – Iterative solution using Gauss-Seidel method – Q-limit check for voltage controlled buses – Power flow model in polar form – Iterative solution using Newton - Raphson method, Fast Decoupled Method for LFA.		
UNIT – III	**ANALYSIS OF BALANCED FAULTS**	**9+3 Periods**
Importance of short circuit analysis – Assumptions in fault analysis – Analysis using Thevenin's theorem – Z-bus-Building algorithm - Fault analysis using Z-bus – Computations of short circuit capacity, post fault voltages and currents.		
UNIT – IV	**ANALYSIS OF UNBALANCED FAULTS**	**9+3 Periods**
Introduction to symmetrical components – Sequence impedances – Sequence circuits of synchronous machine, transformer and transmission lines – Sequence networks - analysis of single line to ground, line to line and double line to ground faults using Thevenin's theorem and Z-bus.		
UNIT – V	**STABILITY ANALYSIS**	**9+3 Periods**
Importance of stability analysis in power system planning and operation – Classification of power system stability – Rotor angle and voltage stability – Single Machine Infinite Bus (SMIB) system: Swing Equation – Equal area criterion – Determination of critical clearing angle and time – Solution of swing equation by Modified Euler method and Runge - Kutta fourth order method.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

TEXT BOOK (Maximum 2):

1	P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan "Electrical Power Systems-Analysis, Security and Deregulation" PHI Learning Private Limited, New Delhi, 2012
2	Nagrath I.J. and Kothari D.P "Modern Power System Analysis" Tata MC Graw Hill, Publishing Co. Ltd., New Delhi, 3rd Edition 2011

REFERENCES (Minimum 4 and Maximum 6):

1	John J Grainger and William D Stevenson J R "Power System Analysis" Tata MC Graw Hill, 6th Reprint, 2007
2	Wadhwa C.L, "Electrical Power Systems", Wiley Eastern Ltd., New Delhi, 2009.
3	Olle. I. Elgerd, "Electric Energy Systems Theory – An Introduction", Tata McGraw Hill Publishing Company Limited, New Delhi, Second Edition, 2012.
4	HadiSaadat, "Power System Analysis", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 21st reprint, 2010.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Model the power system under steady state operating conditions.	K6
CO2	Illustrate numerical methods to solve the power flow problem.	K2
CO3	Analyze the system under fault conditions.	K4
CO4	Examine the transient behavior of the power system under fault conditions.	K4
CO5	Evaluate the power system network for stable operation.	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	3	-	-	-	-	-	-	3	3	3	2
CO2	3	3	3	3	3	-	-	-	-	-	-	3	3	3	2
CO3	3	3	3	3	3	-	-	-	-	-	-	3	3	3	2
CO4	3	3	3	3	3	-	-	-	-	-	-	3	3	3	2
CO5	3	3	3	3	3	-	-	-	-	-	-	3	3	3	2
22EP C517	3	3	3	3	3	-	-	-	-	-	-	3	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.21,10.1.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.21,10.1.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.21,10.1.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.

CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.21,10.1.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.21,10.1.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	20	20	20	-	100
CAT2	20	20	20	20	20	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	20	20	20	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	20	20	30	30	-	100
ESE	20	20	20	20	20	-	100

22EPC620	INDUSTRIAL DRIVES AND CONTROL	SEMESTER VI

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To learn the concepts of electrical drives and their applications in carrying out modern industrial processes and to expose modern drives for energy conservation.	
UNIT – I	**SPEED CONTROL OF DC MOTORS**	**9 Periods**
Concept of Electric Drive – Classification of Electric Drives – Torque calculation, sizing of motor, different types of load torque, Speed/Torque characteristics -Heating and cooling of drives-Braking methods – Methods of speed control – Ward Leonard drives –Semi, Full converter fed DC drives – Single, Two and Four quadrant operations –Dual converter fed DC drives.		
UNIT – II	**DIGITAL CONTROL OF DC MOTORS**	**9 Periods**
Digital technique in speed control of DC motors – Advantages – Limitations – Closed loop control of DC drives – Analog, Digital and Hybrid speed control – control of DC motor using microprocessor.		
UNIT – III	**SPEED CONTROL OF AC MOTORS**	**9 Periods**
Speed control of AC motors – complete Speed / Torque characteristics – Braking methods. AC -AC controller fed AC drives, Inverter fed AC drives, Frequency control, V/F control of induction and synchronous motor - Self control, Margin angle control and power factor control.		
UNIT – IV	**ROTOR SIDE CONTROL OF INDUCTION MOTOR**	**9 Periods**
Rotor side control of Slip ring Induction motor with thyristor chopper – Static control of Rotor resistance – Slip-Energy recovery scheme – Static Scherbius and Kramer systems – Speed control using microprocessor.		
UNIT – V	**INDUSTRIAL APPLICATIONS**	**9 Periods**
Choice of selection of motors – Electric drive applications – Steel rolling mills – Cement mills – Paper mills – Textile mills – Sugar mills – Coal mines – Machine Tools- E mobility		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK :

1	*Dubey G.K* ***"Fundamentals of Electrical Drives"****, Narosa Publishing House, New Delhi, 2nd Ed. 2002.*
2	*Sen, P.C.,* ***"Thyristor DC Drives"****, Krieger Publishing Company 1991.*

REFERENCES :

1	*Vedam Subramaniam,* ***"Electrical Drives and Applications"****, Tata McGraw Hill, New Delhi, 2nd Edition 2010.*
2	*Murphy J.M.D.,* ***"Thyristor Control of AC Motors"****, Pergamon Press, NewYork, 1973.*
3	*Krishnan R.,* ***"Electric Motor and Drives: Modeling, Analysis and Control"****, Pearson Education, New Delhi, 2001.*
4	*Pillai S.K.,* ***"A First Course on Electrical Drives"****, Wiley Eastern Ltd., Bombay, 2nd Ed. 2007*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Illustrate the role of power electronics in modern drives.	K2
CO2	Design the digital controller for drives.	K4
CO3	Demonstrate the speed control techniques for AC drives	K3
CO4	Categorize drive for particular applications considering the present and future needs of industries.	K4
CO5	Apply microprocessors in control of electric drives	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	2	1	2	2	1	-	-	-	2	3	3	3
CO2	2	2	2	2	1	2	2	1	-	-	-	1	3	2	2
CO3	3	2	1	2	2	-	1	1	-	-	-	1	3	3	2
CO4	2	2	1	1	1	3	2	1	-	-	-	2	3	2	1
CO5	3	1	1	2	2	-	2	1	-	-	-	2	3	3	2
22EPC 620	3	2	1	2	1	1	2	1	-	-	-	2	3	3	2

1 – Slight. 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,2.1.2,2.1.3,2.2.1,2.2.4,2.4.2.3.1.1,3.1.2,3.1.5,3.2.2,3.3.2,4.1.1,4.1.3,4.1.2,4.3.3,5.1.1,4.3.2,6.2.1,7.2.1,7.2.2,8.1.2,12.11,12.22
CO2	1.1.2,1.2.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.3,2.1.3,2.4.1,2.4.2,3.1.2,3.1.4,3.2.1,3.3.1,3.4.2,4.1.3,4.3.1,4.3.3,5.2.1,5.3.1,6.1.1,7.1.1,7.2.1,8.1.1,12.1.2,12.3.1
CO3	1.1.1,1.1.2,1.2.1,1.3.1,2.2.1,2.2.2,2.3.2,2.4.2,2.4.4,3.1.1,3.1.2,3.2.2,3.3.2,4.1.1,4.1.3,4.3.1,4.3.4,5.1.2,5.2.2,5.3.2,7.1.2,8.1.1,12.1.1.
CO4	1.1.2,1.4.1,2.1.1,2.1.3,2.2.4,2.3.1,2.4.1,2.4.3,3.1.4,3.2.3,3.4.2,4.1.2,4.3.2,5.1.1,5.3.1,6.1.1,6.2.1,7.2.1,7.2.2,8.2.2,12.1.1
CO5	1.1.1,1.2.1,1.3.1,1.4.1,2.2.2,2.4.3,3.1.2,3.2.1,3.3.1,3.4.1,4.1.4,4.2.2,4.3.3,5.2.1,5.2.2,5.3.2,7.1.1,7.2.2,8.2.1,12.21,12.31,12.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	20	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

22EPC621	POWER SYSTEM PROTECTION	SEMESTER VI

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	Achieve mastery in the principles and applications of protective relays, including types, components, construction, operational principles, protection schemes, and performance considerations.	
UNIT – I	**PROTECTIVE RELAYS**	**9 Periods**
Electromagnetic relays – Basic requirements of relays – Primary and backup protection – Construction details of – Attracted armature, Balanced beam, Inductor type and differential relays – Universal torque equation – Characteristics of over current, Direction and distance relays, Static relays – Advantages and disadvantages – Definite time, Inverse and IDMT static relays – Comparators – Amplitude and phase comparators. Microprocessor based relays – Advantages and disadvantages – Block diagram for over current (Definite, Inverse and IDMT) and Distance relays and their flowcharts.		
UNIT – II	**PROTECTION OF GENERATORS AND TRANSFORMERS**	**9 Periods**
Protection of generators against stator faults, Rotor faults and abnormal conditions. Restricted earth fault and inter-turn fault protection. Numerical problems on percentage winding unprotected. Protection of transformers: Percentage differential protection, Numerical problem on design of CT ratio, Buchholz relay protection, Numerical Problems.		
UNIT – III	**PROTECTION OF FEEDERS AND LINES**	**9 Periods**
Protection of feeder (Radial and ring main) using over current relays. Protection of transmission line – 3 zone protection using distance relays. Carrier current protection. Protection of bus bars.		
UNIT – IV	**CIRCUIT BREAKERS**	**9 Periods**
Elementary principles of arc interruption, Recovery, Restriking voltage and recovery voltage – Restriking phenomenon, Average and max. RRRV, Numerical problems – Current chopping and resistance switching – CB ratings and specifications: Types and numerical problems – Auto reclosures, Description and operation of Minimum oil circuit breakers, Air blast circuit breakers, Vacuum and SF_6 circuit breakers.		
UNIT – V	**OVERVOLTAGE PROTECTION IN POWER SYSTEMS**	**9 Periods**
Overvoltages in power systems – Protection against lightning overvoltages – Valve type and Zinc-Oxide lightning arresters – Insulation coordination – BIL - SIL.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK (Maximum 2):

1	Y. G. Paithankar, S. R. Bhide, “Fundamentals of Power System Protection”, PHI Learning, 2010
2	Badri Ram & D N Vishwakarma, “Power system protection and switch gear”, Tata McGraw Hill Education, 2011.

REFERENCES (Minimum 4 and Maximum 6):

1	Bhavesh Bhalja, Maheshwari,, Nilesh Chothani , “Protection and Switchgear”, OUP India, 2011
2	Ravindra P. Singh, “Switchgear and Power System Protection”, Prentice Hall of India, 2009
3	A. S. Ingole, “Switchgear and protection” Umesh publication, 2006
4	B. Ravindranath and M. Chander, “Power system protection and switchgear”, New age International (P) Ltd., 2003
5	C. Christopoulos and A. Wright, ”Electrical power system protection”, Springer International edition, 2010

Note: Books with 10 years before publications may be avoided

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Discuss the performance of protective relays, components of protection schemes and relay terminology	K2
CO2	Illustrate various protection schemes, construction, operating principle for the protection of power system apparatuses like generators, motors, transformer and bus bar.	K2
CO3	Examine the construction, working of distance relays, the effects of various parameters on the performance of distance relays.	K4
CO4	Summarize the construction and operation of different types of circuit breakers and compare their performances against requirements.	K2
CO5	Analyze causes of overvoltages and Evaluate its protection schemes	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
CO2	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
CO3	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
CO4	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
CO5	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
22EPC621	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.2,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.2,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.2,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.2,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.2,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	20	20	20		-	100
CAT2		40	20	20	20	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	20	20	20		-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	40	20	20	20	-	100
ESE	20	20	20	20	20	-	100

22EPC622	POWER ELECTRONICS AND DRIVES LABORATORY	SEMESTER VI

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objectives	To learn the characteristics of power semiconductor devices, to design, evaluate and analyze the performance of power electronic converters circuits & drives and to study the performance of solid state drives and special machines drives.

List of Experiments: **45 Periods**

1.V-I characteristics of SCR and TRIAC
2. V-I characteristics of MOSFET and IGBT
3. Triggering circuits for SCR,MOSFET and IGBT
4. Single phase half controlled rectifier
5. Single phase fully controlled bridge rectifier
6. Buck, Boost and Buck-Boost converter
7. Single phase PWM inverter
8. Series inverter
9. Single phase voltage control using SCR and TRIAC
10. Speed control of chopper fed separately excited DC drive
11.V/f speed control of the three-phase Induction Motor
12. Speed control of BLDC Motor
13. Speed control of Switched Reluctance Motor

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 45** **Total: 45 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the characteristics of power semiconductor devices	K4
CO2	Build and test various power electronic converters	K5
CO3	Design of control techniques and circuits for power converters	K6
CO4	Determine the performance of solid state drives	K3
CO5	Calculate the performance of special machines drives	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	1	1	3	1	-	2	3	3	2
CO2	3	3	3	3	3	-	1	1	3	1	-	2	3	3	2
CO3	3	3	3	3	3	-	1	1	3	1	-	2	3	3	2
CO4	3	3	3	3	3	-	1	1	3	1	-	2	3	2	3
CO5	3	3	3	3	3	-	1	1	3	1	-	2	2	2	3
22EPC622	3	3	3	3	3	-	1	1	3	1	-	2	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, .5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 7.1.1, 7.2.2, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 11.2.1, 11.3.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, .5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 7.1.1, 7.2.2, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 11.2.1, 11.3.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, .5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 7.1.1, 7.2.2, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 11.2.1, 11.3.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, .5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 7.1.1, 7.2.2, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 11.2.1, 11.3.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, .5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 7.1.1, 7.2.2, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 11.2.1, 11.3.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

22EEE601	DESIGN THINKING FOR ELECTRICAL ENGINEERING	SEMESTERVI

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	3	1.5

Course Objective	Impart design skills to analyze design thinking issues and apply the tools and techniques of design.

DESIGN THINKING PROCESS AND PRACTICE — **45 Periods**

Design thinking: Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts and Brainstorming, Stages of Design Thinking Process (explain with examples) – Empathize, Define, Ideate, Prototype, Test.

Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving.

Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, Examples of best product designs and functions, Assignment – Engineering Product Design.

EXERCISES

1. Design and Development of circuit Diagram for a given problem.
2. Preparation of PCB Layout of a Circuit using suitable software.
3. Preparation of Electrical wiring Layout.
4. Design of Power factor correction capacitors.
5. Identification of the Real-world Problem and Solutions.
6. Study of sensors and Communication Protocols in IoT.
7. IoT Applications in Electrical Engineering.
8. Product Development.

Contact Periods:
Lecture: 00 Periods **Tutorial: 00 Periods** **Practical: 45 Periods** **Total: 45 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Prepare Circuit diagram and PCB layout using suitable software tools.	**K2**
CO2	Illustrate benefits and barriers associated with multidisciplinary team works.	**K2**
CO3	Apply the IoT knowledge to identify and solve the issues in various fields of Electrical Engineering.	**K3**
CO4	Evaluate the suitable approaches to obtain a required final result.	**K3**
CO5	Predict the outcome of the suggested approach in the form of a product.	**K4**

COURSE ARTICULATION MATRIX :

a. CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	3	-	-	-	-	-	-	-	3	3	3
CO2	-	-	-	-	-	3	-	-	3	-	-	-	2	2	2
CO3	2	-	-	-	3	-	-	-	-	1	-	-	2	2	2
CO4	-	-	-	-	-	-	3	-	-	-	-	-	2	2	2
CO5	-	-	3	-	-	-	-	-	-	-	-	-	2	2	2
22EEE 601	**2**	**-**	**3**	**-**	**3**	**3**	**3**	**-**	**3**	**1**	**-**	**-**	**2**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b. CO and Key Performance Indicators Mapping

CO1	5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2
CO2	6.1.1, 6.2.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1
CO3	1.1.2, 1.3.1, 1.4.1, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 10.1.1, 10.1.2
CO4	7.1.1, 7.1.2, 7.2.1, 7.2.2
CO5	3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2

SEMESTER VII

22EPC723	POWER SYSTEM OPERATION AND CONTROL	SEMESTER VII

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To be familiar with operation of power system, security issues and various types of control mechanisms for secure operation	
UNIT – I	**OVERVIEW OF POWER SYSTEMS**	**9 Periods**
System load variation: System load characteristics, load curves - daily, weekly and annual, load-duration curve, load factor, diversity factor - Reserve requirements. Overview of system operation and Control: Load forecasting - concept and techniques - method of extrapolation and correlation. Current scenario of power sector in India – An overview, Timeline of the Indian power sector, Players in the Indian power sector.		
UNIT – II	**LOAD FREQUENCY AND VOLTAGE CONTROL**	**9 Periods**
Need for frequency and voltage control - Plant and system level control - modeling of LFC of single area system - static and dynamic analysis - LFC of two area system - static and dynamic analysis - Tie line bias control - development of state variable model of single and two area systems. Reactive power control – Automatic voltage regulator – synchronous condenser – Tap Changing transformer – static VAR compensators.		
UNIT – III	**UNIT COMMITMENT AND ECONOMIC OPERATION OF POWER GENERATION SYSTEMS**	**9 Periods**
Statement of Unit Commitment (UC) problem; constraints in UC and solution methods: Priority-list method, forward dynamic programming approach, numerical problems. Incremental cost curve, co-ordination equations without loss and with loss, transmission loss formula - optimal scheduling of thermal system by direct methods, λ-iteration method. Gradient method- Newton's method – Base point and participation factor method		
UNIT – IV	**HYDROTHERMAL SCHEDULING**	**9 Periods**
Hydrothermal coordination – hydro electric plant models - short term and long term scheduling problem – gradient approach – Hydro units in series - Hydro-thermal scheduling with pumped hydro plants: Scheduling of systems using classical method and NR method		
UNIT – V	**POWER SYSTEM SECURITY**	**9 Periods**
Importance of power system Security-- Contingency analysis using DC power flow model–- linear sensitivity factors – Security assessment using AC power flow model – contingency selection – concentric relaxation – bounding-security constrained optimal power flow-Interior point algorithm		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK (Maximum 2):

1	Robert H. Miller, James H. Malinowski, '**Power system operation**', Tata McGraw-Hill, 3rd Edition, 2009
2	Abhijit Chakrabarti & Sunita Halder, '**Power system Analysis-Operation & Control**', PHI, 4th Edition, 2022.

REFERENCES:

1	Olle. I. Elgerd, "**Electric Energy Systems Theory – An Introduction**", Tata McGraw Hill Publishing Company Ltd, New Delhi,, 2017.
2	Allen J. Wood, Bruce F. Wollenberg, '**Power Generation, Operation and Control**', Wiley India Edition, 3rd Edition, 2013
3	D.P. Kothari and I.J. Nagrath, "**Modern Power System Analysis**", Fifth Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2022.
4	P. Kundur, Om.P.Malik "**Power System Stability & Control**" Tata McGraw Hill Publishing Company Ltd., USA, 2th Edition, Reprint 2022.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain about power system load characteristics and load forecasting	**K2**
CO2	Realize the requirements and methods of real and reactive power control and apply control and compensations schemes on a power system	**K2**
CO3	Solve unit commitment and economic dispatch problems	**K3**
CO4	Evaluate the solution of hydro thermal scheduling problem for feasible load management	**K4**
CO5	Apply contingency analysis and selection methods to improve system security	**K3**

COURSE ARTICULATION MATRIX :

a. CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	-	-	-	-	-	-	-	-	-	-	3	3	3
CO2	3	1	-	-	-	-	-	-	-	-	-	-	2	2	2
CO3	3	3	1	-	-	-	1	-	-	-	-	-	2	2	2
CO4	3	3	1	1	-	-	-	-	-	-	-	-	2	2	2
CO5	3	3	1	-	-	-	-	-	-	-	-	-	2	2	2
22EPC723	**3**	**2**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b. CO and Key Performance Indicators Mapping	
CO1	1.2.1, 2.1.1, 2.1.2, 2.1.3, 2.4.4
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.4.4
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.2.3, 7.1.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.2.3, 4.1.4
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.2.3

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	40	40	10	-	-	100
CAT2	10	40	40	10	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	20	40	40	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	20	40	40	-	-	100
ESE	10	40	40	10	-	-	100

22EHS701	PROJECT MANAGEMENT AND ENTREPRENEURSHIP	SEMESTER VII

PREREQUISITES	CATEGORY	L	T	P	C
NIL	HSMC	3	0	0	3

Course Objectives	To understand the	
UNIT – I	**ENTREPRENEURSHIP**	**9 Periods**
Need, scope, Entrepreneurial competencies & traits, Factors affecting entrepreneurial development, Entrepreneurial motivation (Mc Clellend's Achievement motivation theory), conceptual model of entrepreneurship, entrepreneur vs. intrapreneur; Classification of entrepreneurs; Entrepreneurial Development Programmes.		
UNIT – II	**ENTREPRENEURIAL IDEA AND INNOVATION**	**9 Periods**
Introduction to Innovation, Entrepreneurial Idea Generation and Identifying Business Opportunities, Management skills for Entrepreneurs and managing for Value Creation, Creating and Sustaining Enterprising Model & Organizational Effectiveness		
UNIT – III	**PROJECT MANAGEMENT**	**9 Periods**
Meaning, scope & importance, role of project manager; project life-cycle Project appraisal: Preparation of a real time project feasibility report containing Technical appraisal; Environmental appraisal, Market appraisal (including market survey for forecasting future demand and sales) and Managerial appraisal.		
UNIT – IV	**PROJECT FINANCING**	**9 Periods**
Project cost estimation & working capital requirements, sources of funds, capital budgeting, Risk & uncertainty in project evaluation, preparation of projected financial statements viz. Projected balance sheet, projected income statement, projected funds & cash flow statements, Preparation of detailed project report, Project finance.		
UNIT – V	**SOCIAL ENTREPRENEURSHIP**	**9 Periods**
Social Sector Perspectives and Social Entrepreneurship, Social Entrepreneurship Opportunities and Successful Models, Social Innovations and Sustainability, Marketing Management for Social Ventures, Risk Management in Social Enterprises, Legal Framework for Social Ventures.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK (Maximum 2):

1	Lipika K Guilani, R K Gupta, "***Fundamentals of Entrepreneurship Development and Project Management*** **"**, Himalaya Publishing House, 2014.
2	Dr. Salahuddin Ansari,Dr. Mohammad Imtiaz, Mrs. Jaya Jain, "***Entrepreneurship and Project Management***", Book Rivers Publishers, 2023.

REFERENCES:

1	Drucker, P.F, "***Innovation and Entrepreneurship***", Harper Business Publisher, 2006.
2	Roy Rajeev, "***Entrepreneurship***", OUP India, 2020.
3	Gopalkrishnan, P. and Ramamoorthy, V.E., "***Text Book of Project Management***",Laxmi Publishers, 2022.
4	Nicholas, J.M., and Steyn, H., "***Project Management for Engineering***", Business and Technology, PHI, IV Edition, 2011.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the factors affecting entrepreneurial development classify the types of Entrepreneurs.	K2
CO2	Apply innovative ideas on in Entrepreneurship	K3
CO3	Prepare project proposal considering various factors	K3
CO4	Estimate cost and present financial report of a Project	K3
CO5	Explain impact of social, environmental and legal factors on Entrepreneurship	K2

COURSE ARTICULATION MATRIX :

a. CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	1	-	-	-	-	-	-	-	-	-	-	3	3	3
CO2	3	1	-	-	-	-	-	-	-	-	-	-	2	2	2
CO3	3	3	1	-	-	-	1	-	-	-	-	-	2	2	2
CO4	3	3	1	1	-	-	-	-	-	-	-	-	2	2	2
CO5	3	3	1	-	-	-	-	-	-	-	-	-	2	2	2
22EHS701	**3**	**2**	**1**	**1**	-	-	**1**	-	-	-	-	-	**2**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b. CO and Key Performance Indicators Mapping

CO1	1.2.1, 2.1.1, 2.1.2, 2.1.3, 2.4.4
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.4.4
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.2.3, 7.1.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.2.3, 4.1.4
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.2.3

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40	-	-	-	100
CAT2	20	40	40	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	40	40	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	40	40	20	-	-	100
ESE	20	40	40	-	-	-	100

22EPC724	POWER SYSTEM LABORATORY	SEMESTER VII

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objectives	Attain expertise in employing digital techniques to address power system operational and control challenges, vital for planning and assessing standard power network configurations.

LIST OF EXPERIMENTS: **45 Periods**

1. Computation of Parameters and Modeling of Transmission Lines
2. Formation of Bus Admittance and Impedance Matrices
3. Load Flow Analysis Using Gauss-Seidel Method
4. Load Flow Analysis Using Newton- Raphson and Fast-Decoupled Methods
5. Symmetrical and Asymmetrical Fault Analysis
6. Transient and Small Signal Stability Analysis: Single-Machine Infinite Bus System
7. Transient Stability Analysis of Multi-machine Power Systems
8. Load – Frequency Dynamics of Single- Area and Two-Area Power Systems
9. Economic Dispatch in Power Systems
10. Unit Commitment in Power Systems
11. Study of various protection schemes for Generator and Transformer protection
12. Voltage Control using passive compensation technique
13. Automatic Voltage Regulator
14. Characteristic study of Solar Photovoltaic Array
15. Characteristic study of Wind Power Generation System
16. Study of Power Quality Problems

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Demonstrate the Power System Analysis, Control, Operation and Protection problems virtually through simulation and hardware setup.	K2
CO2	Apply the concepts described in various power system theories to actual situations.	K3
CO3	Analyze ideas learnt through various power system concepts in designing and planning a new one.	K4
CO4	Evaluate the existing power system for its reliable operation.	K5
CO5	Propose modern technologies for the enhanced operation of power systems.	K6

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping														
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
CO2	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
CO3	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
CO4	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
CO5	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
22EPC 724	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping (Times New Roman, Size 11)

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.21,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.21,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.21,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.21,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.21,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.

22CEE705	ENGINEERING PROJECTS IN COMMUNITY SERVICE	SEMESTER VII

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	4	2

Course Objectives	To provide an environment where teams of students can exercise their engineering skills by being exposed to realistic systems and customers and at the same time helping their community.

Problem identification – Identifying the issues within the community -Preliminary survey - Preparing a questionnaire, formats and survey forms. - A preliminary survey including the socio-economic conditions of the allotted habitation - Different types of surveys, tools and techniques for collecting the information. - Analysis of collected data and mapping of issues with the solutions available. - Based on the survey and the specific requirements of the habitation, Community Awareness Campaigns – Identifying the factors – Normalization of factors and finding the path way for problem solution – Selection of problem from the community and mapping of issues - Planning for working: Aim, objective and scope, time line - Application of engineering knowledge and tools for solutions

Validation of the solution by supervising the execution of solution - Measuring the attainment of the solution: Feedback from community

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 60 Periods Total: 60 Periods

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify engineering related problems in the community.	K2
CO2	Analyze and Design different solutions to solve the problems of community.	K4
CO3	Apply economical solution to those problems in the field.	K4
CO4	To understand complexity and ambiguity	K1
CO5	Connections with professionals and community members for learning and career opportunities	K2

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	2	2	-	1	2	1	-	2	-	1	-	1	1
CO2	-	2	2	-	1	2	1	-	2	-	1	-	1	1
CO3	-	2	2	-	1	2	1	-	2	-	1	-	1	1
CO4	-	2	2	-	1	2	1	-	2	2	1	-	1	1
CO5	-	2	2	-	1	2	1	-	2	2	1	-	1	1
22CEE705	-	2	2	-	1	2	1	-	2	-	1	-	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

22EEE804	CAPSTONE PROJECT	SEMESTER VIII

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	16	8

Course Objectives	To apply the theoretical knowledge acquired throughout the courses of Electrical and Electronics Engineering Programme to a project involving in real time . Students must come up with new designs and Fabrication, algorithms and software programs expressing their ideas in a novel way which helps them enhance their competencies and skill related to critical thinking, decision making and communicate with team.

A Project topic must be selected either from research literature or their own innovative ideas to solve engineering problems in consultation with the guide. The type of project includes Experimental work, fabrication, prototype, Design projects, feasibility studies, simulations, development of software and applications of emerging technologies.

The progress of the project is evaluated based on a minimum of two reviews. Each student has to prepare a portfolio describing the experience of the lessons learned, and interpret the results during the project work.

Each batch will have to submit a project report at the completion of the project for End semester assessment. The project work is evaluated jointly by external and internal examiners based on oral presentation and the project report.

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 240 Periods** **Total: 240 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Demonstrate a problem in Electrical and Electronics Engineering through knowledge gained from the courses studied.	K3
CO2	Develop and apply appropriate techniques, resources, and tools to provide solutions.	K6
CO3	Evaluate technical projects in the context of environmental, societal, and economic consideration.	K5
CO4	Engage effectively in diverse teams, managing information and choosing among alternative solutions for societal challenges and stay current.	K2
CO5	Defend to present and communicate the outcomes of their projects.	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	-	-	-	-	-	-	-	-	3	3	3
CO2	-	-	3	3	3	-	-	-	-	-	-	-	3	3	3
CO3	-	-	-	-	-	3	3	3	-	-	-	-	-	3	2
CO4	-	-	-	-	-	-	-	-	3	-	3	3	3	2	3
CO5	-	-	-	-	-	-	-	-	3	3	-	-	2	-	-
22EEE804	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1,1 .3.1,1.4.1,2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1.2.4.2 , 2.4.3, 2.4.4, 3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3, 3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4, 4.2.1,4.2.2, 4.3.1,4.3.2,4.3.3,4.3.4
CO2	3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3, 3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4, 4.2.1,4.2.2, 4.3.1,4.3.2,4.3.3,4.3.4, 5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,
CO3	6.1.1, 6.2.1 ,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2
CO4	9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.3.1,11.1.1,11.1.2,11.2.1,11.3.1,11.3.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2
CO5	9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.3.1,10.1.1,10.1.2,10.1.3,10.2.1,10.2.2,10.3.1,10.3.2,

PROFESSIONAL ELECTIVES

POWER ENGINEERING - V1

22EPE$01	POWER SYSTEM ECONOMICS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To impart knowledge on the economic principles underlying the operation and planning of the electricity systems including concepts of electricity markets and competition in electricity generation and supply and the opening of the transmission and distribution systems to third party access.	
UNIT – I	**POWER MARKET**	**9 Periods**
Structure and operation:- Objective of market operation, Electricity market models-Power market types-Market power-Key components in market operation. Demand - supply, Demand analysis – Theory, elasticity of demand, Demand forecasting –Types, techniques. Costs: Short run – Long run - Relationship between short run -long run costs, perfect competition – Monopoly- Monopolistic - Oligopolistic, Determination of market price, Price discrimination		
UNIT – II	**ELECTRICITY PRICE**	**9 Periods**
Price volatility-ancillary services in electricity power market-automatic generation control -its pricing, Generation assets valuation- risk analysis. -Introduction, VAR for Generation Asset Valuation, Generation Capacity Valuation.		
UNIT – III	**TRANSMISSION CONGESTION MANAGEMENT AND PRICING**	**9 Periods**
Transmission cost allocation methods- Local Marginal Price- Financial Transmission Right - Congestion Management- Role of Flexible AC Transmission System devices in competitive power market-Available Transfer Capability-Distributed Generation in restructured markets.		
UNIT – IV	**REACTIVE POWER MARKET MANAGEMENT**	**9 Periods**
Reactive power requirements under steady state voltage stability -dynamic voltage stability, reactive power requirements to cover transient voltage stability-System losses - loss reduction methods- Power tariffs - Market Forces shaping of reactive power- reactive power requirement of the utilities.		
UNIT – V	**RELIABILITY ANALYSIS OF GENERATION SYSTEM**	**9 Periods**
Characteristic operation of power plants - Choice of power plants - Hydro, Thermal - Nuclear - Size of plant – Input / Output curves. Economic Planning - Generation system - Cost analysis - Capacity cost -Production cost - Plant cost - Timing of unit additions - System cost analysis.Load forecasting - system reliability : Load forecasting - Generation system reliability - Co-ordination methods - Economic operation of power systems - Simple problems.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK (Maximum 2):

1	Kirchmayer E. K "Economic Operation of Power Systems" John Wiley and sons, New Delhi, vol.1,2, 1985
2	Elgerd O.I "Electric Energy System Theory an Introduction" Tata McGraw Hill, New Delhi, 2008

REFERENCES (Minimum 4 and Maximum 6): -

1	.Turner, Wayne.C., "Energy Management" Hand Book.,2nd Edition.
2	RR Barathwal - Professor IIT Kanpur ."Industrial Economics-an Introductory text book"
3	S.K.Jain, "Applied economics for Engineers and Managers", Vikas Publishing House.
4	D.M.Tagare, " Series on Electrical Power Capacitors Reactive Power Management", Madhav Electricals, Pune, Tata McGraw Hill Publishing Company Ltd.

COURSE OUTCOMES: - Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Elaborate the principles of power system economics	K2
CO2	Apply market/managerial economic aspects	K3
CO3	Illustrate the social efficiency concepts.	K2
CO4	Analyze power systems with application of economics considerations	K5
CO5	Assess electric power system for socio-economic standpoint	K5

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
CO1	3	3	3	3	3	3	2	1	-	-	-	3	3	3	3
CO2	3	3	3	3	3	3	2	1	-	-	-	3	3	3	3
CO3	3	3	3	3	3	3	2	1	-	-	-	3	3	3	3
CO4	3	3	3	3	3	3	2	1	-	-	-	3	3	3	3
CO5	3	3	3	3	3	3	2	1	-	-	-	3	3	3	3
22EPE $01	3	3	3	3	3	3	2	1	-	-	-	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,8.1.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2,
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,8.1.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2,
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,8.1.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2

CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,8.1.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2,
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,8.1.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2,

COURSE ARTICULATION MATRIX : -

ASSESSMENT PATTERN – THEORY (Times New Roman, Size 11)							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40			-	100
CAT2	20	40	40			-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	25	25	25	25	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	25	25	25	25	-	100
ESE	20	40	40	-	-	-	100

22EPE$02	POWER SYSTEM STABILITY

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To disclose the concept of transient and steady state stability, instability in power systems through the approaches of the steady state stability analysis and the transient stability analysis	
UNIT – I	**CONCEPT OF STABILITY**	**9 Periods**
Stability of power system – Simple two machine stability problems – Mechanical Analogy of power transmission systems – Importance of stability to system operation and design – Effect of instability – Representation of power system components – Stability studies on network analysis		
UNIT – II	**STEADY STATE STABILITY ANALYSIS**	**9 Periods**
Introduction – Significance of steady state stability – Power limit of transmission system – Two machine system with negligible losses – Clarke diagram for two machine system with negligible losses – Power angle characteristic and steady state stability limit of salient pole synchronous machines– Two machine system with losses – Clarke diagram for two machine systems with resistance – Steady state stability with automatic voltage regulators.		
UNIT – III	**TRANSIENT STABILITY ANALYSIS - I**	**9 Periods**
General background - Swing equation for synchronous machine – Numerical solutions of Swing Equation – Multi machine stability – Factors affecting transient stability		
UNIT – IV	**TRANSIENT STABILITY ANALYSIS - II**	**9 Periods**
Concepts of equal area criterion – Application of equal area criterion to stability studies under fault conditions – Determination of critical clearing angle – Reduction of a power system to a single equivalent machine connected to infinite bus – Equivalent power angle curve of two finite machines – Graphical integral method of swing curve determination.		
UNIT – V	**EXCITATION SYSTEM AND ITS EFFECT ON STABILITY**	**9 Periods**
Introduction – Definition of terms – Quick response excitation systems – Compounding the excitation of generators – Modern trend in excitation systems – Voltage regulator capability to improve transient stability – Super-excitation for stability – Two axis excitation control – High initial response excitation systems – Exciter response - Determination by graphical integration – Point by point method of calculation.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK (Maximum 2):

1	Gangadhar K.A “Power System Analysis and Stability” Khanna Publishers, New Delhi, 6th reprint 2004
2	Kimbark, “POWER SYSTEMS STABILITY”, Volume - I,II,III, Wiley India Pvt. Limited 2007

REFERENCES (Minimum 4 and Maximum 6):

1	P. Kundur, “Power System Stability and Control”, Tata Mc Graw Hill, 3rd reprint, 2007.
2	M.A.Pai,K.Sengupta and K. R.Padiyar, Tata- McGraw Hills. “Small Signal Analysis of Power System”, Alpha Science International, 2004
3	Paul M.Anderson and A.A. Fouad, “Power system Control and stability” IEEE Press, 2003.
4	Abdelhay A. Sallam, Om P. Malik, “Power System Stability - Modelling, Analysis and Control”, Institution of Engineering and Technology, 2015

Note: Books with 10 years before publications may be avoided

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Illustrate the modeling of a power system suitable for performing stability analysis.	K1
CO2	Analyze the stability of simple power systems using Analytical and graphical approaches.	K4
CO3	Apply computer simulation tools for stability analysis of large power systems.	K3
CO4	Apply and Evaluate control methods for tuning the turbine of voltage controllers in power system.	K5
CO5	Design and Evaluate the power system for stable operation.	K6

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	3	3	1	-	-	-	3	3	3	2
CO2	3	3	3	3	3	3	3	1	-	-	-	3	3	3	2
CO3	3	3	3	3	3	3	3	1	-	-	-	3	3	3	2
CO4	3	3	3	3	3	3	3	1	-	-	-	3	3	3	2
CO5	3	3	3	3	3	3	3	1	-	-	-	3	3	3	2
22EPE$02	3	3	3	3	3	3	3	1	-	-	-	3	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping (Times New Roman, Size 11)

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2.
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2.
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2.
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2.
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2.

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	20	20	20		100
CAT2		20	20	20	20	20	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	20	20	20	20		100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	20	20	20	20	20	100
ESE	20	20	30	30	-	-	100

22EPE$03	HVDC TRANSMISSION SYSTEMS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To familiarize with the HVDC transmission system and its control	
UNIT – I	**GENERAL ASPECTS OF HVDC SYSTEM**	**9 Periods**
Introduction - Comparison between AC and DC transmissions - DC links - DC cables and line insulators - Comparison between ac and dc cables - Important HVDC projects - Components of a HVDC system.		
UNIT – II	**CONVERTER CIRCUITS AND ANALYSIS**	**9 Periods**
Three Phase bridge converter using SCRs - Operating principles - Waveforms - Gate control and overlap – Voltage, current and power factor relations – Commutating resistance – Inversion – Equivalent circuits – Analysis and charts only for overlap less than 60º - Simple problems		
UNIT – III	**CONVERTER CONTROL**	**9 Periods**
Principle of control – Control characteristics – Constant minimum firing angle control – Constant current control – Constant extinction angle control – Tap changer control – Power and frequency control – Stability control – Starting and stopping of DC link- Power control		
UNIT – IV	**FAULTS AND PROTECTION**	**9 Periods**
Bypass valve – SCR valves malfunctions – Over voltage and current oscillations – DC circuit breakers – DC lightning arrestors – Simple problems.		
UNIT – V	**HARMONICS, FILTERS AND GROUND RETURN**	**9 Periods**
Characteristic and uncharacteristic harmonics – Harmonic ac and dc filters – Interference with communication systems – Ground return – land, shore and sea electrodes – Cathodic protection – DC corona.		
Contact Period: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	Kimbark E.W "Direct Current Transmission" Vol I, Wiley – Interscience, New york, Reprint 2016.
2	Padiyar K.R "HVDC Transmission Systems" New Age International Pvt. Ltd, 2016.

REFERENCES:

1	Adamson and Hingorani H.G., "High Voltage DC Power Transmission", Garaway Ltd. England Reprint 2014
2	WadhwaC.L., "Electrical Power Systems", New Age International Pvt. Ltd, New Delhi, 2018.
3	Arillaga J., "High Voltage Direct Current Transmission", Peter Peregrinus, London, Reprint 2015
4	V.K.Sood, HVDC and FACTS controllers–Applications of Static Converters in Power System, Kluwer Academic Publishers, 2018.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze HVDC system and enumerate its merits	K4
CO2	Appraise and analyze different converter circuits	K4
CO3	Apply converter control for power flow	K3
CO4	Select suitable protection method for various converter faults	K2
CO5	Illustrate about harmonic filtering in HVDC systems	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	-	-	-	-	-	-	-	-	2	2	1
CO2	3	3	2	1	-	-	-	-	-	-	-	-	2	2	1
CO3	3	3	2	1	-	-	-	-	-	-	-	-	2	2	1
CO4	3	3	2	1	-	-	-	-	-	-	-	-	2	2	1
CO5	3	3	2	1	-	-	-	-	-	-	-	-	2	2	1
22EPE $03	3	3	2	1	-	-	-	-	-	-	-	-	2	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.2.1,3.2.2,3.2.3,4.1.1,4.1.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.2.1,3.2.2,3.2.3,4.1.1,4.1.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.2.1,3.2.2,3.2.3,4.1.1,4.1.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.2.1,3.2.2,3.2.3,4.1.1,4.1.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.2.1,3.2.2,3.2.3,4.1.1,4.1.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	20	40	20	-	-	100
CAT2	20	20	40	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		30	30	40	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		30	30	40	-	-	100
ESE	20	20	40	20	-	-	100

22EPE$04	FACTS CONTROLLERS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To enrich the knowledge about the functions and characteristics of FACTS controllers and to identify their suitability for various applications.	
UNIT – I	**INTRODUCTION TO POWER TRANSMISSION CONTROL**	**9 Periods**
The concept of flexible AC transmission - Reactive power control in electrical power transmission lines - Uncompensated transmission line – Series and shunt compensation. Calculation of surge impedance loading and midpoint voltage, Transmission problems and needs: the emergence of FACTS- Objectives of FACTS - Thyristor Controlled FACTS Controllers and Converter Based FACTS Controllers.		
UNIT – II	**STATIC VAR COMPENSATOR AND APPLICATIONS**	**9 Periods**
Voltage control by SVC – Advantages of slope in dynamic characteristics – Influence of SVC on system voltage. Applications - Enhancement of transient stability – Steady state power transfer – Enhancement of power system damping – Prevention of voltage instability.		
UNIT – III	**THYRISTOR CONTROLLED SERIES CAPACITOR AND APPLICATIONS**	**9 Periods**
Operation of the TCSC - Different modes of operation – Modeling of TCSC – Variable reactance model – Modeling for stability studies. Applications - Improvement of the system stability limit – Enhancement of system damping – Voltage collapse prevention.		
UNIT – IV	**ADVANCED FACTS CONTROLLERS**	**9 Periods**
Static Synchronous Compensator (STATCOM) – Operating principle – V-I characteristics Unified Power Flow Controller (UPFC) – Principle of operation - Modes of operation – Applications – Modeling of UPFC for power flow studies, Interline Power Flow Controllers (IPFC) - Basic Operating Principles and Characteristics, Control Structures.		
UNIT – V	**COORDINATION OF FACTS CONTROLLERS**	**9 Periods**
Controller Interactions – SVC-SVC, SVC-TCSC and TCSC-TCSC interactions-Coordination of multiple controllers using linear techniques (Quantitative Treatment)		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK :

1	*Mohan Mathur, R., Rajiv. K. Varma “**Thyristor – Based FACTS Controllers for Electrical Transmission Systems**” IEEE press and John Wiley & Sons, Inc., 2002*
2	*K.R.Padiyar, **“FACTS Controllers in Power Transmission and Distribution”**, New Age International (P) Limited, Publishers, New Delhi, 2008.*

REFERENCES :

1	*Yong Huo Song, A.T.John, “**Flexible AC Transmission System**”, IEEE Press, 1999.*
2	*Xiao – Ping Zang, Christian Rehtanz and Bikash Pal, “**Flexible AC Transmission System: Modelling And Control**” Springer, 2012.*
3	*NarainG.Hingorani, Laszio. Gyugyl, “**Understanding FACTS Concepts and Technology of Flexible AC Transmission System**”, IEEE Press, A John Wiley & Sons, Inc. Publication, 2000.*
4	*Kalyan K. Sen, Mey Ling Sen, **“Introduction to FACTS Controllers: Theory, Modeling, and Applications”**, Wiley-IEEE Press, 2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify the problems and issues associated with AC transmission systems	K2
CO2	Summarize the operation and control of various FACTS Controllers	K5
CO3	Develop the modeling of various FACTS Controllers	K3
CO4	Analyze the performance of Power System with FACTS Controllers	K4
CO5	Suggest suitable FACTS device for enhancing the transmission capability	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping (Times New Roman, Size 11)

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	1	2	2	-	1	-	-	-	1	3	2	2
CO2	3	2	2	2	1	2	2	-	-	-	-	2	2	1	2
CO3	3	2	1	2	1	2	-	1	-	-	-	2	3	1	1
CO4	2	2	1	2	1	2	2	1	-	-	-	2	2	2	1
CO5	3	2	1	2	2	-	3	-	-	-	-	2	1	1	1
22EPE $04	3	2	1	2	1	2	2	1	-	-	-	2	2	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,2.1.2,2.2.1,2.2.4,2.3.1,2.3.2,2.4.2,2.4.4,3.1.1,3.1.3,3.1.5,3.2.2,3.3.2,4.1.1,4.2.1,5.1.1,5.3.1,5.3.2,6.2.1,8.1.1,12.1.1,12.3.1,
CO2	1.1.1,1.1.2,1.3.1,1.4.1,2.1.2,2.2.3,2.3.1,2.4.1,2.4.3,3.1.2,3.1.4,3.2.1,3.3.1,3.4.2,4.1.2,4.1.3,4.1.4,4.3.1,4.3.3,5.1.2,5.2.1,6.1.1,7.1.1,7.2.1,12.1.2,12.2.2,12.3.1,
CO3	1.1.1,1.1.2,1.2.1,1.3.1,2.1.1,2.1.3,2.2.1,2.2.2,2.4.2,2.4.4,3.1.1,3.1.2,3.2.2,3.3.2,4.1.1,4.1.3,4.3.1,4.3.2,4.3.4,5.2.2,5.3.2,6.2.1,8.1.1,12.1.1,12.1.2,12.2.2,12.3.1,
CO4	1.1.2,1.2.1,1.4.1,2.1.1,2.1.3,2.2.4,2.3.1,2.4.1,2.4.3,3.1.4,3.2.3,3.4.2,4.1.2,4.1.3,4.2.1,4.3.2,5.1.1,5.3.2,6.1.1,7.2.1,7.2.2,8.2.1,12.1.1,12.2.1,12.2.2,12.3.2,
CO5	1.1.1,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.2,2.3.1,2.3.2,2.4.2,2.4.4,3.1.2,3.2.1,3.3.1,3.4.1,4.1.4,4.2.2,4.3.2,4.3.4,5.2.1,5.2.2,5.3.2,7.1.1,7.1.2,7.2.2,12.2.1,12.3.1,12.3.2,

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Rememberi ng (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Tota l %**
CAT1	20	30	10	30	10		100
CAT2	20	30	10	30	10		100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		30	20	20	30		100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		30	20	20	30		100
ESE	20	30	10	30	10		100

22EPE$05	ENERGY AUDITING AND MANAGEMENT

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To comprehend energy management schemes and perform economic analysis and energy conservation in electrical and thermal systems	
UNIT – I	**BASICS OF ENERGY AUDIT AND MANAGEMENT**	**9 Periods**
Energy Security - Salient Features of Energy Conservation Act 2001 - Objectives of Energy Management - Energy Audit - Need - Types - Methodology - Audit Report - Instruments for Audit - BEE regulations.		
UNIT – II	**ACTION PLANNING AND MONITORING**	**9 Periods**
Energy Action Planning - Energy Cell – Energy Auditor - Energy Manager - Eligibility - Roles and responsibilities - EnMS ISO (50001:2011) - Project management: Steps in detail. – Energy monitoring and interpretation of variances for remedial actions. Environmental concerns: UNFCC – Kyoto protocol – COP – CDM – PCF – Sustainable development.		
UNIT – III	**ENERGY ASSESSMENT OF THERMAL UTILITIES**	**9 Periods**
Boilers - Types - Performance Evaluation of Boilers–Energy Conservation Opportunity – Furnaces - Types – Fuel economy measures in furnaces - Cogeneration: Principle – Classification – Influencing Factors and technical parameters. Waste heat recovery: Classification – application – benefits - Different heat recovery devices		
UNIT – IV	**ENERGY ASSESSMENT OF ELECTRICAL UTILITIES**	**9 Periods**
Electricity Billing – Estimation and minimization of technical losses in distribution system - Motor efficiency and tests – Energy efficient motors – Effects of rewinding - VFD - Lighting System: Choice of lighting - Types and features – recommended luminance levels – Lighting design for interiors - energy saving opportunities - Case studies - ECBC.		
UNIT – V	**ENERGY ASSESSMENT IN UTILITY SYSTEMS**	**9 Periods**
Financial analysis techniques, ROI, Risk and sensitivity analysis - Payback period – methods – factors affecting analysis. Performance assessment of HVAC System - Pumps - Motors and variable speed drives - Measurements, Procedure – Evaluation.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK :

1	Murphy W.R. and G.Mckay Butter worth , “*Energy Management*”, Heinemann Publications, 2019.
2	Paul o’ Callaghan, “*Energy Management*”, Mc-Graw Hill Book Company – 1 st edition; 2018

REFERENCES :

1	John.C.Andreas, “*Energy Efficient Electric Motors*”, Marcel Dekker Inc Ltd – 2 nd edition; 2018
2	W.C.Turner, “*Energy Management Handbook*”, John Wiley and Sons, Fifth edition, 2019
3	Albert Thumann, Terry Niehus and William J Younger, “*Handbook of Energy Audits*”, Taylor & Francis, 2018
4	www.em-ea.org/gbook1.asp

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Observe energy audit and the document audit report	K2
CO2	Demonstrate energy management actions and develop the understanding of implementation	K3
CO3	Examine the operation of thermal utilities	K4
CO4	Plan the operation of electrical utilities	K4
CO5	Evaluate financial analysis and assess different utility systems.	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	3	3	3	-	3	-	3	3	3	3
CO2	3	3	3	3	3	3	3	3	-	3	-	3	3	3	3
CO3	3	3	3	3	3	3	3	3	-	3	-	3	3	3	3
CO4	3	3	3	3	3	3	3	3	-	3	-	3	3	3	3
CO5	3	3	3	3	3	3	3	3	-	3	-	3	3	3	3
22EPE $05	3	3	3	3	3	3	3	3	-	3	-	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1,5.1.2,5.2.1,5.2.2, 5.3.1, 5.3.2, 6.1.1,6.2.1,7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1,8.2.2,10.1.1,10.1.2, 10.1.3,10.2.1,10.2.2, 10.3.1,10.3.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1,5.1.2,5.2.1, 5.2.2, 5.3.1,5.3.2,6.1.1,6.2.1,7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1,8.2.2,10.1.1,10.1.2, 10.1.3,10.2.1, 10.2.2, 10.3.1,10.3.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2,5.2.1, 5.2.2, 5.3.1,5.3.2,6.1.1,6.2.1,7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2,10.1.1, 10.1.2,10.1.3, 10.2.1, 10.2.2, 10.3.1,10.3.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1,5.1.2, 5.2.1,5.2.2, 5.3.1,5.3.2,6.1.1,6.2.1,7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2,10.1.1, 10.1.2,10.1.3,10.2.1, 10.2.2, 10.3.1,10.3.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1,5.1.2,5.2.1, 5.2.2, 5.3.1,5.3.2,6.1.1,6.2.1,7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1,8.2.2, 10.1.1,10.1.2,10.1.3, 10.2.1,10.2.2, 10.3.1,10.3.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	30	20	-	-	100
CAT2	20	30	30	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	40	40	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	40	40	20	-	100
ESE	20	30	30	20	-	-	100

22EPE$06	DIGITAL PROTECTIVE RELAYS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To understandthe fundamentals of digital relays, concepts of digital signal processing used in digital relays and various algorithms utilized in digital/numerical relays.	
UNIT – I	**INTRODUCTION TO DIGITAL RELAYS**	**9 Periods**
Fundamentals of digital relays: Basic layout - elements of the digital relays with visual illustration; The concept of sampling -aliasing for digital relays-Sliding window concept of digital relays- Estimation of phasors using Full-cycle Discrete Fourier Transform (DFT)-Estimation of phasors using Half-cycle DFT - Discrete Cosine Transform-Estimation of phasors using Walsh function technique - Least Error Square technique; Estimation of frequency in digital relays-practical considerations for selection of various algorithms-Digital Differential Protection of Generator-Induction motors - Busbar		
UNIT – II	**DIGITAL DIFFERENTIAL PROTECTION OF TRANSFORMERS**	**9 Periods**
Digital Directional/Non-directional Overcurrent - Earth fault relays-Overcurrent relay coordination in an interconnected power system network- LINKNET structure - determination of primary/backup relay pairs-Overcurrent relay coordination in an interconnected power system network-Problems faced by digital distance relays. Computation of direction -impedance for digital distance relays- Power swing detection-blocking technique in digital distance Relay-Protection of double-circuit transmission line using digital distance relays-Protection of multi-terminal transmission line using digital distance relays- Protection of series compensated transmission line using digital distance relays-Basic components.		
UNIT – III	**PROTECTION OF SERIES COMPENSATED TRANSMISSION LINE**	**9 Periods**
Voltage/current inversion -sub-synchronous oscillations - additional transients; Load shedding - Frequency relaying: Various load shedding techniques -frequency relays; Load shedding - Frequency relaying: Factors to be considered - rate of frequency decline; Islanding phenomena: Hazards -risk of islanding-methods of islanding; Loss of existing protection -coordination among protective devices: Recloser-Fuse coordination for DG interfaced Distribution network Hardware-in-loop testing of an islanding detection technique-Protection of dc microgrid: Review - challenges.AC microgrid protection: Problems -solutions-Insight in to hybrid ac-dc microgrid protection-Application of traveling wave (TW) -wavelet transform (WT) based algorithm		
UNIT – IV	**APPLICATION OF ARTIFICIAL INTELLIGENCE IN DIGITAL RELAYING**	**9 Periods**
Phasor Measurement Unit (PMU)-IEEE C37.118 standard-Wide area monitoring-control- protection using PMU-IEC 61850 -standard for substation automation -relay interoperability		
UNIT – V	**DIGITAL RELAYING STANDARD**	**9 Periods**
Introduction IEC 61850 standard-relay interoperability: Protection of High voltage dc transmission network-Various cyber-attacks at substation/transmission level for Indian power grid network- Basic concept -application.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK (Maximum 2):

1	Anderson, P.M., Power System Protection, IEEE Press, New York, 1999.
2	Blackburn, J.L., Applied Protective Relaying, Westinghouse Electric Corporation, New York, 1982.

REFERENCES (Minimum 4 and Maximum 6):

1	Bhavesh Bhalja, R. P. Maheshwari, N. G. Chothani, Protection and Switchgear, Oxford University Press, 2nd edition, New Delhi, India, 2018.··
2	Oza, B. A., N. C. Nair, R. P. Mehta, et al., Power System Protection & Switchgear, Tata McGraw Hill, New Delhi, 2010.
3	Phadke, A.G. and J.S. Thorp, Computer Relaying for Power Systems, Research Study Press Ltd, John Wiley & Sons, Taunton, UK, 1988.
4	Bhavesh Bhalja and Vijay H. Makwana, ""Transmission Line Protection Using Digital Technology,"" Springer Science+Business Media Singapore Pte. Ltd; Singapore, January 2016.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Illustrate the concept of digital relay	K2
CO2	Explainthe Differential Protection of Transformers	K2
CO3	Describe Protection of Series compensated transmission line using digital distance relays	K2
CO4	Evaluate the digital relay using the AI	K5
CO5	Review the standards	K2

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	3	2	3	-	-	-	3	3	3	3
CO2	3	3	3	3	3	3	2	3	-	-	-	3	3	3	3
CO3	3	3	3	3	3	3	2	3	-	-	-	3	3	3	3
CO4	3	3	3	3	3	3	2	3	-	-	-	3	3	3	3
CO5	3	3	3	3	3	3	2	3	-	-	-	3	3	3	3
22EPE $06	3	3	3	3	3	3	2	3	-	-	-	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,8.1.1,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2,	
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,8.1.1,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2,	

CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,8.1.1,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2,
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,8.1.1,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2,
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,8.1.1,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	40	20		-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	20	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

22EPE$07	RESTRUCTURED POWER SYSTEMS				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	To obtain knowledge about Indian power markets and deregulation	
UNIT – I	**INTRODUCTION TO RESTRUCTURING OF POWER INDUSTRY**	**9 Periods**

Introduction-Reasons for restructuring / deregulation of power industry-Understanding the restructuring process - Entities involved-The levels of competition-The market place mechanisms-Sector-wise-issues involved in deregulation-objectives of deregulation of various power systems across the world. Fundamentals of Economics -Consumer behavior-Supplier behavior- Market equilibrium, Short-run - Long-run costs, Various costs of production, Relationship between short-run - long-run average costs-Perfectly competitive market- Policies of restructured environment.

UNIT – II	**MARKET MODELS AND TRANSMISSION CONGESTION MANAGEMENT**	**9 Periods**

Market models based on contractual arrangements-Comparison of various market models-Electricity vis-à-vis other commodity - Four pillars of market design.- Market architecture-Definition of congestion-transfer capability limitation-Importance of congestion management in deregulated environment-features of congestion management schemes-Classification of congestion management methods-Calculation of ATC - Definition of various terms-ATC calculation using PTDF -LODF based on DC model-Calculation of ATC using AC model- Non-market methods- Market based methods- Nodal pricing- Inter-zonal- Intra-zonal congestion management-Price area congestion management- Capacity alleviation method.

UNIT – III	**LOCATIONAL MARGINAL PRICES AND FINANCIAL TRANSMISSION RIGHTS**	**9 Periods**

Mathematical preliminaries- Fundamentals of locational marginal pricing-Lossless DCOPF model for LMP calculation-Loss compensated DCOPF model for LMP calculation- ACOPF model for LMP calculation-Financial Transmission Rights-Risk Hedging Functionality Of financial Transmission Right-Simultaneous feasibility test -revenue adequacy-FTR issuance process-Treatment of revenue shortfall-Secondary trading of FTRs-Flow Gate rights-FTR -market power-FTR -merchant transmission investment.

UNIT – IV	**ANCILLARY SERVICES AND TRANSMISSION PRICING**	**9 Periods**

Introduction to ancillary services-Types of ancillary services-Classification of ancillary services, Load-generation balancing related services-Voltage control - reactive power support services-Black start capability service-Co-optimization of energy -reserve services, International comparison-Pricing of transmission network usage -loss allocation - transmission pricing-Principles of transmission pricing-Classification of transmission pricing method-Rolled-in transmission pricing methods- Marginal transmission pricing paradigm-Composite pricing paradigm-Merits -de-merits of different paradigms-Debated issues in transmission pricing- loss allocation-Classification of loss allocation methods -comparison.

UNIT – V	POWER MARKETS AND REFORMS IN INDIAN POWER SECTOR	9 Periods
Attributes of a perfectly competitive market-The firm's supply decision under perfect competition-Imperfect competition-Market power-Financial markets associated with electricity markets-optimal bidding by a generator company-Optimal bidding methods- Reforms in Indian power sector:Framework of Indian power sector-Reform initiatives during 1990-1995-Availability Based Tariff (ABT)-The Electricity Act 2003- Open Access issues-Powerexchange-Reforms in near future.		
Contact Periods: **Lecture:45 Periods Tutorial: 0___ Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK (Maximum 2):

1	Kankar Bhattacharya, Jaap E. Daadler, Math H.J Bollen, "Operation of restructured power systems" , Kluwer Academic Pub., 2001.
2	Loi Lei Lai, "Power system Restructuring and Deregulation", John Wiley & sons, 2001

REFERENCES (Minimum 4 and Maximum 6):

1	Sally Hunt, "Making competition work in electricity", John Wiley & Sons, Inc., 2002.
2	Shahidehpour M and Alomoush M, "Restructuring Electrical Power Systems", Marcel Decker Inc., 2001.
3	Daniel S. Kirschen and GoranStrbac, "Fundamentals of Power System Economics", John Wiley &SonsLtd., 2004.
4	Steven Stoft, " Power System Economics", Wiley – IEEE Press, 2002.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Demonstrate the new dimensions associated with the power systems with techno-commercial issues	K2
CO2	Apply various solutions for the commercial problems through study of fundamentals of micro economics	K3
CO3	Design power markets and market architectural aspects as per the restructuring of power system	K4
CO4	Identify operational challenges and manage the same with optimum solution	K5
CO5	Suggest reform practices in developing countries with special focus on Indian power system	K6

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	3	2	2	1	-	-	-	-	-	-	3	3	2	1
CO2	3	3	3	2	2	2	-	-	-	-	-	2	3	3	3
CO3	3	3	2	3	3	-	-	-	-	-	-	2	2	3	2
CO4	3	3	2	3	2	-	-	-	-	-	-	2	2	3	2
CO5	2	2	2	1	1	-	-	-	-	-	-	2	2	3	1
22EPE$07	3	3	2	2	2	-	-	-	-	-	-	2	0	0	0

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.2, 3.1.4,3.1.6,3.2.1,3.2.3,3.3.2,4.1.1,4.1.4,4.3.1,4.3.3,5.1.1,5.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2,
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1, 3.1.2,3.1.3,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,4.1.2,4.2.1,4.3.1,4.3.2,4.3.4,5.1.1,5.1.2,5.2.2,5.3.1, 6.1.1,12.1.1,12.1.2,12.2.2,12.3.2,
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1, 3.1.2,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.2,4.1.1,4.1.3,4.2.2,4.3.1,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.2, 12.1.1,12.2.1,12.3.1,
CO4	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.2,3.1.5,3.2.1, 3.2.2,3.2.3,3.3.2,3.4.1,4.1.2,4.2.1,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.2.1,5.3.1,12.1.1,12.1.2,12.2.1,12.3.1,
CO5	1.1.2,1.2.1,1.3.1,2.1.1,2.1.2,2.2.1,2.2.2,2.2.3,2.3.1,2.4.1,2.4.3,2.4.4,3.1.2,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,4.3.3, 5.1.2,5.2.2,12.1.1,12.1.2,12.2.2,12.3.2,

ASSESSMENT PATTERN – THEORY (Times New Roman, Size 11)

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	20	40	20		-	100
CAT2	20	20	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	20	10	10	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	10	10	100
ESE	10	20	30	20	20	-	100

22EPE$08	HIGH VOLTAGE ENGINEERING

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To impart knowledge on the types of over voltages in power system and protection methods, generation of over voltages in laboratories, measurement of over voltages andbreakdown mechanisms in solid, liquid and gaseous dielectrics.	
UNIT – I	**OVER VOLTAGES IN ELECTRICAL POWER SYSTEMS**	**9 Periods**
Causes of over voltages and its effects on power system – Lightning, switching surges - temporary over voltages, Corona -its effects – Bewley lattice diagram- Protection against over voltages		
UNIT – II	**DIELECTRIC BREAKDOWN**	**9 Periods**
Properties of Dielectric materials - Gaseous breakdown in uniform -non-uniform fields – Corona discharges – Vacuum breakdown – Conduction-breakdown in pure -commercial liquids, Maintenance of oil Quality – Breakdown mechanisms in solid -composite dielectrics- Applications of insulating materials in electrical equipments.		
UNIT – III	**GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS**	**9 Periods**
Generation of High DC voltage: Rectifiers, voltage multipliers, van de graaff generator: generation of high impulse voltage: single -multistage Marx circuits – generation of high AC voltages: cascaded transformers, resonant transformer- tesla coil- generation of switching surges – generation of impulse currents - Triggering - control of impulse generators.		
UNIT – IV	**MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS**	**9 Periods**
High Resistance with series ammeter – Dividers, Resistance, Capacitance - Mixed dividers - Peak Voltmeter, Generating Voltmeters - Capacitance Voltage Transformers, Electrostatic Voltmeters – Sphere Gaps - High current shunts- Digital techniques in high voltage measurement.		
UNIT – V	**HIGH VOLTAGE TESTING AND INSULATION COORDINATION**	**9 Periods**
High voltage testing of electrical power apparatus as per International- Indian standards –Power frequency, impulse voltage -DC testing of Insulators, circuit breakers, bushing, isolators-transformers- Insulation Coordination-testing of capabilities.		
Contact Periods: **Lecture: 45 Periods Tutorial: ___ Periods Practical: ___ Periods Total:45 Periods**		

TEXT BOOK (Maximum 2):

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 (Minimum 4 and Maximum 6):

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.

Note: Books with 10 years before publications may be avoided

COURSE OUTCOMES: - Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain Transients in power system..	K1
CO2	Illustrate Generation and measurement of high voltage.	K3
CO3	Demonstrate High voltage testing.	K4
CO4	Elaborate various types of over voltages in power system	K1
CO5	Measure and Test over voltages, test power apparatus and insulation coordination	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PS O2**	**PSO 3**
CO1	3	3	3	3	3	3	2	-	-	-	-	3	3	3	3
CO2	3	3	3	3	3	3	2	-	-	-	-	3	3	3	3
CO3	3	3	3	3	3	3	2	-	-	-	-	3	3	3	3
CO4	3	3	3	3	3	3	2	-	-	-	-	3	3	3	3
CO5	3	3	3	3	3	3	2	-	-	-	-	3	3	3	3
22EPE$08	3	3	3	3	3	3	2	-	-	-	-	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO 1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1, 3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1, 4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1 ,12.3.2,
CO 2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1, 3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1, 4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1 ,12.3.2,
CO 3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1, 3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1, 4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1 ,12.3.2,
CO 4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1, 3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1, 4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1 ,12.3.2,
CO 5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1, 3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1, 4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1 ,12.3.2,

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	20	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

DRIVES AND ENERGY TECHNOLOGIES – V2

22EPE$09	SPECIAL MACHINES AND CONTROLLERS					
PREREQUISITES :		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	3	0	0	3
Course Objectives	To grasp the principle of working of special electrical machines and to cater the knowledge to real world applications.					
UNIT – I	**STEPPING MOTORS**	**9 Periods**				
Constructional features – Principle of operation – Modes of excitation – Torque production in Variable Reluctance (VR) stepping motor – Dynamic characteristics – Drive systems and circuit for open loop control– Closed loop control of stepping motor						
UNIT – II	**SWITCHED RELUCTANCE MOTORS**	**9 Periods**				
Constructional features – Principle of operation – Torque equation – Power controllers – Characteristics and control : Speed control-current control- Sensor less operation of SRM – Current sensing- rotor position measurement and estimation methods- sensor less rotor position estimation- inductance based estimation - Microprocessor based controller.						
UNIT – III	**SYNCHRONOUS RELUCTANCE MOTORS**	**9 Periods**				
Constructional features –Types –Axial and radial air gap motors –Phasor diagram –Characteristic and Control - Vernier motor - Applications						
UNIT – IV	**PERMANENT MAGNET BRUSHLESS DC MOTORS**	**9 Periods**				
Commutation in DC motors – Difference between mechanical and electronic commutators – Hall sensors – Optical sensors – Multiphase Brushless motor – Square wave permanent magnet brushless motor drives – Torque and emf equation – Torque and Speed characteristics – Microprocessor based controller.						
UNIT – V	**PERMANENT MAGNET SYNCHRONOUS MOTORS**	**9 Periods**				
Constructional features - Principle of operation – EMF, power input and torque expressions – Phasor diagram – Power controllers – Torque and Speed characteristics –Current and Speed control - Self control – Vector control – Current control schemes.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

TEXT BOOK (Maximum 2):

1	R. Krishnan - Switched Reluctance Motor Drives Modeling, Simulation, Analysis, Design, and Applications -CRC Press 2017
2	T.Kenjo, ‘ Stepping motors and their microprocessor controls’, Oxford University press, New Delhi, Dekker 2009

REFERENCES (Minimum 4 and Maximum 6):

1	.T.J.E. Miller, ‘Brushless magnet and Reluctance motor drives’, Clarendon press, London, 1989
2	Ramu Krishnan - Permanent Magnet Synchronous and Brushless DC Motor Drives -CRC Press, Marcel Applications -CRC Press 2009
3	Bilgin, Berker Emadi, Ali Jiang, James Weisheng - Switched reluctance motor drives: fundamentals to applications-CRC 2019.
4	Jacek F. Gieras, Dr. Rong-Jie Wang, Professor Maarten J. Kamper - Axial Flux Permanent Magnet Brushless Machines-Springer Netherlands 2008

Note: Books with 10 years before publication may be avoided

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Describe the constructional features, principle of operation and the types of special electrical machines	K2
CO2	Compute the Torque and EMF equations of the special electrical machines	K3
CO3	Interpret the static and dynamic characteristics of the special electrical machines	K3
CO4	Examine various converter circuits for special electrical machines	K3
CO5	Develop different controllers for special electrical machines.	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	2	1	2	1	1	-	-	1	1	3	3	3
CO2	3	1	1	2	1	2	1	1	-	-	1	1	2	2	2
CO3	3	1	1	2	1	2	1	1	-	-	1	1	2	2	2
CO4	3	1	1	2	1	2	1	1	-	-	1	1	2	2	2
CO5	3	1	1	2	1	2	1	1	-	-	1	1	2	2	2
22EPE$09	3	1	1	2	1	2	1	1	-	-	1	1	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1, 1.3.1, 1.4.1, 2.2.2, 2.2.4, 2.3.1, 2.4.4, 3.1.5, 12.1.1, 12.1.2, 12.3.1
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.3, 2.3.1,2.3.2, 2.4.1, 2.4.2,2.4.3, 2.4.4, 3.1.1 3.1.2, 3.1.3, 3.1.5, 3.1.6, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.3, 4.1.4, 4.2.1, 12.1.1, 12.2.1
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.3.2, 2.4.1,2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.4, 4.2.1, 4.2.2, 12.1.1, 12.1.2, 12.2.1
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 3.1.2, 3.1.3, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.3, 4.2.1, 4.2.2, 4.3.1, 7.2.2, 12.2.1, 12.2.2, 12.3.2
CO5	.1.1, 1.1.2, 1.3.1, 2.1.3, 2.2.2, 2.2.4, 2.3.1, 2.4.2, 3.1.2, 3.1.3, 3.1.4, 3.1.6, 3.3.1, 3.3.2, 3.4.2, 4.1.3, 4.2.1, 4.2.2, 4.3.1, 6.2.1, 7.1.1, 7.2.2, 12.2.1, 12.2.2, 12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	40	40	10	-	-	100
CAT2	10	30	50	10	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	40	30	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	40	30	30	-	-	100
ESE	10	40	40	10	-	-	100

22EPE$10	POWER QUALITY ENGINEERING					
PREREQUISITES :		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	3	0	0	3
Course Objectives	To analyze the power quality issues in power systems and provide practical engineering solutions to mitigate the PQ problems					
UNIT – I	**INTRODUCTION TO POWER QUALITY PROBLEM**	**9 Periods**				
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.						
UNIT – II	**ANALYSIS OF SINGLE PHASE AND THREE PHASE SYSTEM**	**9 Periods**				
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 nonlinear loads – concept of power factor – three phase- three wire – three phase - four wire system.						
UNIT – III	**MITIGATION OF POWER SYSTEM HARMONICS**	**9 Periods**				
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.						
UNIT – IV	**DSTATCOM**	**9 Periods**				
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.						
UNIT – V	**SERIES COMPENSATION OF POWER DISTRIBUTION SYSTEM**	**9 Periods**				
Rectifier supported DVR – DC Capacitor supported DVR – DVR Structure – Voltage Restoration – Series Active Filter – Unified Power Quality Conditioner.						
Contact Periods: **Lecture: _45_ Periods Tutorial: _0__Periods Practical: _0_Periods Total: _45_ Periods**						

TEXT BOOK (Maximum 2):

1	*Arindam Ghosh and GeradLedwich **"Power Quality Enhancement Using Custom Power Devices"**, Springer Publishers, First Edition,2009*
2	*George J. Wakileh, **"Power System Harmonics – Fundamentals, Analysis and Filter Design"**, Springer – Verlag Berlin Heidelberg, New York, 2019.*

REFERENCES (Minimum 4 and Maximum 6):

1	*G.T.Heydt, **"Electric Power Quality"**, Stars in a Circle Publications, Second Edition, 2011.*
2	*R.C.Duggan **"Electric Power Systems Quality"**, Tata MC Graw Hill Publishers, Third Edition, 2012.*
3	*Arrillga**"Power System Harmonics"**, John Wiely and Sons, 2003 2nd Edition.*
4	*Derek A.Paice**"Power Electronic Converter Harmonics"** IEEE Press, 1995, Wiley – IEEE Press 1999, 18th Edition.*

Note: Books with 10 years before publications may be avoided

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Illustrate the importance of power quality and differentiate various power quality issues	**K2**
CO2	Explain the various concepts related with linear / nonlinear loads and single phase / three phase sinusoidal, non-sinusoidal sources.	**K2**
CO3	Identify the sources of harmonics and choose the methods for controlling the harmonic distortion	**K3**
CO4	Analyze load compensation with DSTATCOM	**K4**
CO5	Illustrate the role of DVR, SAFs UPQC in power distribution systems	**K2**

COURSE ARTICULATION MATRIX :

a. CO and PO Mapping

	PO1	PO2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	3	3
CO2	1	3	1	-	-	-	-	-	-	-	-	-	2	2	2
CO3	3	3	1	-	-	-	-	-	-	-	-	-	2	2	2
CO4	3	3	3	3	1	-	-	-	-	-	-	-	2	2	2
CO5	2	3	-	-	-	-	-	-	-	-	-	-	2	2	2
22EPE$10	**2**	**3**	**2**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b. CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.4.1, 2.4.3, 2.4.4
CO2	1.2.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.4, 3.2.1, 3.2.3
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 5.1.1, 5.1.2
CO5	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	40	40	10	-	-	100
CAT2	10	30	50	10	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	40	30	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	40	30	30	-	-	100
ESE	10	40	40	10	-	-	100

22EPE$11	ENERGY STORAGE TECHNOLOGY					
PREREQUISITES :		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To explore the fundamentals, technologies and applications of energy storage systems.					
UNIT – I	**HISTORICAL PERSPECTIVE OF ENERGY STORAGE SYSTEM**	**9 Periods**				
Storage Needs - Variations in Supply and energy demand Interruptions in Energy Supply- Transmission Congestion - Demand for Portable Energy-Demand and scale requirements - Environmental and sustainability issues.						
UNIT – II	**CLASSIFICATION OF STORAGE SYSTEM**	**9 Periods**				
Introduction: Energy and Energy Transformations, Potential energy (pumped hydro, compressed air, springs)- Kinetic energy (mechanical flywheels)- Thermal energy without phase change passive (adobe) and active (water)-Thermal energy with phase change (ice, molten salts, steam)- Chemical energy (hydrogen, methane, gasoline, coal, oil)- Electrochemical energy (batteries, fuel cells)- Electrostatic energy (capacitors), Electromagnetic energy (superconducting magnets)- Different Types of Energy Storage Systems.						
UNIT – III	**PERFORMANCE FACTORS OF ENERGY STORAGE SYSTEMS**	**9 Periods**				
Energy capture rate and efficiency- Discharge rate and efficiency- Dispatch ability and load flowing characteristics, scale flexibility, durability – Cycle lifetime, mass and safety – Risks of fire, explosion, toxicity- Ease of materials, recycling and recovery- Environmental consideration and recycling , Merits and demerits of different types of Storage. Comparison of Storage Technologies- Technology options- Performance factors and metrics- Efficiency of Energy Systems- Energy Recovery						
UNIT – IV	**BATTERY AND THERMAL ENERGY STORAGE SYSTEMS**	**9 Periods**				
Battery Storage System: Lead Acid and Lithium- Chemistry of Battery Operation, Power storage calculations, Charging patterns, Battery Management systems -Areas of Application of Energy Storage: Waste heat recovery- Solar energy storage- Greenhouse heating-Power plant applications-Drying and heating for process industries, energy storage in automotive applications in hybrid and electric vehicles.						
UNIT – V	**HYDROGEN FUEL CELLS AND FLOW BATTERIES**	**9 Periods**				
Hydrogen Economy and Generation Techniques, Storage of Hydrogen, Energy generation - Super capacitors: properties, power calculations – Operation and Design methods - Hybrid Energy Storage: Managing peak and Continuous power needs, Hybrid energy storage: battery and supercapacitor combination, need, operation and Merits; Flow Battery operation-Applications: Storage for Hybrid Electric Vehicles-Regenerative Power-capturing methods.						
Contact Period: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

TEXT BOOK:

1	*DetlefStolten,* **"Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications**", *Wiley, 2014.*
2	*Jiujun Zhang, Lei Zhang,Hansan Liu, Andy Sun, Ru-Shi Liu*, **"Electrochemical Technologies"**, 2012.

REFERENCES :

1	*Francois Beguin and ElzbietaFrackowiak,* **"Super capacitors**", *Wiley, 2015.*
2	*Doughty Liaw, Narayan and Srinivasan,* **"Batteries for Renewable Energy Storage**", *The Electrochemical Society, New Jersy, 2016.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Acquire knowledge on the evolution and technologies of energy storage systems	K2
CO2	Summarize the basics of different energy storage mechanisms.	K2
CO3	Evaluate the performance factors of energy storage systems.	K5
CO4	Identify the field of applications for renewable energy systems.	K4
CO5	Explore the possibilities of hybrid energy storage techniques and applications.	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	2	2	2	-	-	1	2	3	1	2	3
CO2	3	3	1	2	2	-	-	-	-	-	-	2	3	2	2
CO3	3	3	2	2	2	3	2	2	1	1	2	-	2	2	2
CO4	3	3	2	2	2	3	2	2	1	1	2	-	2	2	2
CO5	2	2	2	2	2	2	2	-	-	1	2	3	2	2	3
22EPE$11	3	3	2	2	2	3	2	2	1	1	2	3	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO 1	1.2.1,1.3.1,1.4.1,2.3.1,2.3.2,2.4.4,3.1.3,3.1.6,3.2.1,4.1.4,4.2.1,4.3.4,5.1.1,5.3.1,6.1.1,7.1.1,7.2.2,10.1.1,10.3.1,11.1.1,11.1.2,11.3.1,12.1.1,12.2.1,12.2.2,12.3.1,12.3.2
CO 2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1,3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2
CO 3	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.4,3.1.4,3.15,3.1.6,3.2.1,3.2.2,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,5.2.1,5.2.2,5.3.2,6.1.1,6.2.1,7.1.1,7.2.1,8.1.1,8.2.1,9.1.2,10.1.1,10.3.1,11.1.1,11.1.2,11.2.1
CO 4	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.4,3.1.4,3.15,3.1.6,3.2.1,3.2.2,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,5.2.1,5.2.2,5.3.2,6.1.1,6.2.1,7.1.1,7.2.1,8.1.1,8.2.1,9.1.2,10.1.1,10.3.1,11.1.1,11.1.2,11.2.1
CO 5	1.2.1,1.3.1,1.4.1,2.3.1,2.3.2,2.4.4,3.1.3,3.1.6,3.2.1,4.1.4,4.2.1,4.3.4,5.1.1,5.3.1,6.1.1,7.1.1,7.2.2,10.1.1,10.3.1,11.1.1,11.1.2,11.3.1,12.1.1,12.2.1,12.2.2,12.3.1,12.3.2

ASSESSMENT PATTERN							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	20	10	10	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

22EPE$12	MICROGRID TECHNOLOGY					
PREREQUISITES :		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To study the theory of distributed generations, operation, control and protection of microgrids					
UNIT – I	**DISTRIBUTED GENERATION**				**9 Periods**	
Renewable sources in distributed generation – Current scenario in India – DG: Siting and sizing - Optimal placement of DG sources in distribution systems-Standards for interconnecting Distributed resources to electric power systems: IEEE 1547.						
UNIT – II	**DISTRIBUTED GENERATION IN MICROGRID**				**9 Periods**	
Solar Photovoltaic system : Types of Solar cells - characteristics of solar PV module -MPPT techniques - Wind power generation: Power available in wind- Classification - wind generators- MPPT techniques. Fuel cells: types- working principle of hydrogen fuel cells –applications.						
UNIT – III	**GRID INTEGRATION OF DGs AND ENERGY STORAGE SYSTEMS**				**9 Periods**	
Grid integration and stand alone operation of DG– Energy storage system: need for energy storage in Microgrid- working and characteristics of Batteries, ultra-capacitors and flywheels energy storage systems-Life Cycle Assessment						
UNIT – IV	**OPERATION OF MICROGRID**				**9 Periods**	
Microgrids :Concept and Structure- Operation Modes: Grid connected and stand alone operation - power electronic converter topologies: DC-DC converters- Grid connected converter-Hierarchical Microgrid Control: Local, secondary and Global and Droop Control -Structure and operation of AC, DC and hybrid microgrids.						
UNIT – V	**PROTECTION AND COMMUNICATION IN MICROGRID**				**9 Periods**	
Protection of microgrids - Power quality issues in microgrids- Stability issues in microgrids - Introduction to interconnection of microgrids and Centralized and Decentralized Energy Management -Communication: objectives and requirements - Local, Field, Wide, Neighbourhood, Home area networks - Wireless communication : ZigBee, Wireless local area network and Z-wave -Protocols: IEC 61850 and Modbus						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

TEXT BOOK :

1	*G.D. Rai, "Non Conventional energy Sources", Khanna Publications , New Delhi , Sixth Edition , 2017*
2	*N.M.Tabatabaei, E.Kabalci and N.Bizon,"Microgrid Architectures, Control and Protection Methods", Springer, 2020.*
3	*Bevrani.H, Francois.B and Ise.T, "Microgrid Dynamics and Control", John Wiley & Sons, Inc, 2017*

REFERENCES :

1	*Loi Lei Lai, Tze Fun Chan,* **"Distributed Generation- Induction and Permanent Magnet Generators"**, *IEEE Press, John Wiley & Sons, Ltd., England. 2007.*
2	*John Twidell and Tony Weir,* **"Renewable Energy Resources"**, *Taylor and Francis Publications, Fourth edition 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Acquire knowledge on the concept of distributed generation in a power system	K2
CO2	Gain comprehension of various distributed energy Resources	K2
CO3	Evaluate the technical impacts of DG's in power systems and energy storage technologies.	K5
CO4	Explain the concepts and modeling of DC and AC microgrids	K2
CO5	Analyze the modes of operation and performance of micro grids	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	2	2	2	-	-	1	1	-	3	2	1
CO2	3	3	2	2	2	3	2	2	1	1	3	3	3	2	1
CO3	3	3	1	2	2	-	-	-	-	-	-	2	3	3	2
CO4	3	2	2	2	2	-	2	-	-	1	2	-	3	3	2
CO5	3	3	1	2	2	-	-	-	-	-	-	2	3	3	2
22EPE $12	3	3	2	2	2	3	2	2	1	1	2	2	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1,1.3.1,1.4.1,2.3.1,2.3.2,2.4.4,3.1.3,3.1.6,3.2.1,4.1.4,4.2.1,4.3.4,5.1.1,5.3.1,6.1.1,7.1.1,7.2.2,10.1.1,10.3.1,11.1.1
CO2	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.4,3.1.4,3.15,3.1.6,3.2.1,3.2.2,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,5.2.1,5.2.2,5.3.2,6.1.1,6.2.1,7.1.1,7.2.1,8.1.1,8.2.1,9.1.2,10.1.1,10.3.1,11.1.1,11.1.2,11.2.1,11.3.1,11.3.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1,3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.3,2.2.4,2.4.2,2.4.3,2.4.4,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.3.1,4.1.2,4.1.4,4.2.1,5.1.2,5.2.2,5.3.2,7.1.1,7.2.2,10.1.1,10.3.1,11.2.1,11.1.2,11.3.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1,3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2

ASSESSMENT PATTERN							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	30	10	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

22EPE$13	RENEWABLE ENERGY SOURCES AND TECHNOLOGY					
PREREQUISITES :		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	3	0	0	3
Course Objectives	To elucidate the technologies used for generation and utilization of power from renewable energy resources.					
UNIT – I	**RENEWABLE ENERGY SOURCES**	**9 Periods**				
Conventional energy sources - Environmental consequences - Renewable energy sources - Types of RE sources - Limitations - Present Indian and International scenario of Conventional and RE sources and policies						
UNIT – II	**SOLAR ENERGY AND THERMAL ENERGY**	**9 Periods**				
Solar Radiation, Radiation Measurement : solar spectra-latitude and longitude, Declination angle, solar window, cosine law, seasonal variations, hour angle, calculation of angle of incidence, angstroms equation and constants - Solar Photovoltaic systems : Basic Principle of SPV conversion – Types of PV Systems- Types - Photovoltaic cell concepts: Cell, module, array ,PV Module I-V Characteristics, Efficiency - series and parallel connections, maximum power point tracking, Applications. Solar Thermal Power Plant, Central Receiver Power Plants, Solar Ponds.- Thermal Energy storage system with PCM						
UNIT – III	**WIND ENERGY**	**9 Periods**				
Wind energy - Power in the Windwind data and energy estimation, site selection,- Basic principle of wind energy conversion system - components of wind energy conversion systems - design consideration of horizontal axis wind mill- merits and limitations- Grid integration issues of Wind Power Plant - applications.						
UNIT – IV	**BIOMASS ENERGY**	**9 Periods**				
Biomass, sources of biomass, thermo-chemical and bio-chemical conversion of biomass - Pyrolysis, gasification, combustion and fermentation. Gasifiers – Up draft, downdraft and fluidized bed gasifier. Digesters- Fixed and floating digester biogas plants- Hydrogen Production and Storage- Fuel cell : Principle of working- various types - construction and applications. Energy Storage System- Hybrid Energy Systems.						
UNIT – V	**OCEAN AND GEOTHERMAL ENERGY**	**9 Periods**				
Ocean energy resources - Principles of ocean thermal energy conversion systems - ocean thermal power plants - Principles of ocean wave energy conversion and tidal energy conversion - Difference between tidal and wave power generation, Economics of OTEC. Definition and classification of Geothermal resources, Utilization for electricity generation and direct heating, Wellhead power generating units. Overview of micro and mini hydel power generation.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

TEXT BOOK (Maximum 2):

1	Chetan Singh Solanki, " Solar Photovoltaics: Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2011
2	Kothari, D. P.,Ranjan, Rakesh, Singal, K. C. "Renewable Energy Sources and Emerging Technologies", THIRD EDITION, Print Book ISBN : 9789389347890, 2022.

REFERENCES

1	Shobh Nath Singh, ‘Non-conventional Energy resources’ Pearson Education 2015
2	Godfrey Boyle, “Renewable energy”, Open University, Oxford University Press in association with the Open University, 2004.
3	Roland Wengenmayr, Thomas Buhrke, “Renewable energy: Sustainable energy concepts for the future”, Wiley-VCH, 1st edition, 2008
4	Bansal NK, Kleeman and Meliss, M “Renewable Energy Sources and Conversion Techniques”, Tata McGraw Hill, 1996
5	Sunil S. Rao and Dr. B.B. Parulekar, “Energy Technology”, Khanna Publishers, Second Ed. 1997
6	Rai , G.D., “NonConventional sources of Energy”, Khanna Publishers , IV Ed.,2009

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Interpret the impact and current scenario of renewable energy sources	K2
CO2	Explain the principles and applications of solar and thermal energy technologies	K3
CO3	Describe the principle, types and grid integration of wind energy technology	K3
CO4	Outline the characteristics, types and applications of biomass energy	K2
CO5	Acquire knowledge of the ocean and the geothermal technology	K2

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	2	2	1	1	2	2	-	-	-	-	1	2	1	1
CO2	2	3	2	3	1	1	1	-	-	-	-	1	3	3	1
CO3	3	2	1	3	1	1	1	-	-	-	-	2	3	3	1
CO4	3	2	1	0	1	1	1	-	-	-	-	2	3	2	2
CO5	2	1	1	0	1	2	3	-	-	-	-	2	2	2	2
22EPE$13	2	2	1	1	1	1	1	-	-	-	-	2	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping (Times New Roman, Size 11)

CO1	1.2.1, 2.1.1, 2.2.2, 2.2.3, 2.2.4, 3.1.1, 3.1.3, 3.1.5, 3.1.6, 3.2.3, 3.4.1, 6.1.1, 7.2.1, 7.2.2, 12.1.1, 12.3.1	
CO2	1.1.1, 1.1.2, 1.3.1, 2.1.1, 2.1.2,. 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 3.1.2, 3.1.6, 3.2.2, 3.3.1, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.3, 4.3.4, 12.1.1	
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 3.1.2, 3.1.6, 3.2.2, 3.3.1, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.3, 4.3.4, 12.1.1, 12.2.1	
CO4	1.1.1, 1.1.2,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 3.1.2, 3.1.6, 3.2.2, 3.3.1, 12.2.1, 12.2.2, 12.3.2	
CO5	1.1.1, 1.1.2, 1.3.1, 2.1.3, 3.1.2, 3.1.6, 3.2.2, 3.3.1, 6.2.1, 7.1.1, 7.1.2, 7.2.2, 12.2.1, 12.2.2, 12.3.2	

ASSESSMENT PATTERN – THEORY (Times New Roman, Size 11)							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) % -**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40	-	-	-	100
CAT2	20	30	50	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	10	40	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	20	40	40	-	-	-	100

<table>
<tr><td>22EPE$14</td><td colspan="5">DESIGN OF MOTOR AND POWER CONVERTERS
FOR ELECTRIC VEHICLES</td></tr>
<tr><td colspan="2">PREREQUISITES :</td><td>CATEGORY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2">NIL</td><td>PE</td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td>Course Objectives</td><td colspan="6">To expose the types of different power converters, motors and controllers and their functions for Electric Vehicle.</td></tr>
<tr><td>UNIT – I</td><td colspan="4">POWER CONVERSION CIRCUITS</td><td colspan="2">9 Periods</td></tr>
<tr><td colspan="7">Non-Isolated Power Converters: Half-Bridge Buck-Boost Bidirectional Converter, Buck Converter, Boost Converter - Inductor Sizing - Capacitor Sizing - Isolated Power Converters: Forward Converter - Sizing the Transformer - Full-Bridge Converter - Resonant Power Conversion - Desirable Converter Characteristics for Inductive Charging - Three-Phase Inverters - Modulation Schemes.</td></tr>
<tr><td>UNIT – II</td><td colspan="4">DC MOTOR DRIVES</td><td colspan="2">9 Periods</td></tr>
<tr><td colspan="7">DC Machines: speed torque characteristics - power, losses and efficiency – starting and speed control methods – regenerative braking – closed loop speed control – design criteria of DC motor drives for EVs – Application of DC motor drives in EVs.
PMBLDC Motor - operation – speed torque characteristics – speed control techniques – inverters requirements - closed loop control - outer rotor PMBLDC motor drive - Design criteria of PMBLDC - Application of PMBLDC drives in EVs.</td></tr>
<tr><td>UNIT – III</td><td colspan="4">INDUCTION MOTOR DRIVES</td><td colspan="2">9 Periods</td></tr>
<tr><td colspan="7">Operation - speed torque characteristics – starting methods - speed control and braking techniques – inverters for induction motor – PWM techniques – closed loop speed/torque control – Field Oriented Control (FOC) – Direct Torque Control (DTC) - design criteria of induction motor drives for EVs.</td></tr>
<tr><td>UNIT – IV</td><td colspan="4">PERMANENT MAGNET SYNCHRONOUS MOTOR AND SWITCHED RELUCTANCE MOTOR DRIVES</td><td colspan="2">9 Periods</td></tr>
<tr><td colspan="7">Permanent Magnet Synchronous Motor (PMSM) – operation – speed torque characteristics – speed control techniques – inverters requirements - closed loop control – Planetary geared PMSM drive - Design criteria of PMSM drives for EVs.
Switched Reluctance Motor (SRM) - Geometry structure - principle of operation –converter topologies for SRM – closed loop control – torque ripple reduction techniques - Design criteria of SRM drives for EVs.</td></tr>
<tr><td>UNIT – V</td><td colspan="4">CONTROL OF ELECTRIC DRIVE</td><td colspan="2">9 Periods</td></tr>
<tr><td colspan="7">Introduction - Feedback Controller Design Approach - Modeling the Electromechanical System -Mechanical System -PM DC Machine - DC-DC Power Converter - PI Controller - Designing Torque Loop Compensation - Determining Compensator Gain Coefficients for Torque Loop - Designing Speed Control Loop Compensation - Determining Compensator Gain Coefficients for Speed Loop - Acceleration of Battery Electric Vehicle (BEV) using PM DC Machine.</td></tr>
<tr><td colspan="7">Contact Periods:
Lecture: 45 Periods Tutorial: 0 Periods Practical: Periods Total: 45 Periods</td></tr>
</table>

TEXT BOOK:

1	*Chau K.T., **"Electric Vehicle Machines and Drives: Design, Analysis and Application"**, Wiley – IEEE Press, 2015.*
2	*John G. Hayes, G. Abas Goodarzi, **"Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles"** John Wiley & Sons Ltd., 1st edition, 2018.*

REFERENCES:

1	*Iqbal Hussain, **"Electric and Hybrid Vehicles: Design Fundamentals, Second Edition"** CRC Press, Taylor & Francis Group, Third Edition 2021.*
2	*Bimal K Bose, **"Modern Power Electronics and AC drives"**, Pearson Education, 1st Edition, 2015.*
3	*Krishnan R., **"Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design and Applications"**, CRC Press, 2001.*

Note: Books with 10 years before publications may be avoided

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Illustrate various types of converter/inverter circuits and closed loop operation.	K2
CO2	Demonstrate the working principles, performance and speed - torque characteristics of various types of electrical machines.	K3
CO3	Compare various starting, braking methods and speed control techniques of electrical machines.	K4
CO4	Evaluate various control techniques for electrical drives.	K5
CO5	Use an appropriate electric machine for electric vehicle application.	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	3	2	2	2	1	-	–	-	3	3	2	1
CO2	3	1	1	2	1	2	2	-	-	-	-	2	2	3	1
CO3	2	2	2	2	2	2	1	1	-	-	-	2	1	2	3
CO4	2	2	2	3	2	2	2	-	-	-	-	2	2	3	2
CO5	2	2	2	2	2	-	2	1	-	-	-	2	3	3	2
22EPE $14	3	2	2	3	2	2	2	1	-	-	-	3	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping		
CO1	1.1.1,1.1.2,1.3.1,2.1.2,2.1.3,2.2.1,2.2.4,2.3.1,2.4.2,2.4.4,3.1.1,3.1.3,3.1.5,3.2.1,3.2.2,3.3.2,4.1.1,4.1.3,4.2.1,4.3.1,4.3.2,4.3.3,5.1.1,5.2.1,5.2.2,6.2.1,7.1.2,7.2.2,8.1.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,	
CO2	1.1.1,1.1.2,1.2.1,1.4.1,2.1.3,2.2.3,2.4.1,2.4.3,3.1.2,3.1.4,3.3.1,3.4.2,4.1.3,4.2.1,4.2.2,4.3.1,4.3.3,5.2.1,5.3.1,6.1.1,7.1.1,7.2.1,12.1.2,12.2.1,12.3.1,12.3.2,	
CO3	1.1.1,1.1.2,1.3.1,2.1.1,2.1.2,2.2.1,2.2.2,2.3.2,2.4.2,2.4.4,3.1.1,3.1.2,3.1.4,3.1.6,3.2.1,3.2.2,3.3.2,3.4.1,4.1.1,4.1.3,4.1.4,4.3.1,4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.1.2,8.1.1,12.1.1,12.1.2,12.2.2,	
CO4	1.1.2,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.4,2.3.1,2.4.1,2.4.3,3.1.2,3.1.4,3.2.1,3.2.3,3.3.2,3.4.2,4.1.2,4.1.4,4.2.2,4.3.1,4.3.2,4.3.3,5.1.1,5.2.1,5.3.1,6.2.1,7.2.1,7.2.2,12.1.1,12.2.1,12.2.2,12.3.2,	
CO5	1.1.1,1.4.1,2.1.2,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.2,2.4.4,3.1.2,3.1.5,3.2.1,3.3.1,3.4.1,4.1.4,4.2.2,4.3.3,5.2.1,5.2.2,5.3.2,7.1.1,7.2.2,8.2.1,12.1.1,12.2.1,12.3.1,12.3.2,	

ASSESSMENT PATTERN – THEORY (Times New Roman, Size 11)							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	10	40	10	-	100
CAT2	10	20	10	40	20	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	20	30	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	20	30	20	-	100
ESE	10	20	10	40	20	-	100

INSTRUMENTATION AND CONTROL – V3

22EPE$15	**THERMAL POWER PLANT INSTRUMENTATION** *(Common to EEE and EIE)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

COURSE OBJECTIVE	To impart knowledge on the process variables, measurements and control loops used in thermal power plants.	
UNIT - I	**METHODS OF POWER GENERATION**	**9 Periods**
Methods of Power Generation: Hydro, Thermal, Nuclear, Solar and Wind – Importance of Instrumentation in Power Generation – Basic Building Block for all Types of Power Generation Plants - Details of Boiler Processes – P and I Diagram of Boiler - Cogeneration.		
UNIT - II	**MEASUREMENTS IN POWER PLANTS**	**9 Periods**
Measurement of Feed Water Flow, Air Flow, Steam Flow and Coal Flow – Drum Level Measurement – Temperature Measurement- Steam Pressure Measurement.		
UNIT - III	**ANALYZERS IN POWER PLANTS**	**9 Periods**
Analysis of Impurities in Feed Water and Steam - Oxygen Analyzer - Dissolved Oxygen Analyzer - Chromatography - pH Meter - Fuel Analyzer - Flue Gas Analyzer – Pollution Monitoring Instruments.		
UNIT - IV	**CONTROL LOOPS IN BOILER**	**9 Periods**
Combustion Control: Air/Fuel Ratio Control, Furnace Draft Control - Drum Level Control - Main Steam and Reheat Steam Temperature Control - Superheater Control - Attemperator – Deaerator Control - Interlocks in Boiler Operation - Distributed Control System in Power Plants.		
UNIT - V	**TURBINE AND ITS CONTROL**	**9 Periods**
Types of Steam Turbines: Impulse and Reaction Turbines – Compounding – Turbine Governing System– – Free Governor Mode Operation – Turbine Run up System – Turbine Speed and Vibration Measurement - Speed Control - Automatic Load Frequency Control – Safety Control System - Turbo Alternator lubrication and Cooling System.		
Contact Periods: 45 Periods **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Sam Dukelow, "**Control of Boilers**", Instrument Society of America, 2nd Edition, 1991.*
2	*Krishnaswamy, K. and Ponnibala.M, "**Power Plant Instrumentation**", PHI Learning Pvt. Ltd., New Delhi, 2nd Edition, 2014.*

REFERENCES:

1	*Liptak B.G, "**Instrumentation in Process Industries**", Chilton Book Company, 2005.*
2	*Jain R.K, "**Mechanical and Industrial Measurements**", Khanna Publishers, New Delhi, 11th Edition, 1999.*
3	*Gill.A.B, "**Power Plant performance**", Butterworth and Co (Publishers) Ltd, 2003.*
4	*David Lindsley, "**Boiler Control Systems**", Mc-Graw Hill, 1991.*

COURSE OUTCOMES On Completion of the course, the students will be able to		Bloom's Taxonomy Mapped
CO1	Explain the different methods of generating power	K2
CO2	Select suitable instruments for various process measurements in power plants	K2
CO3	Describe the operation of different analysers used in power plants	K2
CO4	Analyze the control strategies implemented in different stages of power plant	K3
CO5	Elaborate on the types of turbines, their related measurements and control	K2

COURSE ARTICULATION MATRIX

a) CO/PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	-	-	-	-	-	-	-	-	-	-	3	-
CO2	2	1	1	1	-	-	-	-	-	-	-	-	-	3	-
CO3	2	1	1	1	-	-	2	-	-	-	-	-	-	3	-
CO4	2	1	1	-	-	-	-	-	-	-	-	-	-	3	-
CO5	2	1	1	1	-	-	-	-	-	-	-	-	-	3	-
22NPE$10	2	1	1	1	-	-	1	-	-	-	-	-	-	3	-

b) CO and Key Performance Indicators mapping

CO1	1.2.1, 1.3.1, 1.4.1, 2.2.1, 2.2.2, 2.2.4, 2.4.3, 3.1.5, 3.1.6
CO2	1.2.1, 1.3.1, 1.4.1, 2.2.1, 2.2.2, 2.2.4, 2.4.3, 3.1.5, 3.1.6, 4.1.4.
CO3	1.2.1, 1.3.1, 1.4.1, 2.2.1, 2.2.2, 2.2.4, 2.4.3, 3.1.5, 3.1.6, 4.1.4, 7.1.1, 7.2.2.
CO4	1.2.1, 1.3.1, 1.4.1, 2.2.1, 2.2.2, 2.2.4, 2.4.3, 3.1.5, 3.1.6, 4.1.4.
CO5	1.2.1, 1.3.1, 1.4.1, 2.2.1, 2.2.2, 2.2.4, 2.4.3, 3.1.5, 3.1.6, 4.1.4, 7.1.1

ASSESSMENT PATTERN - THEORY

Test/Bloom's Category	Remembering (K1)%	Understanding (K2) %	Applying (K3)%	Analyzing(K4)%	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	80					100
CAT2		80	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		100					100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		60	40				100
ESE	20	60	20				100

22EPE$16	PRINCIPLES OF VIRTUAL INSTRUMENTATION

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To understand the Virtual instrumentation concepts for measurements and control.	
UNIT – I	**OVERVIEW OFVIRTUAL INSTRUMENTATION**	**9 Periods**
Introduction - Block diagram and architecture of a virtual instrument - Conventional Instruments versus Virtual Instruments – Data flow techniques, graphical programming in data flow, comparison with conventional programming		
UNIT – II	**PROGRAMMING TECHNIQUES**	**9 Periods**
Front panel - Block diagram - VIs - Sub-VIs - Simple examples - Looping: For loop, while loop - Shift registers - case and sequence; structures, formula nodes. Arrays - Clusters, charts and graphs - Local and global variables - Property node, string and file I/O. publishing measurement data on the web		
UNIT – III	**DATA ACQUISITION**	**9 Periods**
DAQ – Components - Buffers - Triggering - Analog I/O - Digital I/O - Counters and timers - DMA, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements		
UNIT – IV	**INSTRUMENT CONTROL**	**9 Periods**
VI Chassis requirements. Common Instrument Interfaces: Current loop, RS 232C/ RS485, GPIB. Bus Interfaces: USB, PCMCIA, VXI, SCSI, PCI, PXI, compact RIO - Firewire. PXI system controllers, Ethernet control of PXI. Networking basics for office - Industrial applications, VISA and IVI		
UNIT – V	**APPLICATION OF VIRTUAL INSTRUMENTATION**	**9 Periods**
VI toolsets, Distributed I/O modules Instrument Control, Development of process database management system, Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK (Maximum 2):

1	*Sanjay Gupta and Joseph John “**Virtual Instrumentation using LabVIEW**” Tata McGraw-Hill, Second Ed. 2017*
2	*Jovitha Jerome “**Virtual Instrumentation Using LabVIEW**” PHI Learning Pvt. Ltd 1st Ed., 2010*

REFERENCES (Minimum 4 and Maximum 6):

1	*Lisa K Wells and Jeffrey Travis, “**Labview for everyone**”, Prentice Hall, 3rd Ed. 2009*
2	*Behzad Ehsani, **“Data Acquisition Using LabVIEW”,Ingram short title,**2016*
3	*Gary Johnson, Richard Jennings “**Lab view graphical programming**”, Tata McGraw Hill, 2011*
4	Stephen Philip Tubbs, **“LabVIEW for Electrical Engineers and Technologists”,** 2011.

Note: Books with 10 years before publication may be avoided

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concepts of virtual instrumentation	K2
CO2	Constructa simple measurement system using LABVIEW programs	K3
CO3	Demonstrate the program in LabVIEW for system monitoring, processing and controllingoperations	K4
CO4	Examine the interfacing and programming using related hardware	K4
CO5	Develop real-time applications using LabVIEW	K6

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping (Times New Roman, Size 11)														
COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	-	-	-	-	-	-	-	2	2	2
CO2	3	3	3	3	3	-	-	-	-	-	-	2	3	3	2
CO3	3	3	3	2	3	-	-	-	-	-	-	2	3	3	3
CO4	2	2	2	3	3	-	-	-	-	-	-	1	2	3	2
CO5	2	2	3	3	3	-	-	-	-	-	-	-	2	2	2
22EPE$16	3	2	3	3	3	-	-	-	-	-	-	2	2	3	2
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.3.1,1.1.2,1.2.1,1.4.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.2.2,2.2.3,2.2.4,2.4.2,3.1.1,3.16,3.2.1,3.2.2,3.4.1,3.4.2,4.1.2,4.1.3,4.3.1,5.1.1,5.1.2,5.2.1,5.2.2
CO2	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.4,3.1.1,3.13,3.14,3.16,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.2,12.1.2,12.2.2,12.3.1
CO3	1.1.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.4,3.1.1,3.13,3.16,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.4,4.2.1,4.2.2,4.3.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,12.1.2,12.2.2,12.3.1
CO4	1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.4.2,2.4.3,3.1.1,3.13,3.15,3.16,3.2.3,3.3.1,3.3.2,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.2.2,4.3.1,4.3.2,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,12.3.1
CO5	1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.4.2,2.4.3,3.1.1,3.13,3.15,3.16,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.3.1,4.3.2,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2

ASSESSMENT PATTERN – THEORY (Times New Roman, Size 11)							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	30	40	15			100
CAT2	10	25	20	20	15	10	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	50	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	20	40	20	20	100
ESE	20	20	30	20	10	-	100

22EPE$17	MEMS AND NEMS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To introduce the concepts of micro and nano electromechanical devices. To learn the fabrication process of MEMS for the design of MEMS devices	
UNIT – I	**INTRODUCTION TO MEMS AND NEMS**	**9 Periods**
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.		
UNIT – II	**MEMS FABRICATION TECHNOLOGIES**	**9 Periods**
Photolithography, Ion Implantation, Diffusion, Oxidation, CVD, Sputtering Etching techniques, Micromachining: Bulk Micromachining, Surface Micromachining, LIGA.		
UNIT – III	**MICROSENSORS**	**9 Periods**
MEMS Sensors: Design of Acoustic wave sensors, Vibratory gyroscope, Capacitive Pressure sensors, Case study: Piezoelectric energy harvester		
UNIT – IV	**MICRO ACTUATORS**	**9 Periods**
Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces, Case Study: RF Switch.		
UNIT – V	**NANODEVICES**	**9 Periods**
Atomic Structures and Quantum Mechanics, Schrodinger Equation, ZnO nanorods based NEMS device: Gas sensor.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK (Maximum 2):

1	*Sergey Edward Lyshevski, "**MEMS and NEMS: Systems, Devices, and Structure**" CRC Press, 2002, (ebook 2018)*
2	*Chang Liu "**Foundations of MEMS**" Prentice Hall, 2012*

REFERENCES (Minimum 4 and Maximum 6):

1	*Tai Ran Hsu, "**MEMS and Microsystems Design and Manufacture**", TMH, VII Reprint, 2012*
2	*Marc Madou "**Fundamental of Microfabrication**" CRC Press,3rd Ed, 2011*
3	*Gad-El-Hak, **"MEMS Handbook,"** CRC Press, 2005.*
4	*NitaigourPremchandMahalik, "**MEMS**",TMH, I Reprint, 2009*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Illustrate the basics of micro/nano electromechanical systems	K2
CO2	Recognize the material properties of MEMS performance	K2
CO3	Demonstrate the MEMS fabrication process	K3
CO4	Develop models and simulate sensors and actuators	K5
CO5	Recall the foundation of nano devices	K1

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping															
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	2	2	1	2	-	-	-	-	-	-	2	2	2
CO2	2	2	2	2	1	2	-	-	-	-	-	-	2	2	2
CO3	2	2	3	3	2	-	2	-	-	-	2	-	3	3	2
CO4	2	2	3	3	2	-	-	-	-	-	2	1	3	3	2
CO5	2	2	2	2	2	2	2	-	-	-	-	1	2	2	1
22EPE$17	2	2	2	2	2	2	2	-	-	-	2	1	2	2	2
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO 1	1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.4.2,3.1.1,3.1.6,3.2.1,3.2.2,3.4.1,3.4.2,4.1.1,4.1.3,4.2.1,5.1.1,5.2.2,6.1.1
CO 2	1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.4,3.1.1,3.1.3,3.1.6,3.2.1,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.4,4.2.1,4.2.2,4.3.1,5.2.1,5.3.2,6.1.1
CO 3	1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.4,3.1.1,3.1.3,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,5.1.1,5.1.2,5.3.2,7.1.2,7.2.2,11.1.2,11.2.1
CO 4	1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.4.2,2.4.3,3.1.1,3.1.3,3.1.4,3.1.5,3.1.6,3.2.2,3.2.3,3.3.1,3.3.2,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.4,5.1.2,5.2.1,5.2.2,5.3.1,11.1.2,11.2.1,12.2.2,12.3.2
CO 5	1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.4.2,2.4.3,3.1.1,3.1.3,3.1.5,3.1.6,3.2.3,3.3.1,3.3.2,3.4.2,4.1.1,4.1.2,4.1.3,4.3.4,5.1.2,5.2.1,5.2.2,5.3.1,6.1.1,7.1.2,7.2.2,12.2.2,12.3.1

ASSESSMENT PATTERN – THEORY (Times New Roman, Size 11)							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	30		-	-	100
CAT2	20	20	30	30	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	40	30	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	20	30	30	20	-	100
ESE	20	20	40	20	-	-	100

22EPE$18	LOGIC AND DISTRIBUTED CONTROL SYSTEMS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To study the fundamentals of PLC, exploring the intermediate and advanced functions, design and analysis of DCS with communication standards.	
UNIT – I	**BASICS OF PROGRAMMABLE LOGIC CONTROLLER**	**9 Periods**
Definition – Overview of PLC systems – Input and output modules – Power supplies – Isolators – General PLC programming procedures – Programming on-off outputs – Auxiliary commands and functions – Creating ladder diagrams from process control descriptions – Register basics – Timer functions – Counter functions		
UNIT – II	**PLC INTERMEDIATE AND ADVANCED FUNCTIONS**	**9 Periods**
Arithmetic functions – Number comparison functions – Skip and MCR functions – Data move systems – PLC advanced intermediate functions – Utilizing digital bits – Sequencer functions – Matrix functions – Alternate programming languages – Analog PLC operation – Networking of PLC – PID control of continuous processes – PLC installation – Troubleshooting and maintenance – Controlling a Robot		
UNIT – III	**INTERFACE AND BACKPLANE BUS STANDARDS**	**9 Periods**
Field bus: Introduction – Concept – International field bus standards – HART protocol: Method of operation – Structure – Operating conditions – Applications – Foundation Field bus - Profibus.		
UNIT – IV	**DISTRIBUTED CONTROL SYSTEMS OPERATION**	**9 Periods**
Evolution of DCS – Building blocks – Detailed descriptions and functions of field control units – Process – Interfacing issues - Operator stations– Data highways – Redundancy concepts.		
UNIT – V	**COMMUNICATION IN DCS**	**9 Periods**
DCS – Supervisory computer tasks and configuration – System Integration with PLC and computers - Special requirement of networks used for control – Protocols – Link access mechanisms – Manufacturers automation protocols – Case studies in DCS.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXTBOOK:

1	*John. W. Webb and Ronald A. Reis* ***"Programmable Logic Controllers–Principles and Applications"*** *4th Ed, Prentice Hall Inc., New Jersey, 5thEd. 2002.*
2	*Frank D. Petruzella,* ***"Programmable Logic Controllers"*** *Tata McGraw Hill Book Company Book, Fifth Ed. 2016.*

REFERENCES:

1	*Krishna Kant,* ***"Computer-based Industrial Control"****, Prentice Hall of India, Second Edition 2011.*
2	*Curtis D. Johnson,* ***"Process control Instrumentation Technology"****, 8th Ed. Pearson Education 2013.*
3	*Bela. G. Lipkak,* ***"Process software and digital networks – vol 3"****, CRC press,4th edition ,2012.*
4	*Coulouris George, DollimoreJean , Kindberg Tim, Blair Gordon,****"Distributed Systems: Concepts & Design",*** *5 th Edition, Pearson Education, New York, 2017.*

COURSE OUTCOMES: **On completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Explain different Bus Standards	**K2**
CO2	Identify Network, Protocol and link mechanism required for a given control application	**K2**
CO3	Develop ladder diagrams for basic control applications using PLC	**K3**
CO4	Implement various advanced functions and controllers using PLC	**K3**
CO5	Construct distributed process controller using PLC	**K3**

COURSE ARTICULATION MATRIX :

a. CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	-	3	3	3
CO2	2	3	-	-	-	-	-	-	-	-	-	-	2	2	2
CO3	3	3	2	-	3	-	-	-	-	-	-	-	2	2	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	2	2	2
CO5	2	3	2	3	3	-	-	-	-	-	-	2	2	2	2
22EPE$18	**2**	**3**	**2**	**3**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b. CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1
CO2	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 3.1.1, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2
CO4	1.2.1, 2.1.1, 2.1.2, 2.2.2, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.1
CO5	1.1.2, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 12.1.2, 12.2.1, 12.2.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Rememberi ng (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Tota l %**
CAT1	20	40	40		-	-	100
CAT2	20	40	40		-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	40	40	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	40	40	20	-	-	100
ESE	20	40	40		-	-	100

22EPE$19	MODERN CONTROL THEORY

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To explain the concepts of basic and modern control systems for the real-time analysis and design of control systems, toanalyze non-linear systems and the concept of stability for nonlinear systems and their categorization.	
UNIT – I	**SAMPLED-DATA SYSTEMS AND Z -TRANSFORM**	**9 Periods**
Sampled data theory – Sampling process – Sampling theorem – Signal reconstruction – Sample and hold circuits – Z Transform – Theorems on Z Transforms – Inverse Z Transforms. Pulse transfer function - Response of sampled data system to step and ramp inputs - Steady state error – Stability studies - Jury's test and bilinear transformation.		
UNIT – II	**STATE SPACE ANALYSIS OF DISCRETE SYSTEMS**	**9 Periods**
State variables – Canonical forms – Diagonalization – Solutions of state equations – Controllability and observability – Effect of sampling time on controllability – Pole placement by state feedback – Linear observer design – First-order and second-order problems.		
UNIT – III	**NON -LINEAR SYSTEMS**	**9 Periods**
Introduction – Non-Linear Systems – Types of Non-Linearities – Saturation – Dead-Zone – Backlash– Jump Phenomenon etc., Linearization of nonlinear systems, Singular Points and its types– Describing function–describing function of different types of nonlinear elements, – Stability analysis of Non-Linear systems through describing functions. Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, Stability analysis of nonlinear systems based on phase-plane method.		
UNIT – IV	**LYAPUNOV STABILITY ANALYSIS**	**9 Periods**
Stability in the sense of Lyapunov, Lyapunov's stability, and Lypanov's instability theorems – Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.		
UNIT – V	**OPTIMAL CONTROL**	**9 Periods**
Introduction to Optimal Control, statement of the optimal control problem, general introduction to the principle of optimality, discrete time linear quadratic problem, optimal state feedback solution. Formation of optimal control problems- Hamiltonian formulation-solution of optimal control problems- Evaluation of Riccati equation State and output Regulator problems.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*M. Gopal, "**Modern Control System Theory"** ,New Age International Private Limited, 2014.*
2	*Dorf, Richard C and Bishop, Robert H, "**Modern Control Systems**" , Pearson, Brazil, 2017.*

REFERENCES:

1	*K. Ogata, "**Modern Control Engineering**", 5th edition, PHI, 2012.*
2	*XiangjieLiu,"**Systems Control Theory**",De Gruyter, China Science Publishing & Media Ltd, 2018*
3	*Varmah, K. R, "**Modern Control Theory**", CBS Publishers &Distributors, India, 2020.*
4	*Kirk, Donald E, "**Optimal Control Theory: An Introduction**", Dover Publications, United States, 2012.*
5	*Jacquot, Raymond G, "**Modern Digital Control Systems**", CRC Press, United States, 2019.*
6	*Paraskevopoulos, P.N, "**Modern Control Engineering**", CRC Press, United Kingdom, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Realize the discrete systems and mathematical modelling.	K2
CO2	Examine the properties of nonlinear systems.	K2
CO3	Analyze the stability of nonlinear systems	K4
CO4	Design and Evaluate the optimal controller.	K5
CO5	Apply advanced control strategies to practical engineering problems.	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO2**	**PSO 3**
CO1	3	3	3	3	2	-	-	-	-	-	-	3	3	3	2
CO2	3	3	2	2	2	-	-	-	-	-	-	2	2	3	3
CO3	3	3	3	2	3	-	-	-	-	-	-	2	2	3	3
CO4	3	3	2	2	3	-	-	-	-	-	-	2	1	3	2
CO5	3	3	3	3	2	-	-	-	-	-	-	3	2	3	3
22EPE$19	3	3	3	2	2	-	-	-	-	-	-	2	2	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,5.1.1,5.1.2,5.2.1,5.3.1,12.1.1,12.2.1,12.2.2,12.3.1,12.3.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.2,2.4.1,2.4.2,2.4.3,3.1.1,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.2.1,4.2.2,5.1.1,5.1.2,5.3.1,5.3.2,12.1.1,12.2.1,12.3.1,12.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,3.1.1,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.2.2,5.1.1,5.1.2,5.2.1,5.3.1,5.3.2,12.1.1,12.2.1,12.3.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.4.1,2.4.2,2.4.3,3.1.1,3.1.4,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.2.1,4.2.2,4.3.3,5.1.1,5.1.2,5.2.1,5.3.1,5.3.2,12.1.1,12.2.1,12.3.1,12.3.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.2.2,4.3.3,5.1.1,5.1.2,5.2.1,5.3.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	40	30		-	100
CAT2	10	20	30	30	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	50	50	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	40	40	20	-	100
ESE	10	20	40	30	-	-	100

22EPE$20	ELECTRONIC CIRCUIT DESIGN (Common to EEE, ECE & EIE Branches)

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To impart knowledge of the electronic circuit design from power supplies to SoCs including the connectivity solutions and their static and dynamic behaviour through Simulation	
UNIT – I	**INTRODUCTION TO SENSORS, POWER SUPPLY, SWITCH AND DRIVERS**	**9 Periods**
Introduction: Sensors - Connectivity Solutions - AI/ML - HW requirements - Design Challenges. Non-ideal behavior of Components – Resistors, Capacitors; Inductors; Ferrite Beads; Fundamentals of BJT, MOSFET and IGBT gate driver circuits - Effect of Impedance mismatch and Signal Quality. Linear and Switching regulators- Buck and Boost Converters - Stability, Performance, Dynamic Behavior - EMI Filters - high-side and low-side switches - H-bridge - Current Sensing Techniques.		
UNIT – II	**DATA CONVERTERS AND I/O INTERFACES**	**9 Periods**
Digital IOs; PWM, Frequency Inputs; Data conversion; Quantization; Reference Voltages; Sampling Time; Resolution; ADC Errors – Non-linearity; Offset; Gain; Noise - Dynamic Range – ENOB - Parasitic capacitance - Channel cross-talk - ADC/DAC interface.		
UNIT – III	**SYSTEM ON CHIP**	**9 Periods**
Need for SoC - Components of a SoC - Heterogeneous processing cores : microprocessors, DSPs, hardware processing engines like audio, video, accelerators, memories, and I/O interfaces - System level On-chip Communication Architectures – Bus and NoC based, Application Specific Hardware Accelerators – GPU, Neural, MMA - device management, memory hierarchy, and data movement, virtualization - security, and power - Challenges and optimization of Interconnects, Partitioning and Mapping of a software function to hardware - Power/Performance/Area Trade Offs vs Reliability - Safety and Security Features - Interfaces – External Memory, I/O, ADC/DAC, UART, CAN, Ethernet, USB, MIPI; Insight into SoC Design Process (from RTL to Chip, Requirements and Design Iteration) - Dealing with Design Complexity (Buying IP and Reconfiguration).		
UNIT – IV	**PMICs AND WIRED COMMUNICATIONS**	**9 Periods** **9**
Need for PMIC – On Chip Power Management, State Machine, Compensation Techniques - Voltage and Frequency Scaling - Applications; Examples – PF8101 (NXP), TPS659119-Q1 (TI), MAX20430 (Maxim) - Input and Output Supply Ranges - Power Sequence – Supervisory - Watchdog Operation. High Speed Links – Transmitter, Channel, Receiver - Common Mode Rejection – Serializer, De-Serializer - Controller Area Networks (CAN) - Ethernet (Automotive)- Universal Serial Bus (USB) - Camera Interfaces (FPD or GMSL) - Power over Data Link (PoDL).		
UNIT – V	**WIRELESS COMMUNICATIONS**	**9 Periods**
Fundamentals of RF-Transmission Lines, Resonators, Antennas, Wave Propagation, Transmitters, Receivers - Digital Modulation Techniques - Channel Impairments - MIMO; WLAN; Bluetooth; Cellular – LTE/5G - Navigation Systems - Identification Systems-NFC, RFID; UWB.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0 Periods Total: 45 Periods**		

TEXTBOOK

1	*Ke-Horng Chen, **“Power Management for Integrated Circuit Design”**, Wiley, 2016*
2	*Michael.J. Flynn and Wayne Luk, **“Computer System Design: System-On-Chip, Hoboken, New Jersey”**, Wiley, 2011*
3	*G. Manganaro, **“Advanced Data Converters. Cambridge”**, Cambridge Univ. Press, 2012*

REFERENCES

1	*W. A. Kester,* ***"Data Conversion Handbook"****, Amsterdam, Elsevier Newnes, 2005*
2	*Beuchat R D, et.al,* ***"Fundamentals of System-on-Chip Design on Arm Cortex-M Microcontrollers, Arm Education Media"****, Arm Education Media, 2021*
3	*Joseph Yiu,* ***"System-on-Chip Design with Arm Cortex-M Processors"****, Reference Book, Cambridge, ARM Education Media, 2019*
4	*Mona M. Hella, and Patrick Mercier, Eds.,* ***"Power management integrated circuits"****, CRC Press, 2016*
5	*Forouzan B A,* ***"Data Communications and Networking"****, McGraw-Hill, 5th ed. India, 2017*
6	*Qizheng GU,* ***"RF System Design of Transceivers for Wireless Communications"****, Springer, 2015*
7	*Maniktala S,* ***"Power over ethernet interoperability"****, McGraw-Hill, New York, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret the performance of sensors and power supplies, switches and drivers	K2
CO2	Determine the suitable data converters and I/O interfaces for specific requirement	K3
CO3	Describe the functions of components in the system on chip	K2
CO4	Choose and explain the functional blocks for PMICs and WIRED COMMUNICATIONS	K3
CO5	Analyze different wireless communication technologies	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO3**
CO1	3	2	2	1	1	2	2	1	-	-	1	1	3	3	3
CO2	2	2	1	2	1	-	-	-	-	-	-	2	2	2	2
CO3	2	2	1	-	1	-	-	-	-	-	1	2	2	2	2
CO4	3	2	2	1	1	2	2	1	-	-	1	1	2	2	2
CO5	3	2	2	1	1	2	2	1	-	-	1	1	2	2	2
22EPE$20	3	2	1	1	1	2	2	1	-	-	1	2	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 3.1.3, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.4.2, 4.1.2, 4.1.3, 5.1.1, 5.2.1, 6.2.1, 7.1.1, 7.1.2, 8.2.1, 11.1.1, 12.1.1, 12.1.2
CO2	1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.2.2, 2.2.4, 2.3.1, 2.4.3, 3.1.4, 3.1.6, 3.2.3, 3.3.1, 4.1.2, 4.1.3, 4.1.4, 5.1.1, 12.1.1, 12.1.2, 12.2.2, 12.3.2
CO3	1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.2.2, 2.2.4, 2.3.1, 2.3.2, 3.1.4, 3.1.6, 5.1.1, 5.2.1, 11.1.1, 12.1.1, 12.1.2, 12.2.2
CO4	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 3.1.3, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.4.2, 4.1.2, 4.1.3, 5.1.1, 5.2.1, 6.2.1, 7.1.1, 7.1.2, 8.2.1, 11.1.1, 12.1.1, 12.1.2
CO5	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 3.1.3, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.4.2, 4.1.2, 4.1.3, 5.1.1, 5.2.1, 6.2.1, 7.1.1, 7.1.2, 8.2.1, 11.1.1, 12.1.1, 12.1.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40	-	-	-	100
CAT2	10	40	50	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	40	30	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	40	40	20	-	-	100
ESE	20	40	40	-	-	-	100

22EPE$21	ELECTRONIC SYSTEM DESIGN AND PRODUCTIZATION (Common to EEE, ECE & EIE Branches)

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To introduce broad knowledge for the design, development, fabrication of electronic products, printed circuit boards and systems and its reliability and product safety	
UNIT – I	**PCB DESIGN, RULES, AND MANUFACTURABILITY**	**9 Periods**
PCB Technology – Component Packaging, Layer Stackup, Via Technology, HDI Concept; PCB Materials – Grades and Specification, example - FR4, Weaving Concept, Low Loss & High Performance Materials, Mechanical and Thermal Properties; Layer Stackup – Copper Foil, Pre-pegs and Base Material (Core), Dimensional Stability, CAF Growth; PCB Design Process – Influence from Package types, Material Choices, Fabrication Methods, Lead-free Assembly; Current Capacity; Thermal Signatures, File Format, Rule Checks – ERC and DRC, Power, Ground, and Signal Trace Consideration; Choice of CAD tools; IPC Standards for PCB – Introduction.		
UNIT – II	**ELECTROMAGNETIC COMPATIBILITY AND COMPLIANCE**	**9 Periods**
Introduction – History of Accidents, Impact of Technology Evolution, Importance of EMC and Regulations; EMC Concepts – Conducted, Radiated, Emissions, Susceptibility/Immunity; EMC Control Methods – Impedance Matching, Resonances, Balancing, Filtering, ESD Protection, Shielding, Grounding; PCB Design; Enclosure Design; EMC Prediction using Simulations; EMC Compliance – CISPR Test Setups, IEC Test Standards; Government Regulatory Requirements – FCC, RED, UNCECR10.		
UNIT – III	**THERMAL MANAGEMENT FOR ELECTRONICS**	**9 Periods**
Introduction, Heat Transfer Theory; Concept of thermal resistance; Use of datasheets; Passive and Active Cooling – Forced Air, Liquid, Thermo Electric Cooling; Aspects of Heat Sink Design; Thermal Modeling and Measurement – CFD; Heat Management in Automotive Applications.		
UNIT – IV	**DESIGN FOR RELIABILITY AND MANUFACTURING**	**9 Periods**
Basic Concepts – Quality and Reliability Assurance; Analysis during the Design Phase; Qualification tests for Components and Assemblies; Design guidelines for Reliability and Maintainability; Statistical Quality Control and Reliability Tests; Check lists for Design Reviews; Design FMEA/DRBFM; MTBF Calculation.		
UNIT – V	**PRODUCT SAFETY, SECURITY, COMPLIANCE AND CERTIFICATION**	**9 Periods**
Need for Product Safety; Examples – Automotive; CE/ISO/IEC/BIS; Safety Education: Products-Hazards-Age; Voltage Faults – Surge, Ringing, Polarity reversal, Current fault – short circuit, Inrush, Reverse; Thermal – Over temperature, thermal protection; Battery Safety Standards; Product Construction Requirements; Resistance to Fire and Flame Rating; Human Factors – Ergonomic Hazards; Safety Instructions - Cautions and Warnings. Regulatory compliance – Product Specific - EMC, Safety, and RF; Substance Regulation – RoHS, WEEE, REACH etc; Labeling, Documentation, Marking, Packaging and Testing; Industry Compliance – Industry specific; Technical documentation; EU declaration of conformity; Regional (states, districts) Specific compliance – data security and material; Usage Instructions; Traceability; IATF 16949; ISO 9000; ISO140000; ASPICE; GDPR. Process of Certification : ISO/IEC 17065 Conformity Assessment; ISO 17011; Certifying Bodies; Standards; Marking/Certificate; Accreditation Bodies; IAF, FCC, CE, BIS, NABL.		
Contact Periods: **Lecture: 45 Periods Tutorial:0 Periods Practical:0 Periods Total:45 Periods**		

TEXTBOOK

1	*Clyde F. Coombs and Happy Holden, **"Printed Circuits Handbook"**, McGraw-Hill, 7th Edition, 2015*
2	*Clayton R. Paul, **"Introduction to Electromagnetic Compatibility"**, Wiley 2006*
3	*T. Yomi Obidi, **"Thermal Management in Automotive Applications"**, Warrendale, Pennsylvania, USA, SAE International 2015*

REFERENCES

1	Wilson, P, "The Circuit Designer's Companion", Oxford Newnes, 3rd Edition, 2011
2	Terence Rybak and Mark Stefafika, "Automotive EMC", Kluwer Academic Publishers, 1st Edition, 2003.
3	Ralph Remsburg, "Thermal Design of Electronic Equipment", CRC Press, 1st Edition, 2001
4	Alessandro Birolini, "Reliability Engineering: Theory and Practice", Springer, 8th Edition, 2017.
5	Jan Swart,"Electrical Product Compliance and Safety Engineering", Artech House, 1st Edition, 2017.
6	J. Doherty, "Wireless and Mobile Device Security", Jones and Bartlett Learning, 2nd Edition, 2021.

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Elaborate the PCB design process and the manufacturability requirements	K2
CO2	Enunciate the electromagnetic compatibility required for a product and its standards	K3
CO3	Outline the thermal management strategies required for automotive applications	K2
CO4	Analyze a design for its failure modes; and design a reliable, safe product and compute its failure rate or MTBF	K4
CO5	Identify and fulfill all requirements for the product compliance and certification considering EMC, RF, safety and security	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO2**	**PSO 3**
CO1	3	3	2	0	1	2	1	-	-	-	-	-	2	1	1
CO2	3	3	2	0	1	2	1	-	-	-	-	-	2	1	1
CO3	3	3	2	0	1	2	1	-	-	-	-	-	2	1	1
CO4	3	3	2	2	1	2	1	-	-	-	-	-	2	1	1
CO5	3	3	2	2	1	2	1	-	-	-	-	-	2	1	1
22EPE$21	3	3	2	1	1	2	1	-	-	-	-	-	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3,2.2.1,2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 5.1.1, 6.1.1, 7.1.1
CO2	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3,2.2.1,2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 5.1.1, 6.1.1, 7.1.1
CO3	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3,2.2.1,2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 5.1.1, 6.1.1, 7.1.1
CO4	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3,2.2.1,2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 5.1.1, 6.1.1, 7.1.1
CO5	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3,2.2.1,2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 5.1.1, 6.1.1, 7.1.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	60	40		-	-	100
CAT2	-	40	40	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	40	40	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	40	40	20	-	-	100
ESE	-	40	40	20	-	-	100

22EPE22	ADAPTIVE CONTROL *(Common to EEE and EIE)Branches*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

COURSE OBJECTIVE	To study the definition of adaptive control and methods of adaptation, the parameter identification of systems, the self-tuning of PID controllers based on parameter identification, the model reference adaptive control.	
UNIT - I	**INTRODUCTION TO ADAPTIVE CONTROL SCHEMES**	**9 Periods**
Introduction to adaptive control – Effects of process variations –Adaptive control schemes – Adaptive control problem – Non-parametric identification – Step response method – Impulse response method – Frequency response method.		
UNIT - II	**PARAMETRIC IDENTIFICATION**	**9 Periods**
Parametric Identification - Linear in parameter models - ARX - ARMAX - ARIMAX - Least square estimation - Recursive least square estimation - Extended least square estimation - Maximum likelihood estimation – Non-linear system identification – Pseudo random binary sequence.		
UNIT - III	**SELF-TUNING REGULATOR**	**9 Periods**
Self-Tuning regulator- Deterministic indirect self-tuning regulators - Deterministic direct self-tuning regulators - Stochastic self-tuning regulators – Stochastic indirect self-tuning regulator.		
UNIT - IV	**MODEL REFERENCE ADAPTIVE SYSTEM**	**9 Periods**
The MIT rule – Lyapunov theory – Design of model reference adaptive controller using MIT rule and Lyapunov theory – Relation between model reference adaptive controller and self-tuning regulator.		
UNIT - V	**TUNING OF CONTROLLERS AND CASE STUDIES**	**9 Periods**
Tuning of Controllers and Case Studies- Design of gain scheduling controller – Auto-tuning of PID regulator – Stability analysis of adaptive controllers – Application of adaptive control in chemical reactor, distillation column and variable area tank system.		
Contact Periods: 45 Periods **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Karl J. Astrom and Bjorn Wittenmark," **Adaptive Control**", Pearson Education , 2nd edition, 2013.*
2	*I. D. Landau, R. Lozano, and M. M.Saad, "**Adaptive Control: Algorithms, Analysis and Applications**",2nd edition, Springer-Verlag, 1998*

REFERENCES:

1	*Chalam, "**Adaptive Control Systems: Techniques and Applications**", CRC Press,1st edition ,, 1987*
2	*Landau, I.D., Lozano, R., MSaad, M., Karimi, A, "**Adaptive Control Algorithms, Analysis and Applications**", Springer,2nd edition, 2011*
3	*Gang Tao, "**Adaptive Control Design and Analysis**", Wiley-IEEE Press,1st edition, 2003*
4	*Kumpati S. Narendra,Anuradha M. Annaswamy, "**Stable Adaptive Control Systems**", Dover Publications, Illustrated edition,2005.*

COURSE OUTCOMES Upon Completion of the course, the students will be able to		Bloom's Taxonomy Mapped
CO1	Interpret the effect of parameter variation and principle of adaptive control schemes.	K2
CO2	Categorize different parametric identification methods..	K3
CO3	Comprehend Deterministic and Stochastic Self Tuning Regulators	K2
CO4	Design of model reference adaptive controller.	K3
CO5	Devise a gain scheduling controller and analyze adaptive control schemes for industrial processes.	K3

COURSE ARTICULATION MATRIX

a) CO/PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	3	3	1	-	-	-	-	-	-	1	-	2	1
CO2	3	3	3	3	1	-	-	-	-	-	-	1	-	2	1
CO3	3	3	2	3	1	-	-	-	-	-	-	1	-	2	1
CO4	3	3	3	3	1	-	-	-	-	-	-	1	-	2	1
CO5	3	3	3	3	1	-	-	-	-	-	-	1	-	2	1
22NPE$06	**3**	**3**	**3**	**3**	**1**	**-**	-	-	-	-	**-**	**1**	**-**	**2**	**1**

b) CO and Key Performance Indicators mapping

CO1	1.1.1,1.2.1,2.1.3,2.2.2,4.1.4,5.2.1,12.3.1
CO2	1.1.1,1.2.1,2.1.3,2.2.2,4.1.4,5.2.1,12.3.1
CO3	1.1.1,1.2.1,2.1.3,2.2.2,4.1.4,5.2.1,12.3.1
CO4	1.1.1,1.2.1,2.1.3,2.2.2,4.1.4,5.2.1,12.3.1
CO5	1.1.1,1.2.1,2.1.3,2.2.2,4.1.4,5.2.1,12.3.1

ASSESSMENT PATTERN - THEORY

Test/Bloom's Category	Remembering (K1)%	Understanding (K2) %	Applying (K3)%	Analyzing(K4)%	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	50	-	-	-	100
CAT2	20	30	50	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	20	40	40	-	-	-	100

ELECTRIC VEHICLE SYSTEMS – V4

22EPE$23	ELECTRIC VEHICLE ARCHITECTURE					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	**3**	**0**	**0**	**3**

Course Objectives	To explore and learn about the architecture, various components and control strategies of electric vehicles.	
UNIT – I	**VEHICLE MECHANICS**	**9 Periods**
Vehicle mechanics: Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tyre –Road mechanics, Propulsion System Design.		
UNIT – II	**VEHICLE ARCHITECTURE AND SIZING**	**9 Periods**
History- and Evolution of Electric Vehicle -Series, Parallel and Series parallel Architecture, Micro and Mild architectures - Mountain Bike - Motorcycle- Electric Cars and Heavy Duty-EVs. -Details and Specifications.		
UNIT – III	**POWER COMPONENTS AND BRAKES**	**9 Periods**
Powertrain Component sizing :Gears, Clutches, Differential, Transmission and Vehicle Brakes -EV Powertrain sizing-HEV Powertrain sizing- Example.		
UNIT – IV	**HYBRID VEHICLE CONTROL STRATEGY**	**9 Periods**
Vehicle supervisory controller-Mode selection strategy: Mechanical Power-split hybrid modes,series-parallel hybrid modes- Modal Control strategies: series,parallel,series-parallel,Energy Storage system and regenerative control strategies		
UNIT – V	**PLUG-IN HYBRID ELECTRIC VEHICLE**	**9 Periods**
Introduction-Comparison with Electrical and Hybrid Electric Vehicle-Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Iqbal Husain* "**Electric and Hybrid vehicles :Design Fundamentals",** *second edition, CRC press,2011.*
2	*Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi*, **"Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design"**, *CRC Press, 2018.*

REFERENCES

1	*Wei Liu* "**Hybrid Electric Vehicle System Modeling and Control",***Second Edition ,Wiley, 2017*
2	*Chris Mi,M. Abul Masrur* "**Hybrid Electric Vehicles Principles and Applications with Practical Perspectives" ,***Second Edition,Wiley,2018.*
3	*Patel, Akash Kumar Bhoi,SanjeevikumarPadmanaban, Jens Bo Holm-Nielsen* "**Electric Vehicles: Modern Technologies and Trends**", *Springer,2020.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Extendknowledge on history and evaluation of Electric Vehicles	K2
CO2	Illustratethe scientific concepts related to Electric Vehicles	K2
CO3	Summarize the various components in Electric Vehicles	K2
CO4	Evaluate the control strategies of Electric Vehicles	K5
CO5	Demonstrate the fundamental operating mechanism of a hybrid Electric Vehicle	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	2	2	2	-	-	1	2	3	3	3	1
CO2	3	2	2	2	2	-	2	-	-	1	2	-	2	3	1
CO3	3	3	1	2	2	-	-	-	-	-	-	2	2	3	2
CO4	3	3	2	2	2	3	2	2	1	1	2	-	3	2	3
CO5	3	3	1	2	2	-	-	-	-	-	-	2	2	2	2
22EPE$23	3	3	2	2	2	3	2	2	1	1	2	2	2	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1,1.3.1,1.4.1,2.3.1,2.3.2,2.4.4,3.1.3,3.1.6,3.2.1,4.1.4,4.2.1,4.3.4,5.1.1,5.3.1,6.1.1,7.1.1,7.2.210.1.1,10.3.1,11.1.1,11.1.2,11.3.1,12.1.1,12.2.1,12.2.2,12.3.1,12.3.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.3,2.2.4,2.4.2,2.4.3,2.4.4,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.3.1,4.1.2,4.1.4,4.2.1,5.1.2,5.2.2,5.3.2,7.1.1,7.2.2,10.1.1,10.3.1,11.2.1,11.1.2, 11.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1,3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1,3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1,3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2

ASSESSMENT PATTERN

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	40	20	-	-	100
CAT2	10	30	40	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	20	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	20	-	100
ESE	10	30	40	20	-	-	100

22EPE$14	DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	PE	3	0	0	3

Course Objectives	To expose the types of different power converters, motors and controllers and their functions for Electric Vehicle.	
UNIT – I	**POWER CONVERSION CIRCUITS**	**9 Periods**
Non-Isolated Power Converters: Half-Bridge Buck-Boost Bidirectional Converter, Buck Converter, Boost Converter - Inductor Sizing - Capacitor Sizing - Isolated Power Converters: Forward Converter - Sizing the Transformer - Full-Bridge Converter - Resonant Power Conversion - Desirable Converter Characteristics for Inductive Charging - Three-Phase Inverters - Modulation Schemes.		
UNIT – II	**DC MOTOR DRIVES**	**9 Periods**
DC Machines: speed torque characteristics - power, losses and efficiency – starting and speed control methods – regenerative braking – closed loop speed control – design criteria of DC motor drives for EVs – Application of DC motor drives in EVs. PMBLDC Motor - operation – speed torque characteristics – speed control techniques – inverters requirements - closed loop control - outer rotor PMBLDC motor drive - Design criteria of PMBLDC - Application of PMBLDC drives in EVs.		
UNIT – III	**INDUCTION MOTOR DRIVES**	**9 Periods**
Operation - speed torque characteristics – starting methods - speed control and braking techniques – inverters for induction motor – PWM techniques – closed loop speed/torque control – Field Oriented Control (FOC) – Direct Torque Control (DTC) - design criteria of induction motor drives for EVs.		
UNIT – IV	**PERMANENT MAGNET SYNCHRONOUS MOTOR AND SWITCHED RELUCTANCE MOTOR DRIVES**	**9 Periods**
Permanent Magnet Synchronous Motor (PMSM) – operation – speed torque characteristics – speed control techniques – inverters requirements - closed loop control – Planetary geared PMSM drive - Design criteria of PMSM drives for EVs. Switched Reluctance Motor (SRM)- Geometry structure - principle of operation –converter topologies for SRM – closed loop control – torque ripple reduction techniques - Design criteria of SRM drives for EVs.		
UNIT – V	**CONTROL OF ELECTRIC DRIVE**	**9 Periods**
Introduction - Feedback Controller Design Approach - Modeling the Electromechanical System -Mechanical System -PM DC Machine - DC-DC Power Converter - PI Controller - Designing Torque Loop Compensation - Determining Compensator Gain Coefficients for Torque Loop - Designing Speed Control Loop Compensation - Determining Compensator Gain Coefficients for Speed Loop - Acceleration of Battery Electric Vehicle (BEV) using PM DC Machine.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: Periods Total: 45 Periods**		

TEXT BOOK:

1	*Chau K.T., **"Electric Vehicle Machines and Drives: Design, Analysis and Application"**, Wiley – IEEE Press, 2015.*
2	*John G. Hayes, G. Abas Goodarzi, **"Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles"** John Wiley & Sons Ltd., 1st edition, 2018.*

REFERENCES:

1	*Iqbal Hussain, **"Electric and Hybrid Vehicles: Design Fundamentals, Second Edition"** CRC Press, Taylor & Francis Group, Third Edition 2021.*
2	*Bimal K Bose, **"Modern Power Electronics and AC drives"**, Pearson Education, 1st Edition, 2015.*
3	*Krishnan R., **"Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design and Applications"**, CRC Press, 2001.*

Note: Books with 10 years before publications may be avoided

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Illustrate various types of converter/inverter circuits and closed loop operation.	K2
CO2	Demonstrate the working principles, performance and speed - torque characteristics of various types of electrical machines.	K3
CO3	Compare various starting, braking methods and speed control techniques of electrical machines.	K4
CO4	Evaluate various control techniques for electrical drives.	K5
CO5	Use an appropriate electric machine for electric vehicle application.	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping															
COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	3	2	2	2	1	-	–	-	3	3	2	1
CO2	3	1	1	2	1	2	2	-	-	-	-	2	2	3	1
CO3	2	2	2	2	2	2	1	1	-	-	-	2	1	2	3
CO4	2	2	2	3	2	2	2	-	-	-	-	2	2	3	2
CO5	2	2	2	2	2	-	2	1	-	-	-	2	3	3	2
22EPE$14	3	2	2	3	2	2	2	1	-	-	-	3	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.1.2,1.3.1,2.1.2,2.1.3,2.2.1,2.2.4,2.3.1,2.4.2,2.4.4,3.1.1,3.1.3,3.1.5,3.2.1,3.2.2,3.3.2,4.1.1,4.1.3,4.2.1,4.3.1,4.3.2,4.3.3,5.1.1,5.2.1,5.2.2,6.2.1,7.1.2,7.2.2,8.1.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,
CO2	1.1.1,1.1.2,1.2.1,1.4.1,2.1.3,2.2.3,2.4.1,2.4.3,3.1.2,3.1.4,3.3.1,3.4.2,4.1.3,4.2.1,4.2.2,4.3.1,4.3.3,5.2.1,5.3.1,6.1.1,7.1.1,7.2.1,12.1.2,12.2.1,12.3.1,12.3.2,
CO3	1.1.1,1.1.2,1.3.1,2.1.1,2.1.2,2.2.1,2.2.2,2.3.2,2.4.2,2.4.4,3.1.1,3.1.2,3.1.4,3.1.6,3.2.1,3.2.2,3.3.2,3.4.1,4.1.1,4.1.3,4.1.4,4.3.1,4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.1.2,8.1.1,12.1.1,12.1.2,12.2.2,
CO4	1.1.2,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.4,2.3.1,2.4.1,2.4.3,3.1.2,3.1.4,3.2.1,3.2.3,3.3.2,3.4.2,4.1.2,4.1.4,4.2.2,4.3.1,4.3.2,4.3.3,5.1.1,5.2.1,5.3.1,6.2.1,7.2.1,7.2.2,12.1.1,12.2.1,12.2.2,12.3.2,
CO5	1.1.1,1.4.1,2.1.2,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.2,2.4.4,3.1.2,3.1.5,3.2.1,3.3.1,3.4.1,4.1.4,4.2.2,4.3.3,5.2.1,5.2.2,5.3.2,7.1.1,7.2.2,8.2.1,12.1.1,12.2.1,12.3.1,12.3.2,

ASSESSMENT PATTERN – THEORY (Times New Roman, Size 11)

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	20	10	40	10	-	100
CAT2	10	20	10	40	20	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	20	30	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	20	30	20	-	100
ESE	10	20	10	40	20	-	100

22EPE$24	HYBRID ELECTRIC AND FUEL CELL VEHICLES					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To learn the mechanics, operation and performance of hybrid electric and fuel cell vehicles.					
UNIT – I	**HYBRID ELECTRIC VEHICLES**	**9 Periods**				
Concept of Hybrid Electric Drive Trains- Architectures of Hybrid Electric Drive Trains- Series/Parallel - Torque-Coupling Parallel Hybrid Electric Drive Trains - Speed-Coupling Parallel Hybrid Electric Drive Trains-Torque-Coupling and Speed-Coupling Parallel Hybrid Electric Drive Trains						
UNIT – II	**ELECTRIC PROPULSION SYSTEMS**	**9 Periods**				
Principle and Operation: DC series motor drives- Induction Motor Drives - Permanent Magnet Brushless DC Motor Drives -Permanent Magnet Synchronous motor Drives - Switched Reluctance Motor Drives						
UNIT – III	**SERIES HYBRID ELECTRIC DRIVE TRAIN DESIGN**	**9 Periods**				
Operation Patterns - Control Strategies - Sizing of the Major Components - Design of Traction Motor, Gear Ratio, Acceleration Performance, Gradeability, Engine / Generator Size, Power and Energy Capacity.						
UNIT – IV	**MILD HYBRID ELECTRIC DRIVE TRAIN DESIGN**	**9 Periods**				
Energy Consumed in Braking and Transmission- Parallel Mild Hybrid Electric Drive Train- Series–Parallel Mild Hybrid Electric Drive Train- Configuration- Operating Modes and Control- Control Strategy						
UNIT – V	**FUEL CELL VEHICLES**	**9 Periods**				
Operating Principles of Fuel Cells-Electrode Potential and Current–Voltage Curve-Fuel and Oxidant Consumption-Fuel Cell System Characteristics-Fuel Cell Technologies-Fuel Supply- Non Hydrogen Fuel Cells						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

TEXTBOOK :

1	*Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi*, **"Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design"**, *CRC Press, 2018.*
2	*Iqbal Husain*, ***"Electric and Hybrid Vehicles, Design Fundamentals"***, *Third Edition, CRC Press, 2021*

REFERENCES :

1	*Ali Emadi, Mehrdad Ehsani, John M. Miller,* ***"Vehicular Electric Power Systems",*** *Special Indian Edition, Marcel Dekker, Inc 2003, 1st Edition.*
2	*C.C. Chan and K.T. Chau,* ***'Modern Electric Vehicle Technology',*** *OXFORD University Press, 2001, 1st Edition.*
3	*Wie Liu,* ***"Hybrid Electric Vehicle System Modeling and Control"****, Second Edition, John Wiley & Sons, 2017, 2nd Edition.*
4	*Chee Mun Ong,* ***"Dynamic Simulation of Electric Machinery using MATLAB",*** *Prentice Hall,1997, 1st Edition.*
5	*Atif Iqbal, Shaikh Moinoddin, BhimireddyPrathap Reddy,* ***"Electrical Machine Fundamentals with Numerical Simulation using MATLAB/ SIMULINK"****, Wiley, 2021, 1st Edition.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Describe the concepts related to EV, and HEV and compare the same with internal combustion engine vehicles	**K2**
CO2	Relate the electric drives used in HEV	**K2**
CO3	Analyze and design the hybrid electric train components	**K4**
CO4	Examine the concepts related to series/parallel hybrid electric drive train	**K4**
CO5	Demonstrate the architecture of fuel cell vehicles.	**K2**

COURSE ARTICULATION MATRIX :

a. CO and PO Mapping

CO/ PO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	-	-	-	-	3	-	-	-	-	-	3	3	3
CO2	2	3	-	-	-	-	-	-	-	-	-	-	2	2	2
CO3	3	3	3	3	3	-	-	-	-	-	-	-	2	2	2
CO4	3	3	-	1	-	-	-	-	-	-	-	-	2	2	2
CO5	3	3	-	1	-	-	-	-	-	-	-	-	2	2	2
22EPE$ 24	**3**	**3**	**3**	**2**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b. CO and Key Performance Indicators Mapping

CO1	1.1.2, 1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 7.1.1, 7.1.2, 7.2.1, 7.2.2
CO2	1.1.2, 1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 4.1.1, 4.2.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 4.1.1, 4.2.2

ASSESSMENT PATTERN – THEORY (Times New Roman, Size 11)							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	40	40	10	-	-	100
CAT2	10	40	40	10	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	40	30	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	40	30	-	-	100
ESE	10	40	40	10	-	-	100

22EPE$25	**DESIGN OF ELECTRICAL VEHICLE CHARGING SYSTEM**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**2**	**0**	**2**	**3**

Course Objectives	To demonstrate the concepts of power converters in charging Electric Vehicles and power factor correction techniques.	
UNIT – I	**CHARGING STATIONS AND STANDARDS**	**6 Periods**
Introduction-Charging technologies- Conductive charging, EV charging infrastructure, International standards and regulations - Inductive charging, need for inductive charging of EV, Modes and operating principle, Static and dynamic charging, Bidirectional power flow, International standards and regulations.		
UNIT – II	**POWER ELECTRONICS FOR EV CHARGING**	**6 Periods**
Layouts of EV Battery Charging Systems-AC charging-DC charging systems- Power Electronic Converters for EV Battery Charging- AC–DC converter with boost PFC circuit, with bridge and without bridge circuit - Bidirectional DC–DC Converters- Non-isolated DC–DC bidirectional converter topologies- Half-bridge bidirectional converter.		
UNIT – III	**EV CHARGING WITH RENEWABLE AND STORAGE SYSTEMS**	**6 Periods**
Introduction- - EV charger topologies , EV charging/discharging strategies - Integration of EV charging-home solar PV system , Operation modes of EVC-HSP system , Control strategy of EVC-HSP system - fast-charging infrastructure with solar PV and energy storage.		
UNIT – IV	**WIRELESS POWER TRANSFER**	**6 Periods**
Introduction - Inductive, Magnetic Resonance, Capacitive types. Wireless Chargers for Electric Vehicles - Types of Electric Vehicles - Battery Technology in EVs -Charging Modes in EVs - Benefits of WPT. - WPT Operation Modes - Standards for EV Wireless Chargers, SAE J2954, IEC 61980. ISO 19363.		
UNIT – V	**POWER QUALITY ISSUES IN CHARGING SYSTEM**	**6 Periods**
Need for power factor correction- Boost converter for Power Factor Correction, Sizing the inductor-Active front end converter - Average current in the rectifier and calculation of power losses- Analysis of Harmonics due to charging System		
EXPERIMENTS		**30 Periods**
1. Simulation and analysis for bi-directional charging V2G and G2V. 2. Design and demonstrate solar PV based EV charging stations. 3. Simulate and infer wireless power charging station for EV charging. 4. Simulation of boost converter based power factor correction.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 30 Periods Total: 60 Periods**		

TEXT BOOK :

1	***Mobile Electric Vehicles Online Charging and Discharging***, *Miao Wang Ran Zhang Xuemin (Sherman) Shen, Springer 2016, 1st Edition.*
2	*Alicia Triviño-Cabrera, José M. González-González, José A. Aguado,* ***Wireless Power Transferor Electric Vehicles: Foundations and Design Approach****, Springer Publisher 1st Edition. 2020.*

REFERENCES :

1	*Patel, Akash Kumar Bhoi, SanjeevikumarPadmanaban, Jens Bo Holm-Nielsen, "****Electric Vehicles Modern Technologies and Trends****", Springer Publisher 1st Edition, 2021.*
2	*Rajiv Singh, SanjeevikumarPadmanaban, Sanjeet Dwivedi, Marta Molinas and FredeBlaabjerg,* ***"Cable Based and Wireless Charging Systems for Electric Vehicles, Technology and control, management and grid integration"****, IET 2021, 1st Edition.*
3	*James D Halderman,* ***"Electric and Hybrid Electric Vehicles"****, Pearson, 2022, 1st Edition.*
4	*Ali Emadi,* ***"Handbook of Automotive Power Electronics and Motor Drives"****, Taylor & Francis, 2005.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Illustrate various charging techniques and know charging standards and regulations.	K2
CO2	Demonstrate the working of DC-DC converters used for charging systems and principles	K2
CO3	Summarize the advantages of renewable system-based charging systems	K5
CO4	Demonstrate the principles of wireless power transfer.	K2
CO5	Analyze the standards for wireless charging.	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO2	PSO3
CO1	3	2	2	3	1	3	2	-	-	-	-	2	3	2	3
CO2	2	2	2	3	2	2	3	-	-	-	-	3	3	2	1
CO3	2	1	2	3	2	2	1	1	-	-	-	2	2	2	3
CO4	2	2	1	2	2	2	3	-	-	-	-	2	2	3	2
CO5	3	2	2	3	2	-	3	1	-	-	-	2	3	2	2
22EPE $25	3	2	2	3	2	3	3	1	-	-	-	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.2.1,1.3.1,1.4.1,2.1.2,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.4.2,2.4.4,3.1.1,3.1.5,3.2.1,3.2.2,3.2.3,3.3.2,3.4.1,4.1.2,4.1.3,4.2.1,4.3.1,4.3.3,4.3.4,5.1.1,5.2.2,6.1.1,6.2.1,7.1.2,7.2.2,12.1.1,12.2.2,12.3.2,
CO2	1.1.1,1.1.2,1.4.1,2.1.2,2.2.2,2.2.3,2.3.1,2.4.1,2.4.3,3.1.2,3.1.3,3.1.4,3.2.2,3.3.1,3.4.2,4.1.1,4.1.3,4.2.1,4.2.2,4.3.2,4.3.3,5.1.1,5.2.2,5.3.1,6.1.1,7.1.1,7.2.1,7.2.2,12.1.1,12.1.2,12.2.1,12.3.1,12.3.2
CO3	1.1.1,1.1.2,1.3.1,2.1.1,2.2.2,2.3.2,2.4.2,3.1.1,3.1.2,3.1.4,3.1.5,3.2.1,3.2.2,3.3.1,3.4.1,4.1.1,4.1.2,4.1.4,4.3.1,4.3.2,4.3.4,5.1.2,5.2.1,5.2.2,5.3.2,6.1.1,7.1.2,8.2.2,12.1.1,12.1.2,12.2.2,12.3.2,
CO4	1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.3,3.1.2,3.1.4,3.2.1,3.2.3,3.3.1,3.3.2,3.4.2,4.1.2,4.1.4,4.2.2,4.3.1,4.3.3,5.1.1,5.2.1,5.3.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,12.1.1,12.1.2,12.2.2,12.3.2,
CO5	1.1.1,1.2.1,1.3.1,1.4.1,2.1.2,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.4,3.1.2,3.1.5,3.2.1,3.3.1,3.4.1,4.1.1,4.1.2,4.1.4,4.2.2,4.3.2,4.3.3,5.1.1,5.1.2,5.2.2,5.3.2,7.1.1,7.2.1,7.2.2,8.2.1,12.1.1,12.3.1,12.3.2

ASSESSMENT PATTERN – THEORY (Times New Roman, Size 11)							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	10	40	10	-	100
CAT2	10	20	10	40	20	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	20	20	30	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	20	20	30	-	100
ESE	10	20	10	40	20	-	100

22EPE$26	TESTING OF ELECTRIC VEHICLES					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	2	0	2	3
Course Objectives	To know various standardization procedures, testing procedures for EV & HEV components, functional safety and EMC, effect of EMC in EVs , effect of EMI in motor drives and in DC-DC converter system.					
UNIT – I	**EV STANDARDIZATION**	**6 Periods**				
Introduction - Current status of standardization of electric vehicles, electric vehicles and Standardization - Standardization Bodies Active in the Field – Standardization activities in countries like Japan. The International Electro-Technical Commission - Standardization of Vehicle Components						
UNIT – II	**TESTING OF ELECTRIC MOTORS AND CONTROLLERS FOR ELECTRIC AND HYBRID ELECTRIC VEHICLES**	**6 Periods**				
Test Procedure Using M-G Set, electric motor, controller, application of Test Procedure, Analysis of Test Items for the Type Test - Motor Test and Controller Test (Controller Only). - Test Procedure Using Eddy Current Type Engine Dynamometer, Test Strategy, Test Procedure, Discussion on Test Procedure. Test Procedure Using AC Dynamometer.						
UNIT – III	**FUNDAMENTALS OF FUNCTIONAL SAFETY AND EMC**	**6 Periods**				
Functional safety life cycle - Fault tree analysis - Hazard and risk assessment - re development - Process models - Development assessments - Configuration management - Reliability - Reliability block diagrams and redundancy - Functional safety and EMC - Functional safety and quality - Standards - Functional safety of autonomous vehicles.						
UNIT – IV	**EMC IN ELECTRIC VEHICLES**	**6 Periods**				
Introduction - EMC Problems of EVs, EMC Problems of Motor Drive, EMC Problems of DC-DC Converter System, EMC Problems of Wireless Charging System, EMC Problem of Vehicle Controller, EMC Problems of Battery Management System, Vehicle EMC Requirements						
UNIT – V	**EMI IN MOTOR DRIVE SYSTEM**	**6 Periods**				
Overview -EMI Mechanism of Motor Drive System, Conducted Emission Test of Motor Drive System, IGBT EMI Source, EMI Coupling Path, EMI Modelling of Motor Drive System. EMI in DC-DC Converter, EMI Source, The Conducted Emission High-Frequency, Equivalent Circuit of DC-DC Converter System, EMI Coupling Path.						
LAB COMPONENT: -		**30 Periods**				
1. Design and simulate motor controller for hybrid electric vehicle applications 2. Simulation of EMC analysis for Wireless power transfer EV charging. 3. Design and simulation of EMI filter						
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical:30 Periods Total: 60 Periods**						

TEXT BOOK

1	Handbook of Automotive Power Electronics and Motor Drives, Ali Emadi, Taylor & Francis, 2005, 1st Edition.
2	Electromagnetic Compatibility of Electric Vehicle, Li Zhai, Springer 2021, 1st Edition.

REFERENCES (Minimum 4 and Maximum 6):

1	EMC and Functional Safety of Automotive Electronics, Kai Borgeest, IET 2018, 1st Edition.
2	EMI/EMC Computational Modeling Handbook, DruceArchambeault, colin branch, Omar M.Ramachi ,Springer 2012, 2nd Edition.
3	Automotive EMC, Mark Steffika, Springer 2013, 1st Edition
4	Electric Vehicle Systems Architecture and Standardization Needs, Reports of the PPP European Green Vehicles Initiative, Beate Müller, Gereon Meyer, Springer 2015, 1st Edition.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Describe the status and other details of standardization of EVs	K2
CO2	Illustrate the testing protocols for EVs and HEV components	K3
CO3	Analyze the safety cycle and need for functions safety for EVs	K4
CO4	Analyze the problems related with EMC for EV components.	K4
CO5	Evaluate the EMI in the motor drive and DC-DC converter system.	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	1	1	-	-	-	2	-	-	-	-	-	3	-	2
CO2	3	1	1	-	-	-	1	-	-	-	-	-	3	-	2
CO3	3	1	1	-	-	-	2	-	-	-	-	-	3	-	2
CO4	3	1	1	-	-	-	1	-	-	-	-	-	3	-	2
CO5	3	1	1	-	-	-	2	-	-	-	-	-	3	3	3
22EPE $26	3	1	1	-	-	-	2	-	-	-	-	-	3	1	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,3.1.1,7.1.1,7.1.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,3.1.1,7.1.1
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,3.1.1,7.1.1,7.1.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,3.1.1,7.1.1
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,3.1.1,7.1.1,7.1.2

ASSESSMENT PATTERN – THEORY (Times New Roman, Size 11)

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	20	10	40	10	-	100
CAT2	10	20	10	40	20	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	20	20	30	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	20	20	30	-	100
ESE	20	20	10	40	10	-	100

22EPE$27	**GRID INTEGRATION OF ELECTRIC VEHICLES**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	PE	3	0	0	3

Course Objectives	To gain overall idea about Grid integration of Electric vehicles, their effects and remedies.

UNIT – I	**STATUS OF V2G**	**9 Periods**
Defining V2G - History and Development of V2G. Incorporating V2G to the EV, Auditing and Metering , V2G in Practice , V2G, Power Markets and Applications . Electricity Markets and V2G Suitability , Long-Term Storage, Renewable Energy, and Other Grid Applications , Beyond the Grid: Other Concepts Related to V2G.		
UNIT – II	**BENEFITS AND CHALLENGES OF V2G**	**9 Periods**
Benefits of V2G, Technical Benefits: Storage Superiority and Grid Efficiency, Economic Benefits: EV Owners and Societal Savings, Environment and Health Benefits: Sustainability in Electricity and Transport, Other Benefits.		
UNIT – III	**CHALLENGES TO V2G**	9 **Periods**
Technical Challenges-Battery Degradation, Charger Efficiency, Aggregation and Communication, V2G in a Digital Society. The Economic and Business Challenges to V2G - Evaluating V2G Costs and Revenues , EV Costs and Benefits , Adding V2G Costs and Benefits , Additional V2G Costs , The Evolving Nature of V2G Costs and Benefits. Regulatory and Political Challenges to V2G , V2G and Regulatory Frameworks , Market Design Challenges. Other V2G Regulatory and Legal Challenges		
UNIT – IV	**IMPACT OF EV AND V2G ON THE SMART GRID AND RENEWABLE ENERGY SYSTEMS**	9 **Periods**
Introduction - Types of Electric Vehicles - Motor Vehicle Ownership and EV Migration - Impact of Estimated EVs on Electrical Network - Impact on Drivers and the Smart Grid - Standardization and Plug-and-Play - IEC 61850 Communication Standard and IEC 61850-7-420 Extension.		
UNIT – V	**GRID INTEGRATION AND MANAGEMENT OF EVS**	**9 Periods**
Introduction-M2M in distributed energy management systems - M2M communication for EVs - M2M communication architecture (3GPP) - Electric vehicle data logging - Scalability of electric vehicles - M2M communication with scheduling.		

Contact Periods: (Times New Roman, Size 11, BOLD, Sentence case)
Lecture:45 Periods **Tutorial: ___ Periods** **Practical: ___ Periods** **Total:45 Periods**

TEXT BOOK

1	Advanced Electric Drive Vehicles, Ali Emadi, CRC Press 2017, 1st Edition.
2	Plug In Electric Vehicles in Smart Grids, Charging Strategies, Sumedha Rajakaruna ,Farhad Shahnia and Arindam Ghosh,Springer,2015, 1st Edition

REFERENCES

1	ICT for Electric Vehicle Integration with the Smart Grid, Nand Kishor 1; Jesus Fraile-Ardanuy, IET 2020, 1st Edition..
2	Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid, Junwei Lu and Jahangir Hossain, IET 2015, 1st Edition.
3	Lance Noel · Gerardo Zarazua de Rubens Johannes Kester · Benjamin K. Sovacool, Vehicleto-Grid A Socio technical Transition Beyond Electric Mobility, 2019, 1st Edition.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the concepts related with V2G.	K2
CO2	Study the grid connection of 3 phase Q inverter	K1
CO3	Explain technical, economics. business, regulatory & political challenges related with V2G	K3
CO4	Demonstrate the impact of EV and V2G on smart grid and renewable energy system	K4
CO5	Explain the concept of grid integration and management of EVs.	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	-	-	-	-	-	2	1	-	2	-	-	3	-	1
CO2	3	3	-	-	3	-	2	1	-	2	-	-	3	-	-
CO3	3	-	-	-	-	-	2	1	-	2	-	-	3	-	-
CO4	3	-	-	-	-	-	2	1	-	2	-	-	3	-	2
CO5	3	-	-	-	-	-	2	1	-	2	-	-	3	-	3
22EPE $27	3	1	-	-	1	-	2	1	-	2	-	-	3	-	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,7.1.1,7.1.2,8.1.1,10.1.1,10.1.2,10.2.1,10.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,7.1.1,7.1.2,8.1.1,10.1.1,10.1.2,10.2.1,10.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,7.1.1,7.1.2,8.1.1,10.1.1,10.1.2,10.2.1,10.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,7.1.1,7.1.2,8.1.1,10.1.1,10.1.2,10.2.1,10.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,7.1.1,7.1.2,8.1.1,10.1.1,10.1.2,10.2.1,10.2.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	10	40	10	-	100
CAT2	10	20	10	40	20	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	20	20	30	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	20	20	30	-	100
ESE	10	20	10	40	20	-	100

22EPE$28	INTELLIGENT CONTROL OF ELECTRIC VEHICLES					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	2	0	2	3
Course Objectives	To design and derive the mathematical model of a BLDC motor and its characteristics and to learn the different control schemes for BLDC motor and implement in Fuzzy/FPGA.					
UNIT – I	**ANALYSIS OF BLDC MOTOR**					**6 Periods**
Structure and Drive Modes - Basic Structure, General Design Method, Drive Modes. Mathematical Model, Differential Equations, Transfer Functions, State-Space Equations. Characteristic Analysis, Starting Characteristics, Steady-State Operation, Dynamic Characteristics, Load Matching Commutation Transients.						
UNIT – II	**CONTROLLERS FOR BLDC MOTOR**					**6 Periods**
Introduction -PID Control Principle, Anti-windup Controller, Intelligent Controller - Fuzzy Logic-Control applied to BLDC motor						
UNIT – III	**FPGA ARCHITECTURE**					**6 Periods**
Introduction – FPGA Architecture-Advantages-Review of FPGA family processors- Spartan 3, Spartan 6 and Spartan 7.						
UNIT – IV	**FPGA PROGRAMMING**					**6 Periods**
VHDL Basics- Fundamentals-Instruction set-data type-conditional statements- programs : arithmetic, sorting, PWM generation, Speed detection, Speed Control.						
UNIT – V	**REAL TIME IMPLEMENTATION**					**6 Periods**
Inverter design, identifying rotor position via hall effect sensors, open loop and fuzzy logic control of BLDC motor using FPGA- Introduction to Battery Management System in EV.						
LAB COMPONENT:						**30 Periods**
1. Design and simulate speed controller for BLDC in EV for both dynamic and steady state performance. 2. Code VHDL programming for the control of BLDC motors. 3. Fuzzy logic control of BLDC motor using FPGA in real time .						
Contact Periods: **Lecture:30 Periods** **Tutorial: 0 Periods** **Practical: 30 Periods** **Total:60 Periods**						

TEXT BOOK

1	*John G. Hayes, G. Abas Goodarzi,* ***Electric Powertrain Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles****, Wiley 1st Edition 2018.*
2	*Jayaram Bhasker,* ***VHDL Primer****, (3rd Edition), Prentice Hall, 1 st Edition 2015.*

REFERENCES (Minimum 4 and Maximum 6):

1	*Iqbal Hussain, "**Electric and Hybrid Vehicles: Design Fundamentals, Third Edition**" CRC Press, Taylor & Francis Group, 2021, 1 st Edition.*
2	*Chang-liang, "**Permanent Magnet Brushless DC Motor Drives and Controls**", Wiley 2012, 1 st Edition.*
3	*M.N. Cirstea, A. Dinu, J.G. Khor,M. McCormick, "**Neural and Fuzzy Logic Control of Drives and Power Systems, Newnes publications**", 1 st Edition, 2002.*
4	*Wei Liu, "**Hybrid Electric Vehicle System Modeling and Control**", Wiley 2017, 2nd Edition*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret the mathematical model of a BLDC motor and discuss its characteristics	K2
CO2	Demonstrate the different controller actions applied to the BLDC motor.	K3
CO3	Review the basics of fuzzy logic systems.	K2
CO4	Develop the control of EVs through VHDL coding.	K3
CO5	Devise fuzzy logic control scheme for BLDC motor using FPGA in real-time.	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	2	2	-	1	1	-	-	1	1	3	3	2
CO2	3	3	2	2	2	-	1	1	-	-	1	1	2	2	2
CO3	3	2	2	2	2	-	1	-	-	-	1	1	2	2	2
CO4	3	3	2	2	2	-	1	1	-	-	1	1	2	2	2
CO5	3	2	2	2	2	-	1	1	-	-	1	1	2	2	2
22EPE$28	3	3	2	2	2	-	1	1	-	-	1	1	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 7.2.2, 8.2.1, 11.1.1, 12.1.2, 12.2.1
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 7.2.2, 8.2.1, 11.1.1, 12.1.2, 12.2.1
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 7.2.2, 11.1.1, 12.1.2, 12.2.1
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 7.2.2, 8.2.1, 11.1.1, 12.1.2, 12.2.1
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 7.2.2, 8.2.1, 11.1.1, 12.1.2, 12.2.1

ASSESSMENT PATTERN – THEORY (Times New Roman, Size 11)

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	20	20	40	-	-	100
CAT2	10	20	30	40	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	50	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	50	20	-	-	100
ESE	10	20	30	40	-	-	100

DIVERSIFIED COURSES – V5

23EPE$29	**OPTIMIZATION TECHNIQUES AND APPLICATIONS**

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To formulate the mathematical models, Engineering design methodology and perform quantitative analysis of managerial problems in industries.	
UNIT – I	**LINEAR PROGRAMMING**	**9 Periods**
Introduction – formulation of linear programming model-Graphical solution–solving LPP using a simplex algorithm – Revised Simplex Method.		
UNIT – II	**ADVANCEDLINEAR PROGRAMMING**	**9 Periods**
Duality theory- Dual simplex method – Sensitivity analysis–-Transportation problems–Assignment problems - Travelling sales man problem -Data envelopment analysis.		
UNIT – III	**NONLINEAR PROGRAMMING**	**9 Periods**
Classification of Non-Linear programming – Lagrange multiplier method – Karush – Kuhn Tucker conditions–Reduced gradient algorithms–Quadratic programming method – Penalty and Barrier method.		
UNIT – IV	**INTERIOR POINT METHODS**	**9 Periods**
Karmarkar's algorithm–Projection Scaling method–Dual affine algorithm–Primal affine algorithm Barrier algorithm.		
UNIT – V	**DYNAMIC PROGRAMMING**	**9 Periods**
Formulation of Multi-stage decision problem–Characteristics–Concept of sub-optimization and the principle of optimality–Formulation of Dynamic programming–Backward and Forward recursion– Computational procedure–Conversion of final value problem into Initial value problem.		
Contact Periods: **Lecture:45 Periods Tutorial: 0 Periods Practical:0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*G. Sreenivasan, "* ***Operations Research: Principles and Applications****", PHI,2017*
2	*Hillier and Lieberman "* ***Introduction to Operations Research****", TMH, 2017*

REFERENCES :

1	*R.Panneerselvam, "* ***Operations Research****", PHI, 2016*
2	*HamdyATaha, "* ***Operations Research –An Introduction****", Prentice Hall India, 2016.*
3	*Philips, Ravindran and Solberg, "* ***Operations Research****", John Wiley, 2007.*
4	*Ronald L.Rardin, "* ***Optimization in Operation Research****" Pearson Education Pvt. Ltd. New Delhi, 2013.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret the basic concepts of optimization techniques.	K2
CO2	Illustrate the basics and advancements in Linear programming techniques	K2
CO3	Observe the significance of non-linear programming techniques and suitable techniques to solve real world problem	K2
CO4	Compute the solutions foroptimisation problems using interior point methods.	K3
CO5	Develop dynamic programming problems and evaluate its solution methods	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs /POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	2	2	2	-	1	1	-	-	1	1	2	2	2
CO2	3	3	2	2	2	-	1	1	-	-	1	1	2	2	2
CO3	3	2	2	2	2	-	1	-	-	-	1	1	3	2	2
CO4	3	3	2	2	2	-	1	1	-	-	1	1	2	2	1
CO5	3	2	2	2	2	-	1	1	-	-	1	1	2	1	1
22EPE$29	3	2	2	2	2	-	1	1	-	-	1	1	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 7.2.2, 8.2.1, 11.1.1, 12.1.2, 12.2.1
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 7.2.2, 8.2.1, 11.1.1, 12.1.2, 12.2.1
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 7.2.2, 11.1.1, 12.1.2, 12.2.1
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 7.2.2, 8.2.1, 11.1.1, 12.1.2, 12.2.1
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 7.2.2, 8.2.1, 11.1.1, 12.1.2, 12.2.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	25	25	20	10		100
CAT2	20	20	30	20	10		100

Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	20	25	20	15		100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	20	30	20	10		100
ESE	20	20	30	20	10		100

22EPE$30	SOFT COMPUTING TECHNIQUES

PREREQUISITES		CATEGORY	L	T	P	C
NIL		PE	3	0	0	3
Course Objectives	To provide in-depth knowledge on the fundamentals of intelligent systems , their applications and develop intelligent solutions to real world problems.					

UNIT – I	INTRODUCTION TO SOFT COMPUTING	9 Periods
Soft Computing Constituents – From Conventional AI to Computational Intelligence-Soft computing versus Hard computing - Neural Networks Basic structure of ANN and Fuzzy Logic System - Introduction to Nature inspired search methodologies - Basic idea of Genetic Algorithm - Application scope of ANN, Fuzzy Logic and Genetic Algorithms.		
UNIT – II	**ARTIFICIAL NEURAL NETWORKS**	**9 Periods**
McCulloch-Pitts neuron - linear separability - Hebb network - supervised learning networks: perceptron networks - adaptive linear neuron, multiple adaptive linear neuron, BPN. Associative memory network: auto-associative memory network, hetero-associative memory network, Bi-directional Associative Memory (BAM), Hopfield networks. Unsupervised learning networks: Kohonen self-organizing feature maps – Counter Propagation networks, Adaptive Resonance Theory network.		
UNIT – III	**FUZZY SYSTEMS**	**9 Periods**
Membership functions: features, fuzzification, methods of membership value assignments-Defuzzification: lambda cuts - methods - fuzzy arithmetic and fuzzy measures: fuzzy arithmetic - extension principle - fuzzy measures - measures of fuzziness -fuzzy integrals - fuzzy rule base and approximate reasoning : truth values and tables, fuzzy propositions, formation of rules-decomposition of rules, aggregation of fuzzy rules, fuzzy reasoning-fuzzy inference systems-overview of fuzzy expert system-fuzzy decision making.		
UNIT – IV	**GENETIC ALGORITHMS**	**9 Periods**
Introduction- Biological Background –Genetic Algorithm (GA) vs. Traditional Algorithm – Basic Terminologies in GA: Individuals-Genes-Fitness-Population- Operators in GA: Encoding- Selection – Crossover – Mutation – Constraints in GA- Real coded GA		
UNIT – V	**HYBRID SYSTEMS**	**9 Periods**
Neuro-Fuzzy Hybrid Systems – Genetic Neuro-Hybrid Systems - Genetic Fuzzy Hybrid and Fuzzy Genetic Hybrid System – Simplified Fuzzy ARTMAP – Applications of Soft Computing techniques to simple problems		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK (Maximum 2):

1	*S.N.Sivanandam , S.N.Deepa, **"Principles of Soft Computing"**, Wiley India Pvt.Ltd., 3rd Edition, 2018.*
2	*S.Rajasekaran, G.A.Vijayalakshmi Pai, **"Neural Networks, Fuzzy Logic and Genetic Algorithm, Synthesis and Applications "**, PHI Learning Pvt.Ltd., 2017.*

REFERENCES (Minimum 4 and Maximum 6):

1	*Jyh-Shing Roger Jang, Chuen-Tsai Sun, EijiMizutani,* ***—Neuro-Fuzzy and Soft Computing****, Prentice-Hall of India, 2008.*
2	*Kwang H.Lee,* ***—First course on Fuzzy Theory and Applications‖****, Springer, 2005.*
3	*George J. Klir and Bo Yuan,* ***—Fuzzy Sets and Fuzzy Logic-Theory and Applications‖****, Pearson Education India, First Edition, 2015.*
4	*James A. Freeman and David M. Skapura,* ***—Neural Networks Algorithms****, Applications, and Programming Techniques,Pearson Education India, Third Edition, 2008.*
5	*N.P.Padhy, S.P.Simon,* ***"Soft Computing with MATLAB Programming"****, Oxford University Press, 2015.*

Note: Books with 10 years before publications may be avoided

COURSE OUTCOMES: **Upon completion of the course, the students will be able to:**		**Bloom's Taxonomy Mapped**
CO1	Explain about soft computing techniques and their roles in building intelligent systems.	**K2**
CO2	Examine the artificial neural networks to classification and regression problems.	**K3**
CO3	Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems.	**K3**
CO4	Implement the combinatorial optimization problems using genetic algorithms	**K3**
CO5	Evaluate the hybridization of different intelligent techniques for solving complex problems.	**K5**

COURSE ARTICULATION MATRIX :

a. CO and PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	-	-	-	-	-	-	-	-	-	-	-	3	3	3
CO2	2	3	-	-	-	-	-	-	-	-	-	-	2	2	2
CO3	3	3	2	-	3	-	-	-	-	-	-	-	2	2	2
CO4	3	3	-	1	-	-	-	-	-	-	-	-	2	2	2
CO5	3	3	3	3	3	-	-	-	-	-	-	2	2	2	2
22EPE$ 30	**3**	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b. CO and Key Performance Indicators Mapping	
CO1	1.1.2, 1.2.1, 1.4.1
CO2	1.1.2, 1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.2.1, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 4.1.1, 4.2.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	40	40	10	-	-	100
CAT2	10	40	40	10	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	10	40	40	10	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	10	40	40	10	-	100
ESE	10	40	40	10	-	-	100

22EPE$31	AUTOMOTIVE ELECTRONICS FOR ELECTRICAL ENGINEERING					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To explore the role of electronic systems, in-vehicle networking and comfort/safety in automotive control applications.					

UNIT – I	**FUNDAMENTALS OF AUTOMOTIVE ELECTRONICS**	**9 Periods**
Evolution of electronics in automobiles, emission laws, introduction to Euro standards, equivalent Bharat standards, Charging systems: Working and design of charging circuit, alternators, requirements of starting system, starter motors and starter circuits.		
UNIT – II	**IGNITION AND INJECTION SYSTEMS**	**9 Periods**
Ignition systems: Ignition fundamentals, Electronic Ignition system, programmed ignition, distribution less ignition, direct ignition, spark plugs, Electronic fuel control, basics of combustion, engine fuelling and exhaust emission, electronic control of carburetion, petrol fuel injection, diesel fuel injection.		
UNIT – III	**SENSORS AND ACTUATORS**	**9 Periods**
Working principle and characteristics of airflow rate, engine crankshaft angular position, hall effect, throttle angle, temperature, exhaust gas oxygen sensors. Fuel injector, exhaust gas recirculation actuators, stepper motor actuator and vacuum operated actuator.		
UNIT – IV	**ENGINE CONTROL SYSTEM**	**9 Periods**
Control modes for fuel control, engine control subsystems, ignition control methodologies, different ECUs used in engine management. Vehicle networks: CAN standard. Diagnostic systems in modern automobiles		
UNIT – V	**CHASSIS AND SAFETY SYSTEMS**	**9 Periods**
Traction control system, cruise control system, electronic control of automatic transmission, antilock braking system, electronic suspension system, working of airbag, centralized door locking system, climate control of cars.		
Contact Periods: **Lecture:45 Periods Tutorial:0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*Tom Denton, "**Automobile Electrical and Electronic Systems**", Arnold Publishers, fifth Edition 2017.*
2	*William B Ribbens, "**Understanding Automotive Electronics**", Eighth Edition, Newness Publishers, 2017*

REFERENCES

1	*V A W Hillier "**Fundamentals of Automotive Electronics**", OUP Oxford, Second Edition 2012.*
2	*Ronald K Jurgen, "**Automotive Electronic Handbook**", McGraw Hill, Second Edition, 1999.*
3	*Robert Bosch, "**Automotive Electrics and Automotive Electronics**", Springer, Fifth Edition,2014.*
4	*Bogdan M. Wilamowski, J. David Irwin "**The Industrial Electronics Handbook**", CRC Press ,second edition,2011*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Perceive the electronics involved in automotive systems	K2
CO2	Outline the fundamentals involved in ignition systems	K2
CO3	Choose appropriate sensors for automobiles based on applications	K3
CO4	Implement simple and safe control systems in automobiles	K5
CO5	Analyze the safety issues that occur in automotive systems	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	2	2	2	2	-	-	1	1	-	3	1	1
CO2	3	2	2	2	2	-	2	-	-	1	2	-	3	3	1
CO3	3	3	1	2	2	-	-	-	-	2	3	2	2	3	1
CO4	3	3	1	2	2	3	2	2	1	-	-	3	3	3	3
CO5	3	3	1	2	2	3	2	2	1	-	-	3	3	3	1
22EPE$31	3	3	1	2	2	3	2	2	1	1	2	3	3	3	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1,1.3.1,1.4.1,2.3.1,2.3.2,2.4.4,3.1.3,3.1.6,3.2.1,4.1.4,4.2.1,4.3.4,5.1.1,5.3.1,6.1.1,7.1.1,7.2.2, 10.1.1,10.3.1,11.1.1
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.3,2.2.4,2.4.2,2.4.3,2.4.4,3.1.3,3.1.4,3.1.5, 3.1.6,3.2.1,3.2.2,3.3.1,4.1.2,4.1.4,4.2.1,5.1.2,5.2.2,5.3.2,7.1.1,7.2.2,10.1.1,10.3.1,11.2.1,11.1.2, 11.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1, 3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2,10.1.1,10.2.2,10.3.1,11.1.1,11. 2.1,11.3.1,11.3.2,12.3.1,12.3.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1, 3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,8.2.2,9.1.2,7.2.1,7.2.2,6.2.1,6.1.1,5.3.2,5.3.1,5.3.2 ,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1, 3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,8.2.2,9.1.2,7.2.1,7.2.2,6.2.1,6.1.1,5.3.2,5.3.1,5.3.2 ,12.1.2,12.2.2,12.3.2

ASSESSMENT PATTERN

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	30	10	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	20	-	100
ESE	10	30	40	10	10	-	100

22EPE$32	DIGITAL SIGNAL PROCESSING AND PROCESSORS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To emphasize intuitive understanding of the concepts of Digital Signal Processing, design FIR and IIR Filters, insist knowledge on DSP processors for practical applications.	
UNIT – I	**DISCRETE TIME LINEAR SYSTEMS**	**9 Periods**
Discrete Linear systems – Time invariance –Causality, Stability, Difference Equations-Transfer functions of linear discrete systems – Impulse, step and frequency response – Linear and circular convolution- Recursive and non-recursive filters – Digital filter realization – Direct, Canonic, Cascade, Parallel and ladder realizations.		
UNIT – II	**TRANSFORMATIONS IN DSP**	**9 Periods**
Discrete Fourier Transform – Properties – IDFT- Convolution: Linear and Circular-Fast Fourier Transform: Introduction to Radix- 2 FFT – Properties – Decimation in time – Decimation in frequency – Computation of IDFT using DFT.		
UNIT – III	**IIR DIGITAL FILTERS**	**9 Periods**
Approximation of analog filters – Butterworth -Chebyshev – Properties of IIR filter – IIR filter design-Bilinear transformation and Impulse invariance method – Digital transformation.		
UNIT – IV	**FIR DIGITAL FILTERS**	**9 Periods**
Characteristics of FIR filter - Frequency response of linear phase FIR filter - Design of FIR filter – Fourier series method–Window function- Rectangular, Kaiser and Bartlett window methods.		
UNIT – V	**DIGITAL SIGNAL PROCESSOR**	**9 Periods**
dsPIC30F4011 – Architecture - MCU and DSP features - Hardware DMA - Interrupt Controller - Digital I/O, On-chip Flash, Data EE and RAM - Peripherals - Timers, Communication Modules Motor Control Peripherals - Capture/Compare/PWM, Analog-to-Digital Converters		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	B.Venkataramani, M.Bhaskar, ***"Digital Signal Processors – Architecture, Programming and Applications"***, Tata McGraw Hill, Revised Edition, 2017.
2	C. Ramesh BabuDurai, ***"Digital Signal Processing"***, Tata McGraw Hill, Reprint, 2018.

REFERENCES :

1	John.G.Proakis, Dimitrias.G. and Manolakis. "DSP Principles Algorithms and Applications", Prentice Hall of India – Fourth Edition, 2014
2	Emmanuel C.Ifeachor, University of Plymouth. Barrie.W.Jervis, Sheffield Hallam University, "Digital Signal Processing. A Practical Approach", Pearson Education, II Edition, 2015.
3	SanjitK.Mitra, "Digital Signal Processing: A computer Based approach" Tata Mc Graw Hill, Fourth Edition, 2014
4	Farzad Nekoogar, Gene moriarty. "Digital Control Using Digital Signal Processing" P.H. International Inc. New Jersey.2012.

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Classify the digital signals and systems and perform filter realizations.	K2
CO2	Develop the ability to execute various transformations for DSP	K3
CO3	Design digital IIR filters	K3
CO4	Design digital FIR filters	K3
CO5	Explain the DSP processor and analyze it for practical applications	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	3	1	-	-	-	-	-	-	-	3	3	3
CO2	3	3	2	3	1	-	-	-	-	-	-	-	3	3	3
CO3	3	3	2	3	1	-	-	-	-	-	-	-	3	3	3
CO4	3	3	2	3	1	-	-	-	-	-	-	-	3	3	3
CO5	3	3	2	3	1	-	-	-	-	-	-	-	1	1	1
22EPE$32	3	3	2	3	1	-	-	-	-	-	-	-	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.2.1, 3.2.2, 3.2.3, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.2.1, 3.2.2, 3.2.3, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.2.1, 3.2.2, 3.2.3, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.2.1, 3.2.2, 3.2.3, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.2.1, 3.2.2, 3.2.3, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	40	40	10	-	-	100
CAT2	10	40	40	10	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	20	40	40	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	20	40	40	-	-	100
ESE	10	40	40	10	-	-	100

22EPE$33	PRINCIPLES OF EMBEDDED SYSTEMS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To impart the knowledge on embedded systems and key concepts in real time embedded application development using RTOS.	
UNIT – I	**FUNDAMENTALS OF EMBEDDED SYSTEMS**	**9 Periods**
Classification of Embedded Systems - Embedded System on Chip - Structural Units in a Processor – Processor Selection - Memory Selection - Allocation of Memory to Segment - Block Memory Map of a System – Serial Communication using PC bus and CAN bus - Parallel Communication using ISA and PCI busses.		
UNIT – II	**INTERRUPTS AND SOFTWARE ARCHITECTURES**	**9 Periods**
Interrupt Basics - Shared Data Problem - Interrupt Latency - Round Robin Architecture - Round Robin with Interrupts - Function - Queues - Scheduling Architecture - Real Time Operating System Architecture– Selecting an Architecture.		
UNIT – III	**REAL TIME OPERATING SYSTEMS**	**9 Periods**
Tasks and Task States - Tasks and Data - Semaphores and Shared Data - Message Queues, Mailboxes and Pipes - Timer Functions – Events - Memory Management - Interrupt Routines in RTOS Environment		
UNIT – IV	**DESIGN USING RTOS**	**9 Periods**
Overview - Principles - Encapsulating Semaphores and Queues - Hard Real-time Scheduling Consideration - Saving Memory SpacSaving Power.		
UNIT – V	**EMBEDDED SOFTWARE DEVELOPMENT TOOLS**	**9 Periods**
Host and Target Machines - Linker / Locators for Embedded Software - Getting Embedded Software into Target - Testing on Host Machine - Instructions Set Simulators-Basic Embedded C programming		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK (Maximum 2):

1	*David E. Simon "**An Embedded Software Primer**", Pearson Education, Reprint 2008*
2	*Navabi "**Embedded Core Design with FPGA's**", Tata McGraw-Hill, First Ed. 2008*

REFERENCES (Minimum 4 and Maximum 6):

1	*Peckol, "**Embedded system Design**", John Wiley & Sons, 2010.*
2	*Lyla B Das, "**Embedded Systems-An Integrated Approach**", Pearson, 2013.*
3	*Raj Kamal "**Embedded Systems**" Tata McGraw-Hill, Third Ed. 2017.*
4	*Tammy Noergaard, "**Embedded Systems Architecture**", Elsevier, Second Ed. 2012*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Summarize the functions of communication between digital systems.	K2
CO2	Prepare a real-time model and construct the digital system.	K3
CO3	Demonstrate the practical use of embedded systems.	K3
CO4	Interpret the software and hardware components and their usage.	K3
CO5	Illustrate in-depth knowledge of embedded processor architecture and the behaviour of embedded systems with appropriate software tools.	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping															
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	2	2	2	2	1	1	-	-	1	1	3	3	2
CO2	2	3	2	2	2	2	-	1	-	-	1	1	2	2	2
CO3	2	2	2	2	2	2	1	-	-	-	1	1	3	3	2
CO4	3	3	2	2	2	2	-	1	-	-	1	1	2	2	1
CO5	2	2	2	2	2	2	-	1	-	-	1	1	2	1	1
23EPE$33	2	2	2	2	2	2	1	1	-	-	1	1	2	2	2
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 6.1.1, 7.1.1, 8.2.1, 11.1.1, 12.1.2, 12.2.1
CO2	1.1.1, 1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 6.1.1, 8.2.1, 11.1.1, 12.1.2, 12.2.1
CO3	1.1.1, 1.1.2, 1.3.1, 2.1.2, 2.1.3, 2.2.2, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 6.1.1, 7.1.1, 11.1.1, 12.1.2, 12.2.1
CO4	1.1.1, 1.1.2, 1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 6.1.1, 8.2.1, 11.1.1, 12.1.2, 12.2.1
CO5	1.1.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 6.1.1, 8.2.1, 11.1.1, 12.1.2, 12.2.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	35	25	20	-	-	100
CAT2	20	25	30	25	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	25	30	25	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	25	30	25	-	-	100
ESE	15	30	30	25	-	-	100

22EPE$34	IoT FOR ELECTRICAL ENGINEERING					SEMESTER
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	3	0	0	3

Course Objectives	To outline Smart Objects and IoT Architectures and functional stacks, various IOT-related protocols, build simple IoT Systems using Arduino and Raspberry Pi, data analytics and cloud in the context of IoT to apply IoT infrastructure for Electrical Power Industry	
UNIT – I	**FUNDAMENTALS OF IoT**	**9 Periods**
Evolution of Internet of Things - Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT models – Simplified IoT Architecture and Core IoT Functional Stack -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects.		
UNIT – II	**IoT PROTOCOLS**	**9 Periods**
IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition – Application Layer Protocols: CoAP and MQTT		
UNIT – III	**DESIGN AND DEVELOPMENT**	**9 Periods**
Design Methodology - Embedded computing logic - Microcontroller, System on Chips - IoT system building blocks - Arduino - Board details, IDE programming - Raspberry Pi - Interfaces and Raspberry Pi with Python Programming.		
UNIT – IV	**DATA ANALYTICS AND SUPPORTING SERVICES**	**9 Periods**
Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG.		
UNIT – V	**IoT in ELECTRICAL POWER INDUSTRY**	**9 Periods**
IoT in the Electrical Power Industry – SCADA, Smart Grids, Power transmission line state monitoring, Effective Power Conservation, Smart Metering, Advanced Metering Infrastructure, Building Automation, Connected Public Lighting, Smart Grid, Smart Inverters, Remote control operation of energy consuming devices		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, ―IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things, Cisco Press, 2017
2	Dr Kamlesh Lakhwani, Dr Hemant Kumar Gianey, Joseph Kofi Wireko, Kamal Kant Hiran, “Internet of Things – Principles, Paradigms and Applications of IoT” BPB Publications, 2020

REFERENCES:

1	VlasiosTsiatsis, Stamatis Karnouskos, Jan Holler, David Boyle, Catherine Mulligan, "Internet of Things – Technologies and Applications for a New Age of Intelligence", Elsevier Science, 2018
2	Olivier Hersent, David Boswarthick, Omar Elloumi , ―The Internet of Things – Key applications and Protocols‖, Wiley, 2012
3	Jan Ho¨ ller, VlasiosTsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
4	Michael Margolis, Arduino Cookbook, Recipes to Begin, Expand, and Enhance Your Projects, 2nd Edition, O'Reilly Media, 2011. https://www.arduino.cc/ https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet
5	Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), ―Architecting the Internet of Things‖, Springer, 2011
6	ArshdeepBahga, Vijay Madisetti, ―Internet of Things – A hands-on approach‖, Universities Press, 2015

Note: Books with 10 years before publications may be avoided

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concept of IoT.	K2
CO2	Analyze various protocols for IoT	K4
CO3	Design and develop a PoC of an IoT system using Raspberry Pi/Arduino	K6
CO4	Apply data analytics and use cloud offerings related to IoT	K3
CO5	Identify and evaluate the application of IoT to the Electric Power Industry	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
CO2	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
CO3	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
CO4	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
CO5	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
22EPE$34	3	3	3	3	3	3	3	2	-	-	-	3	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.21,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.	
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.21,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.	
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.21,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.	
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.21,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.	
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.2.21,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2.	

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	20	20	20	-	100
CAT2	-	20	20	20	20	20	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	20	20	20	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	20	20	20	20	20	100
ESE	10	10	20	20	20	20	100

22EPE$35	MACHINE LEARNING FOR ELECTRICAL ENGINEERING

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To outline the basic concepts of machine learning algorithms and their applications to Electrical Engineering.	
UNIT – I	**SUPERVISED LEARNING**	**9 Periods**
Linear Regression – Classification – Support Vector Machines – Neural Network Representation – Perceptrons – Multilayer Networks and Back Propagation Algorithms – Decision tree Learning – issues in decision tree learning- K- Nearest Neighbor Learning – Locally Weighted Regression – Radial Basis Functions.		
UNIT – II	**UNSUPERVISED LEARNING**	**9 Periods**
Clustering- Mixture Densities- K-means clustering- Hierarchical Clustering-Distributional clustering - Association Rules - The Curse of dimensionality- Dimensionality reduction. -Principal Component Analysis		
UNIT – III	**BAYESIAN AND NEURAL NETWORKS**	**9 Periods**
Bayes Theorem – Concept Learning – Maximum Likelihood – Minimum Description Length Principle – Bayes Optimal Classifier – Gibbs Algorithm – Naïve Bayes Classifier– Artificial neural networks - Learning rules – Training- Theory, Architecture and Applications of Back propagation network.		
UNIT – IV	**NEURAL SEQUENCE NETWORKS**	**9 Periods**
Introduction to Deep Neural Networks - Convolutional Neural Networks – Feature Detection– Recurrent Neural Networks – LSTMs – Libraries – Building a model–Training with data–Validation.		
UNIT – V	**APPLICATION TO ELECTRICAL ENGINEERING**	**9 Periods**
Application of artificial neural network in: DC Motor Speed Control– Smart Grid – Load Forecasting– Fault Prediction in Power Systems – Battery Management		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK :

1	*Tom Mitchell, "**Machine Learning**" McGraw-Hill, 2017*
2	*Ian Goodfellow, Aaron Courville, YoshuaBengio, "**Deep Learning**", MIT Press,2015*

REFERENCES :

1	*Kevin P. Murphy, "**Machine Learning: A Probabilistic Perspective**", MIT Press, 2012*
2	*Andreas C. Müller and Sarah Guido, "**Introduction to Machine Learning with Python: A Guide for Data Scientists**",Shroff Publishers, 2016*
3	*Manaranjan Pradhan, "**Machine Learning using Python**", Wiley,2019.*
4	*Machine Learning - NPTEL Course - https://nptel.ac.in/courses/106106139*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Illustrate supervised and unsupervised learning for real-time applications	K3
CO2	Develop neural networks with backpropagation for appropriate applications	K3
CO3	Devise basic machine learning algorithms using Machine learning tools	K4
CO4	Prepare and train models with CNN,R NN and LSTM	K3
CO5	Solve electrical engineering problems with machine learning algorithms.	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	2	2	2	1	2	-	-	1	1	3	2	2
CO2	3	3	2	2	2	2	-	2	-	-	1	1	2	1	2
CO3	3	2	2	2	2	2	1	2	-	-	1	1	3	1	2
CO4	3	3	2	2	2	2	-	2	-	-	1	1	2	2	2
CO5	2	2	2	2	2	2	-	2	-	-	1	1	3	3	3
22EPE$35	3	2	2	2	2	2	1	2	-	-	1	1	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 6.1.1, 7.1.1, 8.2.1, 8.2.2, 11.1.1, 12.1.2, 12.2.1
CO2	1.1.1, 1.1.2, 1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 6.1.1, 8.2.1, 8.2.2, 11.1.1, 12.1.2, 12.2.1
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.2, 2.1.3, 2.2.2, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 6.1.1, 7.1.1, 8.2.1, 8.2.2, 11.1.1, 12.1.2, 12.2.1
CO4	1.1.1, 1.1.2, 1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 6.1.1, 8.2.1, 8.2.2, 11.1.1, 12.1.2, 12.2.1
CO5	1.1.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 6.1.1, 8.2.1, 8.2.2, 11.1.1, 12.1.2, 12.2.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	30	20	-	-	100
CAT2	20	25	35	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	25	25	25	25	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	25	25	25	25	-	-	100
ESE	25	25	20	30	-	-	100

22COE$01	**DISASTER MANAGEMENT AND MITIGATION** *(Common to All Branches)*					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**

Course Objective	To impart knowledge to create appropriate planning, preparation and response for emergency treatment in disaster situation

UNIT – I	**INTRODUCTION TO DISASTERS**	**9 Periods**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Classification, Causes, Impacts - Global Trends in Disasters: Urban Disasters, Pandemics, Complex Emergencies, Climate Change- Dos and Don'ts during various types of Disasters.

UNIT – II	**HAZARDS AND RISK VULNERABILITY**	**9 Periods**

Hazard Identification and Hazard Profiling - Hazard Analysis - Types of hazards - Natural and technological Components of Risk- likelihood and Consequence, Trends and Computation of likelihood and Consequence. Risk Evaluation – Purpose, Risk Acceptability, Alternatives, Personnel. Political/ Social, Economic. Vulnerability-Physical Profile, Social Profile, Environmental Profile, Economic Profile - Factors Influencing Vulnerability, Risk Perception.

UNIT – III	**MITIGATION AND PREPAREDNESS**	**9 Periods**

Mitigation - Types, Obstacles, Assessment and Selection of Mitigation options, Emergency Response capacity, Incorporating Mitigation into Development and Relief Projects. Preparedness- Government Preparedness, Public Preparedness, Media as a Public educator. Obstacles to public education and preparedness.

UNIT – IV	**RESPONSE AND RECOVERY**	**9 Periods**

Response the Emergency- Pre disaster, post disaster, Provision of Water, Food and Shelter, Volunteer Management, Command, Control and Coordination. Recovery- Short Term and Long-term Recovery- Components of Recovery- Planning, Coordination, Information, Money and Supplies, Allocation of Relief Funds, Personnel. Types of Recovery- Government, Infrastructure, Debris Removal Disposal and Processing, Environment, Housing, Economic and Livelihood, Individual, Family and Social Recovery- Special Considerations in Recovery.

UNIT – V	**DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES**	**9 Periods**

Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and implementation and review – ISO 45001-Strucure and Clauses-Case Studies.

Contact Periods:

Lecture: 45 Periods **Tutorial: 00 Periods** **Practical: 00 Periods** **Total: 45 Periods**

TEXT BOOKS :

1	*Singhal J.P.* ***"Disaster Management",*** *Laxmi Publications, 2010.*
2	*Tushar Bhattacharya,* ***"Disaster Science and Management",*** *McGraw Hill India Education Pvt. Ltd., 2012.*

REFERENCES:

1	*Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005.*
2	*Government of India, National Disaster Management Policy,2009.*
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*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the types of disasters, causes and their impact on environment and society	K2
CO2	Assess vulnerability and various methods of risk reduction measures as well as mitigation.	K2
CO3	Comprehend the mitigation and preparedness process.	K2
CO4	Describe about response and recovery process during disaster.	K2
CO5	Perform disaster damage assessment and management.	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	1	-	1	-	2	3	3	2	2	2	-	3	2	-	2
CO2	1	-	1	-	2	3	3	2	2	2		3	2	-	2
CO3	1	-	1	-	2	3	3	2	2	2	-	3	2	-	2
CO4	1	-	1	-	2	3	3	2	2	2	-	3	2	-	2
CO5	1	-	1	-	2	3	3	2	2	2	-	3	2	-	2
22COE$01	1	-	1	-	2	3	3	2	2	2	-	3	2	-	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.2.1, 3.1.5, 5.1.1, 5.2.1, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 8.1.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 10.1.1, 10.1.2, 10.1.3
CO2	1.2.1, 3.1.5, 5.1.1, 5.2.1, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, **7.2.2,** 8.1.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 10.1.1, 10.1.2, 10.1.3
CO3	1.2.1, 3.1.5, 5.1.1, 5.2.1, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 10.1.1, 10.1.2, 10.1.3
CO4	1.2.1, 3.1.5, 5.1.1, 5.2.1, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 10.1.1, 10.1.2, 10.1.3
CO5	1.2.1, 3.3.6, 5.1.1, 5.2.1, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 10.1.1, 10.1.2, 10.1.3

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	25	50	25	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	25	50	25	-	-	100
ESE	30	30	40	-	-	-	100

22COE$02	**WATER SANITATION AND HEALTH** *(Common to All Branches)*					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objective	To understand the overview of Environment, Health and Safety (EHS) in industries and related Indian regulations, types of Health hazards, effect, assessment and control methods and EHS Management System					
UNIT – I	**INTRODUCTION**	**9 Periods**				
Need for developing Environment, Health and Safety systems in work places- International initiatives, National Policy and Legislations on EHS in India - Regulations and Codes of Practice - Role of Trade Union Safety Representatives – Ergonomics.						
UNIT – II	**OCCUPATIONAL HEALTH AND HYGIENE**	**9 Periods**				
Definition of occupational health and hygiene - Categories of health hazards – Exposure pathways and human responses–Exposure Assessment-occupational exposure limits - Hierarchy of control measures - Role of personal protective equipment and the selection criteria.						
UNIT – III	**WORKPLACE SAFETY AND SAFETY SYSTEMS**	**9 Periods**				
Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and color, Ventilation and Heat Control, Noise, Chemical and Radiation Safety – Electrical Safety – Fire Safety – Safety at Construction sites, ETP – Machine guarding – Process Safety, Working at different levels.						
UNIT – IV	**HAZARDS AND RISK MANAGEMENT**	**9 Periods**				
Safety appraisal – Job Safety Analysis-Control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques –Onsite and Offsite emergency Plans. Employee Participation- Education and Training- Case Studies.						
UNIT – V	**ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT**	**9 Periods**				
Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and implementation and review – ISO 45001-Strucure and Clauses-Case Studies.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 00 Periods** **Practical: 00 Periods** **Total: 45 Periods**						

TEXT BOOKS:

1	***Industrial Health and Safety Acts and Amendments**, by Ministry of Labour and Employment, Government of India.*
2	*Dr.K.U.Mistry, Siddharth Prakashan, **"Fundamentals of Industrial Safety and Health"**, 2012*

REFERENCES:

1	*Bill Taylor, **“Effective Environmental, Health, and Safety Management Using the Team Approach”,** Culinary and Hospitality Industry Publications Services, 2005.*
2	*Nicholas P.Cheremisinoff and Madelyn L. Graffia, **“Environmental and Health and Safety Management”**, William Andrew Inc. NY, 1995.*
3	*Brian Gallant, **“The Facility Manager's Guide to Environmental Health and Safety”** , Government Inst Publ., 2007.*
4	*https://archive.nptel.ac.in/courses/114/106/114106017/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Outline the needs for EHS in industries and related Indian regulations	K2
CO2	Assess the various types of Health hazards, effect, assessment and control methods	K2
CO3	Identity the various safety systems in working environments	K2
CO4	Select the methodology for preparation of Emergency Plans and Accident investigation	K3
CO5	Describe the EHS Management System and its elements	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	-	1	-	3	3	3	2	1	-	2	-	1	1	-
CO2	2	-	1	-	3	3	3	2	1	-	2	-	1	1	-
CO3	2	-	1	-	3	3	3	2	1	-	2	-	1	1	-
CO4	2	-	1	-	3	3	3	2	1	-	2	--	1	1	-
CO5	2	-	1	-	2	3	3	2	1	-	2	-	1	1	-
22COE$02	2	-	1	-	3	3	3	2	1	-	2	-	1	1	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1, 1.3.1, 3.1.4, 3.1.5, 5.1.1, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.2, 11.1.1, 11.2.1.

CO2	1.2.1, 1.3.1, 3.1.4, 3.1.5, 5.1.1, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.2, 11.1.1, 11.2.1.
CO3	1.2.1, 1.3.1, 3.1.4, 3.1.5, 5.1.1, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.2, 11.1.1, 11.2.1.
CO4	1.2.1, 1.3.1, 3.1.4, 3.1.5, 5.1.1, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.2, 11.1.1, 11.2.1.
CO5	1.2.1, 1.3.1, 3.1.4, 3.1.5, 5.1.1, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.2, 11.1.1, 11.2.1.

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	25	50	25	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	25	50	25	-	-	100
ESE	30	30	40	-	-	-	100

22MOE$03	NANOTECHNOLOGY AND SURFACE ENGINEERING *(Common to All Branches)*					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**

Course Objectives	To educate the production techniques and characterization techniques of nano materials and to familiarize about the surface modification techniques using nano materials.

UNIT – I	**ELEMENTS OF NANO-SCIENCE ANDNANOTECHNOLOGY**	**(9 Periods)**
Engineering scale of nanotechnology, different classes of nano-materials, synthesis of nano-materials, fabrication and characterization of nanostructures, Engineering applications- Cosmetics and Consumer Goods, Nano Sensor, Nano catalysts, Water Treatment and the Environment, Paints, Food and Agriculture Industry.		
UNIT – II	**NANOTECHNOLOGY AND CERAMICS**	**(9 Periods)**
Introduction, Vapor Condensation Methods, Sputtering, Laser Method, Spray Pyrolysis, Thermo Chemical /Flame Decomposition of metal organic Precursors methods		
UNIT – III	**CHARACTERIZATION OF NANOMATERIALS**	**(9 Periods)**
X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy, UV / Visible Spectroscopy.		
UNIT – IV	**SURFACE ENGINEERING**	**(9 Periods)**
Introduction to surface engineering, Scope of surface engineering for different engineering materials, Surface Preparation methods such as Chemical, Electrochemical, Mechanical: Sand Blasting, Shot peening, Shot blasting, Hydro-blasting, Vapor Phase Degreasing etc., Coatings: Classification, Properties and applications of Various Coatings.		
UNIT – V	**SURFACE MODIFICATION TECHNIQUES**	**(9 Periods)**
Surface modification by use of directed energy beams, Plasma, Sputtering & Ion Implantation. Surface modification by Friction stir processing. Surface composites.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*G. Cao, **"Nanostructures and Nanomaterials: Synthesis",** Properties and Applications by Imperial College Press, 2^{nd} edition, 2011.*
2	*Keith Austin "**Surface Engineering Hand Book"**, London : Kogan Page, 1998*

REFERENCES:

1	*Gregory Timp, "**Nanotechnology",** Springer, 2012*
2	*Dheerendra Kumar Dwivedi, **"Surface Engineering: Enhancing Life of Tribological Components"**, Springer, 2018*
3	*D. Phil Woodruff,**"Modern Techniques of Surface Science**", Cambridge University Press, 2016*
4	*Sulabha K. Kulkarni ,**"Nanotechnology: Principles and Practices**", Springer, 2019*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Choose appropriate nano material and its manufacturing method.	K1
CO2	Select most suitable technique to deposit a layer of nano material on ceramic surface.	K2
CO3	Identify appropriate techniques to characterize nano materials.	K2
CO4	Select surface preparation, coating techniques and predict their combinational effect for engineering applications.	K2
CO5	Adopt different techniques to modify surfaces and make surface composites as per requirement.	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	0	1	2	1	1	0	0	0	0	0	0	0	2	2	3
CO2	0	1	2	1	1	0	0	0	0	0	0	0	2	2	3
CO3	0	1	2	1	1	0	0	0	0	0	0	0	2	2	3
CO4	0	2	2	1	1	0	0	0	0	0	1	0	2	3	3
CO5	0	1	2	1	1	0	0	0	0	0	1	0	3	2	3
22MOE$03	0	1	2	1	1	0	0	0	0	0	1	0	2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	2.2.2, 2.2.3, 2.2.4, 2.3.1, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 4.1.1, 4.3.4, 5.1.2
CO2	2.2.2, 2.2.3, 2.2.4, 2.3.1, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 4.1.1, 4.3.4, 5.1.2
CO3	2.2.2, 2.2.3, 2.2.4, 2.3.1, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 4.1.1, 4.3.4, 5.1.2
CO4	2.1.1, 2.1.2, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 4.1.1, 4.3.4, 5.1.2, 5.3.1, 11.3.1
CO5	2.2.2, 2.2.3, 2.2.4, 2.3.1, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 4.1.1, 4.3.4, 5.1.2, 5.3.1, 11.3.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	50	-	-	-	-	100
CAT2	30	70	-	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50	50	-	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	70	-	-	-	-	100
ESE	40	60	-	-	-	-	100

22MOE$04	**INDUSTRIAL SAFETY MANAGEMENT** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To learn the techniques of industrial safety and management to implement and solve safety problems in engineering.	
UNIT – I	**ENVIRONMENT AND SAFETY PHILOSOPHY**	**(9 Periods)**
Henrichs Axioms Of Industrial Safety - Concepts Of Safety – Ethics of environmental conservation – Environmental Impact Assessment – Environmental economics – Safety philosophy – Planning for safety – Organising for safety – Directing for safety - Role of Occupier and Factory Manager, Factory Safety Committee, Structure and Functions and Working Tenure Details		
UNIT – II	**SAFETY APPRAISAL AND CONTROL TECHNIQUES**	**(9 Periods)**
Plant and equipment safety appraisal techniques – Laws and regulation – Hazards and Risks – Major accident hazard control – Importance of Disaster management		
UNIT – III	**ACCIDENT PREVENTION AND SAFETY MANAGEMENT**	**(9 Periods)**
Incident - Accident - Injury - Dangerous occurrence - Unsafe Act - Unsafe Conditions - Hazards - Error, Oversight - Mistake , Near Miss - Measurement of safety performance - Key elements of Safety Management system (ISO 14001, OHSAS 18001 etc.). ILO Legislations – Convention and Recommendation concerning Safety, Health and Environment – Objectives of Health, Safety and Environment Policy, Responsibility for Implementation of HSE Policy.		
UNIT – IV	**SAFETY MANAGEMENT IN INDUSTRIES**	**(9 Periods)**
Safe Guarding of machines – Manual handling and storage of materials – Mechanical handling of materials – Hand tools and portable power tools – Electrical hazards – Earth , insulation and continuity tests – Industrial lighting – Safety of pressure vessels – Ventilation and heat control – Housekeeping – Special precautions - Safety in Construction Industry – Safety in Engineering Industry – Safety in Chemical Industries – Safety in Textile Industries – Safety in Dock and Port – Transportation Safety – Safety in Fire and explosive industries.		
UNIT – V	**INDUSTRIAL HYGIENE AND POLLUTION CONTROL**	**(9 Periods)**
Industrial Hygiene – Air sampling – Noise and vibration – Industrial physiology - Occupational health – Personal Protective Equipment's – Pollution Control strategies.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOKS:

1	*Akhil Kumar Das*, ***"Principles of Industrial Safety Management":Understanding the Ws of Safety at Work"*** *PHI Learning , 2021*
2	*Jain R K and Sunil.S.Rao*, ***"Industrial Safety Health and Environment Management System"***, *Seventh reprint, Khanna publishers, 2023.*

REFERENCES:

1	*Prathibha Bansal and Anupama Prashar,* ***"Industrial safety and Environment"***, *S.K.Kattaria Sons, 2005.*
2	*A.K.Gupta,* ***"Industrial safety and Environment"***, *Laxmi Publication Pvt Limited, 2008.*
3	***"Accident Prevention Manual For Industrial Operations***", *N.S.C Chicago, 13th Edition 2009.*
4	*Dan Petersen*, ***"Techniques of Safety Management***", *Americal Society of Safety Emgineers, 4th edition, 2003.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand Environment and safety philosophy.	K1
CO2	Frame Safety appraisal and control technique to create safety management.	K2
CO3	Follow accident prevention procedure to solve safety problem.	K2
CO4	Implement safety management for Industries.	K3
CO5	Follow Industrial Hygiene and Pollution control	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	0	1	3	0	0	0	0	0	0	0	3	1	2
CO2	3	3	0	1	2	0	0	0	0	0	0	0	3	2	2
CO3	3	3	0	0	3	0	0	0	0	0	0	0	3	1	2
CO4	3	3	0	1	2	0	0	0	0	0	0	0	3	2	2
CO5	3	3	0	0	3	0	0	0	0	0	0	0	3	1	2
22MOE $04	3	3	0	1	3	0	0	0	0	0	0	0	3	1	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.3, 2.2.1, 2.2.3, 2.2.4, 2.4.4, 4.3.4, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2
CO2	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.3, 2.4.4, 4.1.4, 5.1.2, 5.2.1, 5.3.1, 5.3.2
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.3, 2.4.4, 5.1.1, 5.1.2, 5.2.1, 5.3.1, 5.3.2
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.3, 2.4.4, 4.1.4, 5.1.2, 5.2.1, 5.3.1, 5.3.2
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.3, 2.4.4, 5.1.1, 5.1.2, 5.2.1, 5.3.1, 5.3.2

ASSESSMENT PATTERN

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	70	20	10	-	-	-	100
CAT2	50	30	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	60	40		-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	50	30	20	-	-	-	100
ESE	50	30	20	-	-	-	100

22EOE$05	RENEWABLE POWER GENERATION SYSTEMS *(Common to All Branches)*					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		OE	3	0	0	3
Course Objectives	To understand energy scenarios, energy sources and their utilization, society's present needs and future energy demands, the principles of renewable energy conversion systems					
UNIT – I	**ENERGY SCENARIO**	**9 Periods**				
Principles of renewable energy; energy and sustainable development, fundamentals and social implications. worldwide renewable energy availability, renewable energy availability in India, brief descriptions on solar energy, wind energy, tidal energy, wave energy, ocean thermal energy, biomass energy, geothermal energy, oil shale. Introduction to Internet of energy (IOE).						
UNIT – II	**SOLAR ENERGY**	**9 Periods**				
Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Solar radiation Measurements- Pyrheliometers, Pyrometer, Sunshine Recorder. Solar Thermal systems: Flat plate collector; Solar distillation; Solar pond electric power plant. Solar electric power generation- Principle of Solar cell, Photovoltaic system for electric power generation, advantages, Disadvantages and applications of solar photovoltaic system.						
UNIT – III	**WIND AND BIOMASS ENERGY**	**9 Periods**				
Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, Basic components of wind energy conversion system (WECS); Classification of WECS- Horizontal axis- single, double and multi blade system. Vertical axis- Savonius and Darrieus types. Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies -fixed dome; Urban waste to energy conversion; Biomass gasification (Downdraft).						
UNIT – IV	**TIDAL AND OCEAN THERMAL ENERGY**	**9 Periods**				
Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, advantages and limitations. Ocean Thermal Energy Conversion: Principle of working, OTEC power stations in the world, problems associated with OTEC.						
UNIT – V	**GREEN ENERGY**	**9 Periods**				
Introduction, Fuel cells: Classification of fuel cells – H_2; Operating principles, Zero energy Concepts. Benefits of hydrogen energy, hydrogen production technologies (electrolysis method only), hydrogen energy storage, applications of hydrogen energy, problem associated with hydrogen energy.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

TEXT BOOK (Maximum 2):

1	G D Rai, Non Conventional Energy sources, Khanna Publication, Fourth Edition, 2009
2	Boyle, “Renewable Energy – Power For A Sustainable Future”, Oxford, 2012

REFERENCES (Minimum 4 and Maximum 6):

1	S Rao,B.B.Parulekhar, “Energy Technology 3/e: Nonconventional, Renewable and Conventional”, Khanna Publishers, 1994
2	G. N. Tiwari,“Solar Energy - Fundamentals, Design, Modelling and Applications”, 2002
3	Gilbert M. Masters, “Renewable and Efficient Electric Power Systems” Wiley,2005
4	Shobh Nath Singh, “Non-Convention Energy Resources”, Pearson, 2018

Note: Books with 10 years before publications may be avoided

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the environmental aspects of renewable energy resources in comparison with various conventional energy systems, their prospects and limitations.	K2
CO2	Summarize the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, electric power generation.	K2
CO3	Apply the conversion principles of wind and tidal energy for the production of electric power generation	K3
CO4	Apply the concept of biomass energy resources and green energy for developing sustainable electric power generation set-up	K3
CO5	Analyze the basic knowledge of ocean thermal energy conversion and hydrogen energy and hence design & evaluate the power generation system	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	3	3	-	-	-	-	3	3	3	2
CO2	3	3	3	3	3	3	3	-	-	-	-	3	3	3	2
CO3	3	3	3	3	3	3	3	-	-	-	-	3	3	3	2
CO4	3	3	3	3	3	3	3	-	-	-	-	3	3	3	2
CO5	3	3	3	3	3	3	3	-	-	-	-	3	3	3	2
22EOE$05	3	3	3	3	3	3	3	-	-	-	-	3	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2.
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2.
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2.
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2.
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2.

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	30	30	-	-	100
CAT2	20	20	30	30	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	20	30	30	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	20	30	30	-	-	100
ESE	20	20	30	30	-	-	100

22EOE$06	SMART GRID TECHNOLOGY *(Common to All Branches)*					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**

Course Objectives	To provide a comprehensive understanding of Smart Grid Technology, including its components, functions, applications and implications for Energy Management and Distribution.	
UNIT – I	**BASICS OF POWER SYSTEMS**	**9 Periods**
Basics of Power Systems: Load and Generation - Power Flow Analysis- Economic Dispatch and Unit Commitment Problems. Smart Grid: Definition – Applications- Government and Industry- Standardization		
UNIT – II	**SMART GRID COMMUNICATIONS**	**9 Periods**
Two-way Digital Communications Paradigm - Network Architectures - IP-based Systems - Power Line Communications - Advanced Metering Infrastructure		
UNIT – III	**WIDE AREA MEASUREMENT**	**9 Periods**
Sensor Networks - Phasor Measurement Units- Communications Infrastructure- Fault Detection and Self-Healing Systems -Applications and Challenges		
UNIT – IV	**SECURITY AND PRIVACY**	**9 Periods**
Cyber Security Challenges in Smart Grid - Load Altering Attacks- False Data Injection Attacks- Defense Mechanisms - Privacy Challenges- Cyber Security Standards		
UNIT – V	**ECONOMICS AND MARKET OPERATIONS**	**9 Periods**
Introduction, Reasons for restructuring / deregulation of power industry, Understanding the restructuring process - Entities involved. The market place mechanisms-Energy and Reserve Markets- Market Power - Generation Firms- Locational Marginal Prices- Financial Transmission Rights		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK :

1	*Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage "***Smart Grid Technologies and applications***" John Wiley Publishers Ltd., 2012.*

2	*P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan "***Electrical Power Systems- Analysis, Security and Deregulation"** *PHI Learning Private Limited, New Delhi, 2012.*

REFERENCES

1	*Lars T. Berger, Krzysztof Iniewski "***Smart Grid applications, Communications and Security***" John Wiley Publishers Ltd., 2012.*
2	*Yang Xiao,* **"Communication and Networking in Smart Grids",** *CRC Press Taylor and Francis Group, 2012.*
3	*Caitlin G. Elsworth,* **"The Smart Grid and Electric Power Transmission",** *Nova Science Publishers Inc, August 2010*
4	*Lars T. Berger, Krzysztof Iniewski "***Smart Grid applications, Communications and Security***" John Wiley Publishers Ltd., 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recollect the fundamentals of conventional power systems and learn the concept of smart grid	K1
CO2	Interpret the role of communication Technologies in a smart grid	K2
CO3	Apply the state-of-the-art measurement and protection techniques for reliable grid	K3
CO4	Utilize the techniques for ensuring safety and security of the smart grid	K3
CO5	Analyze the economical aspects of the smart grids	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping															
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	2	2	2	2	2	-	-	1	1	-	3	2	1
CO2	3	3	1	2	2	-	-	-	-	2	3	2	3	2	1
CO3	3	3	1	2	2	-	-	-	-	2	3	2	3	3	2

CO4	3	3	1	2	2	3	2	2	1	-	-	3	3	3	2
CO5	3	2	2	2	2	-	2	2	-	1	3	3	3	3	2
22EOE $06	3	3	1	2	2	3	2	2	1	2	3	3	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1,1.3.1,1.4.1,2.3.1,2.3.2,2.4.4,3.1.3,3.1.6,3.2.1,4.1.4,4.2.1,4.3.4,5.1.1,5.3.1,6.1.1,7.1.1,7.2.2,10.1.1,10.3.1,11.1.1
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.13.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2,10.1.1,10.2.2,10.3.1,11.1.1,11.2.1,11.3.1,11.3.2,12.3.1,12.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.13.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2,10.1.1,10.2.2,10.3.1,11.1.1,11.2.1,11.3.1,11.3.2,12.3.1,12.3.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.13.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,8.2.2,9.1.2,7.2.1,7.2.2,6.2.1,6.1.1,5.3.2,5.3.1,5.3.212.1.2,12.2.2,12.3.2,
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.13.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2

ASSESSMENT PATTERN

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	40	20	-	-	100
CAT2	10	30	40	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	30	20	20	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	20	20	-	100
ESE	10	30	40	20	-	-	100

22LOE$07	**CMOS VLSIDESIGN** *(Common to All Branches)*					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**

Course Objective	To introduce various aspects of CMOS logic design in combinational and sequential circuit to design CMOS VLSI system components	
UNIT – I	**CMOSLOGICDESIGN**	**9 Periods**
Inverter- CMOS Logic Gates: Compound Gates – Pass Transistors and Transmission Gates –Tristated – Multiplexers –CMOS Fabrication and Layout: Fabrication Process – Layout Designrule–Gate Layouts–Stick Diagrams– Design Partitioning.		
UNIT – II	**MOSTRANSISTORTHEORY**	**9 Periods**
Introduction – Long Channel I-V Characteristics – C-V Characteristics – Non-ideal I-V Effects –DC Transfer Characteristics – CMOS Technologies – Sources of Power Dissipation – Dynamic Power–Static Power.		
UNIT – III	**COMBINATIONALCIRCUITDESIGN**	**9 Periods**
CircuitFamilies:StaticCMOS–RatioedCircuits–CascodeVoltageSwitchLogic–Dynamic Circuits–PassTransistorCircuits.Silicon-on-InsulatorCircuitDesign–SubthresholdCirucitDesign.		
UNIT – IV	**SEQUENTIALCIRCUITDESIGN**	**9 Periods**
Sequentialstaticcircuits–Circuitdesignoflatchedandflip-flops–Sequencingdynamiccircuits–Synchronizers–Wavepipelining –VLSI clocking :CMOS clocking styles-Pipelinedsystems-Clock generation and distribution.		
UNIT – V	**DESIGNOFVLSISYSTEMS**	**9 Periods**
System Specifications – Structural Gate Level Modeling – Switch Level Modeling – Behavioral and RTL Modeling-Addition/subtraction–Comparators–counters—Multiplexers-BinaryDecoders – Comparators – Priority Encoders – Latches - Flip-Flops and Registers – SRAM –DRAM–ROM.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOKS:

1	*N. Weste and David Money Harris, "**CMOS VLSI Design**", Fourth Edition, PearsonEducation,2011*
2	*Uyemura, John P, "**Introduction to VLSI Circuits and Systems**", Wiley & Sons, 8th Reprint 2009*

REFERENCES:

1	*JanM.Rabaey,"**DigitalIntegratedCircuits:ADesignPerspective**",PHI,SecondEdition,2012.*
2	*R.JacobBaker,"**CMOS:CircuitDesign,Layout,andSimulation**",Wiley-IEEE,RevisedSecondEdition,2008.*
3	*Pucknell,"**BasicVLSIDesign**",PrenticeHall,2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Realize the CMOS logic design	K2
CO2	Explain the basic MOS transistor theory and power dissipation in CMOS logic.	K2
CO3	Develop combinational circuit design of CMOS logic	K3
CO4	Interpret sequential circuit design of CMOS logic	K2
CO5	Model the digital system using Hardware Description Language	K2

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	-	-	2	-	-	-	2	-	3	3	1	3
CO2	3	2	1	-	-	2	-	-	-	2	-	3	2	1	2
CO3	3	3	2	-	-	2	-	-	-	2	-	3	3	1	3
CO4	3	3	2	-	-	2	-	-	-	2	-	3	3	1	3
CO5	3	3	2	-	-	2	-	-	-	2	-	3	3	1	3
22LOE$07	**3**	**3**	**2**	-	-	**2**	-	-	-	**2**	-	**3**	**3**	**1**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.4, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	50	-		-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	40	40	20	-	-	-	100

22LOE$08	MOBILE COMMUNICATION *(Common to All Branches)*					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**

Course Objective	To understand and recall the mobile radio propagation, cellular architectures, equalization and diversity techniques, digital modulation techniques and various wireless network standards.	
UNIT – I	**MOBILE RADIO PROPAGATION**	**9 Periods**
Review of free-space propagation - Radio Wave Propagation in wireless environment - Free Space Propagation Model - Ground Reflection Model, Diffraction, Scattering - Practical link budget design - Small scale fading - Time dispersion parameters - Coherence bandwidth - Doppler spread & Coherence time, Fading due to Multipath time delay spread - Fading due to Doppler spread.		
UNIT – II	**CELLULAR CONCEPT**	**9 Periods**
Hexagonal cell-Cell clustering-Frequency Reuse-Static and dynamic channel assignment strategies - Handoff Strategies - Interference and System Capacity - Trunking - Capacity in Cellular Systems. Multiple Access Techniques: FDMA, TDMA, CDMA, OFDMA.		
UNIT – III	**MULTIPATH MITIGATION TECHNIQUES**	**9 Periods**
Equalization – Adaptive equalization: Linear and Non-Linear equalization, - Diversity – Micro and Macro diversity - Diversity combining techniques - Rake receiver- MIMO Coding: Alamouti Scheme (Qualitative)		
UNIT – IV	**MODULATION TECHNIQUES**	**9 Periods**
Modulation in cellular wireless systems: Binary Phase Shift Keying (BPSK) – QPSK –Orthogonal QPSK-Minimum Shift Keying-Gaussian Minimum Shift Keying - Multicarrier modulation: Orthogonal Frequency Division Multiplexing (OFDM) -PAPR reduction –Windowed OFDM - Filtered OFDM		
UNIT – V	**WIRELESS NETWORKS**	**9 Periods**
Second Generation Cellular Standard: GSM - Third Generation Cellular standards: CDMA -WCDMA- Fourth Generation Cellular Standards: 4G LTE – LTE Advanced – 5G Network – Near Field Communication (NFC) systems – Wireless LAN technology – Hyper LAN – Bluetooth technology – Ultra Wideband (UWB) communication - Introduction to 60 GHz mm Wave.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Theodore S. Rappaport, “Wireless communications”, 2nd Edition, Pearson Education, 2010*
2	*Mischa Schwartz, “Mobile Wireless Communications”, 1st Edition, Cambridge University Press, 2010*

REFERENCES:

1	*Suvra Sekhar Das and Ramjee Prasad, “Evolution of air interface towards 5G Radio Access Technology and Performance Analysis”, River Publishers,2018*
2	*David Tse, Pramod Viswanath, "Fundamentals of Wireless Communication", 1st Edition, Cambridge University Press, 2006.*
3	*Andreas.F. Molisch, “Wireless Communications”, 2nd Edition, Wiley, 2011.*
4	*Aditya K Jagannatham, “Principles of Modern Wireless Communication Systems Theory and Practice”, 1st Edition, McGraw Hill Education (India) Private Limited, 2017*
5	*William Stallings, "Wireless Communications and networks", 2nd Edition, Pearson, 2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Interpret the concepts of radio propagation and fading channel models in wireless communication	K3
CO2	Interpret the functionalities of various cellular concepts and multiple access techniques and solve problems in channel assignment and traffic intensity in cellular system	K4
CO3	Explain various equalization and diversity combining techniques used in multipath propagation	K2
CO4	Discuss the need for digital and multicarrier modulation techniques used in modern cellular system	K2
CO5	Recall the functionalities of various wireless networks used in day-today life.	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
22LOE$08	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	20	20			100
CAT2	50	50					100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	20	20			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	50	50					100
ESE	20	40	20	20			100

22POE$09	RAPIDPROTOTYPING *(Common to All Branches)*					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**

Course Objectives	*To educate the students with fundamental and advanced knowledge in the field of Rapid Prototyping technology and associated Aerospace, Architecture, Art, Medical and Industrial applications.

UNIT- I	**INTRODUCTION**	**(9 Periods)**
Overview - Need - Development of Rapid Prototyping (RP) Technology: Rapid Prototyping -Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. RP Process Chain, Benefits, Applications: Building Printing, Bio Printing, Food Printing, Electronics Printing, Automobile, Aerospace, Healthcare.		
UNIT- II	**VAT POLYMERIZATION AND MATERIAL EXTRUSION**	**(9 Periods)**
Photo polymerization: Stereo lithography Apparatus (SLA) - Materials -Process - top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Material Extrusion: Fused Deposition Modelling (FDM) - Process-Materials -Applications and Limitations.		
UNIT- III	**POWDER BED FUSION AND BINDER JETTING**	**(9 Periods)**
Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits - Limitations - Applications.		
UNIT- IV	**MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION**	**(9 Periods)**
Material Jetting: Multi jet Modelling- Materials - Process - Benefits - Applications. Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery -Materials –Benefits - Applications.		
UNIT- V	**SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY**	**(9 Periods)**
Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding - Materials - Application and Limitation. Ink-Based Direct Writing (DW): Nozzle Dispensing Processes, Inkjet Printing Processes, Aerosol DW - Applications of DW.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "**Additive manufacturing technologies".** 3rd edition Springer Cham, Switzerland, 2021.*
2	*Andreas Gebhardt and Jan-Steffen Hötter "**Additive Manufacturing: 3D Printing for Prototyping and Manufacturing**", Hanser publications, United States, 2015.*

REFERENCES:

1	*Andreas Gebhardt, **"Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing"**, Hanser Gardner Publication, Cincinnati., Ohio, 2011.*
2	*Milan Brandt, **"Laser Additive Manufacturing: Materials, Design, Technologies, and Applications"**, Woodhead Publishing., United Kingdom, 2016.*

3	*Amit Bandyopadhyay and Susmita Bose, **"Additive Manufacturing",** 1st Edition, CRC Press., United States, 2015.*
4	*Kamrani A.K. and Nasr E.A., **"Rapid Prototyping: Theory and practice",** Springer., United States ,2006.*
5	*Liou, L.W. and Liou, F.W., **"Rapid Prototyping and Engineering applications: A tool box for prototype development"**, CRC Press., United States, 2011.*

COURSE OUTCOMES: upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Discuss the development of RP technology and how RP technology propagated into various businesses and developing opportunities.	K3
CO2	Demonstrate the Vat polymerization and material extrusion processes and its applications.	K3
CO3	Elaborate the process and applications of powder bed fusion and binder jetting.	K3
CO4	Evaluate the advantages, limitations, applications of material jetting and directed energy deposition processes.	K3
CO5	Describe the sheet lamination and direct write technology.	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	2	2	2	0	2	0	3	0	3	3	3	3	0	0	0
CO2	2	2	3	2	3	0	3	0	3	3	1	2	0	0	0
CO3	2	2	3	2	3	0	3	0	3	3	1	2	0	0	0
CO4	2	2	3	2	3	0	3	0	3	3	1	2	0	0	0
CO5	2	2	3	2	3	3	3	0	3	3	1	3	0	0	0
22POE$09	**2**	**2**	**3**	**2**	**3**	**1**	**3**	**0**	**3**	**3**	**2**	**3**	**0**	**0**	**0**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.3, 5.2.2, 5.3.1, 5.3.2, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.2.1, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.2, 12.3.1, 12.3.2.
CO2	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.2, 12.2.2, 12.3.1, 12.3.2.
CO3	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.2, 12.2.2, 12.3.1, 12.3.2.
CO4	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.2, 12.2.2, 12.3.1, 12.3.2.
CO5	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.1, 12.1.2, 12.2.2, 12.3.1, 12.3.2.

ASSESSMENT PATTERN– THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	52	33	-	-	-	100
CAT2	15	68	17	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	100	-	-	-	100
ESE	9	75	16	-	-	-	100

22POE$10	**MANAGERIALECONOMICS** *(Common to All Branches)*

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	*To introduce the fundamental economic principles necessary for production managers	
UNIT- I	**FUNDAMENTALS OF MANAGERIAL ECONOMICS**	**(9 Periods)**
Introduction to Economics - Scope of Managerial Economics - General Foundations of Managerial Economics: Economic Approach, Working of Economic System and Circular Flow of Activities - Economics and Business Decisions: Relationship between Economic Theory and Managerial Economics - Role of managerial Economics in Decision making - Concept of Economic Rationality - Opportunity Cost - Marginal and Incremental approach.		
UNIT- II	**DEMAND ANALYSIS**	**(9 Periods)**
Demand and Supply - Determinants of Demand - Demand Estimation and Forecasting - Price Elasticity of Demand - Price Elasticity- Factors Affecting Price Elasticity - Cross Price Elasticity - Income Elasticity of Demand - Advertisement or Promotional Elasticity - Elasticity of Supply.		
UNIT- III	**DEMAND THEORY**	**(9 Periods)**
Utility Analysis - Total and Marginal Utility - Law of Diminishing marginal utility - Indifference curve analysis - Consumer Equilibrium - Consumer Surplus - Price effect, Substitution Effect and Income Effect.		
UNIT- IV	**THEORY OF PRODUCTION AND COST**	**(9 Periods)**
The Production Function - Profit-Maximizing Input Usage - Isoquants and Isocosts – CostMinimization and Optimal Input Substitution - The Cost Function - Breakeven analysis,Contribution analysis - Long-run Costs and Economies of Scale - Multiple Cost Functions andEconomies of Scope - Learning curve.		
UNIT- V	**THEORY OF MARKET AND PRICING**	**(9 Periods)**
Forms of Markets: Meaning and Characteristics - Market Equilibrium: Practical Importance, Market Equilibrium and Changes in Market Equilibrium. Pricing Functions: Market Structures - Pricing and output decisions under different competitive conditions: Monopoly Monopolistic completion and Oligopoly.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Maheshwari.Y* ***“Managerial Economics”,*** *Prentice Hall of India, 2012*
2	*Thomas and Maurice* ***“Managerial Economics: Concept and Applications”,*** *McGrawHill, 2005*

REFERENCES:

1	*D.N. Dwivedi,* ***“Managerial Economics”,*** *Vikas Publishing house, 2015*
2	*Christopher R Thomas, S Charles Maurice,* ***“Managerial economics”,*** *Mcgraw Hill, 2014*
3	*M. A. Beg, “****Managerial Economics****”,Global Professional Publishing Ltd, 2010*
4	*K.C. Sankaranarayanan, "****Managerial Economics****", CBS, 2015*

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain fundamentals of managerial economics	K2
CO2	Discuss the dynamics of Demand	K3
CO3	Explain about various theories of demand	K3
CO4	Discuss about the factors influencing production	K4
CO5	Describe about the theory of market and pricing method	K4

COURSE ARTICULATION MATRIX:

	a) CO and PO Mapping														
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	1	2	1	3	1	3	3	0	1	3	3	3	0	1	2
CO2	1	3	2	3	1	3	3	0	1	3	3	3	0	1	2
CO3	1	3	2	3	1	3	3	0	1	3	3	3	0	1	2
CO4	1	3	2	3	1	3	3	0	1	3	3	3	1	1	2
CO5	1	3	2	3	1	3	3	0	1	3	3	3	0	1	2
22POE$10	**1**	**3**	**2**	**3**	**1**	**3**	**3**	**0**	**1**	**3**	**3**	**3**	**0**	**1**	**2**
	1 – Slight, 2 – Moderate, 3 – Substantial														

	b) CO and Key Performance Indicators Mapping
CO1	1.2.1, 2.1.2, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.4, 3.1.1, 3.1.3, 3.1.5, 3.2.3, 3.3.1, 3.4.1, 4.1.1, 4.1.2, 4.3.4, 5.2.1, 5.3.1, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.2.1, 11.3.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.3, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.4, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.3.1, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.2.1, 11.3.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.3, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.4, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.3.1, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.2.1, 11.3.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.3, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.4, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.3.1, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.2.1, 11.3.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.3, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.4, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.3.1, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.2.1, 11.3.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN– THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	50		-	-	-	100
CAT2	50	50		-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	33.33	33.33	33.33	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	33.33	33.33	33.33	-	-	-	100
ESE	42	42	16	-	-	-	100

22NOE$11	**MEASUREMENT AND CONTROL** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

COURSE OBJECTIVE	To teach about the concepts of variable sensors for industrial parameter measurement and to impart knowledge on automatic control system	
UNIT - I	**INTRODUCTION TO MEASUREMENTS**	**9 Periods**
Elements of measurement system - Classification of Instruments – Static and dynamic characteristics of a measurement system - Errors in measurement - Calibration of instruments.		
UNIT - II	**STRAIN AND DISPLACEMENT MEASUREMENT**	**9 Periods**
Strain: Types of strain gauges, theory of operation, strain gauge materials, strain gauge circuits and applications. Displacement: Resistive potentiometer: Linear, circular and helical – LVDT - RVDT - Capacitance transducers – Piezoelectric transducers – Hall Effect devices - Proximity sensors.		
UNIT - III	**PRESSURE AND TEMPERATURE MEASUREMENT**	**9 Periods**
Pressure: Mechanical devices: Diaphragm, bellows, and bourdon tube - Electrical devices: Variable resistance, inductance and capacitance transducers. Temperature: Resistance type temperature sensors: RTD , Thermocouples, Thermopiles and Thermistor - Laws of thermocouple – Radiation methods for temperature measurement.		
UNIT - IV	**FLOW AND LEVEL MEASUREMENT**	**9 Periods**
Flow: Variable head type flow meters: Orifice plate, Venturi tube, Flow nozzle, Pitot tube - Variable area type: Rotameter - Turbine flow meter - Electromagnetic flow meter - Ultrasonic flow meter. Level: Resistive, inductive and capacitive techniques – Ultrasonic methods – Air purge system .		
UNIT - V	**AUTOMATIC CONTROL SYSTEM**	**9 Periods**
Elements of control system – Concept of open loop and closed loop systems – Mathematical modelling - Controllers – Brief idea of Proportional, Derivative and Integral Modes – Pneumatic Controller – Hydraulic Controller.		
Contact Periods: 45 Periods **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*A.K. Sawhney, Puneet Sawhney,* ***"A Course in Mechanical Measurements and Instrumentation & Control"*** *Dhanpat Rai & Co, 2012.*
2	*S. K. Singh, "***Industrial Instrumentation and Control***", McGraw Hill Publication, 3rd Edition, 2016.*

REFERENCES:

1	*William Bolton, "***Instrumentation and Control Systems***,'' Newnes, Publication, 3rd Edition, 2021.*
2	*E. D. Doeblin,* ***"Measurement Systems: Application and Design",*** *McGraw Hill Publication, 6th Edition, 2017.*
3	*E.W. Golding and F.C. Widdis,* ***"Electrical Measurements and Measuring Instruments"*** *A.H.Wheeler and Co., 5th Edition, 2011.*
4	*Alan S. Morris,* ***"Measurement and Instrumentation Principles",*** *Butterworth-Heinemann Publications, 3rd Edition, 2011.*

COURSE OUTCOMES On Completion of the course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Describe the methods of measurement and classification of measuring instruments.	K2
CO2	Suggest suitable sensor for the measurement of strain and displacement.	K2
CO3	Explain the construction and working of transducers for pressure and temperature measurement.	K2
CO4	Elucidate the characteristics of flow and level measuring instruments.	K2
CO5	Elaborate the concept of automatic control system.	K2

COURSE ARTICULATION MATRIX

a) CO/PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	-	-	-	-	-	-	-	-	3	2
CO2	3	2	2	2	-	-	-	-	-	-	-	-	-	3	2
CO3	3	2	2	2	-	-	-	-	-	-	-	-	-	3	2
CO4	3	2	2	2	-	-	-	-	-	-	-	-	-	3	2
CO5	3	3	3	2	-	-	-	-	-	-	-	-	-	3	3
22NOE$11	**3**	**3**	**3**	**2**	-	-	-	-	-	-	-	-	-	**3**	**2**

b) CO and Key Performance Indicators mapping	
CO1	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 3.2.1, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.2, 4.1.3, 4.1.4
CO2	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2,2.2.3, 2.3.1, 2.3.2, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 4.1.2, 4.1.3, 4.1.4
CO3	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2
CO4	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2,2.2.3, 2.2.4, 2.3.1, 2.3.2, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2
CO5	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2

ASSESSMENT PATTERN - THEORY

Test/Bloom's Category	Remembering (K1)%	Understanding (K2) %	Applying (K3)%	Analyzing(K4)%	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60	-	-	-	-	100
CAT2	40	60	-	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	70	-	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	70	-	-	-	-	100
ESE	40	60	-	-	-	-	100

22NOE$12	INDUSTRIAL AUTOMATION *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

COURSE OBJECTIVE	To elaborate on the basic concept of automation, including the necessary components and various automation controllers utilized in industrial automation.	
UNIT - I	**INTRODUCTION TO AUTOMATION**	**9 Periods**
Automation overview – Requirement of automation systems – Architecture of industrial automation system –Industrial bus systems: Modbus and Profibus.Introduction to Industry 4.0 and its evolution.		
UNIT - II	**AUTOMATION COMPONENTS**	**9 Periods**
Sensors for temperature – Pressure – Force – Displacement - Speed – Flow- level – Humidity and pH measurement. Actuators – Process control valves –Power electronic drives: DIAC- TRIAC –power MOSFET – IGBT. Introduction to DC and AC servo drives for motion control.		
UNIT - III	**PROGRAMMABLE LOGIC CONTROLLERS**	**9 Periods**
PLC Hardware – power supplies and isolators –Relays – Switches -Seal-in circuits – PLC programming – ladder diagram – sequential flow chart – PLC communication and networking – PLC selection – PLC installation – Advantages – Application of PLC to process control industries and Robotics.		
UNIT - IV	**DISTRIBUTED CONTROL SYSTEM**	**9 Periods**
Overview of DCS – DCS hardware – DCS software configuration – DCS communication – DCS supervisory computer tasks – DCS integration with PLC and Computers.		
UNIT – V	**SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEMS**	**9 Periods**
Introduction - Supervisory Control and Data Acquisition Systems – SCADA HMI Essentials – SCADA Components – SCADA Configuration and Software – HMI hardware and software.		
Contact Periods: 45 Periods **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Frank D. Petruzella, "**Programmable Logic Controllers**", 5th Edition, McGraw Hill, 2016.*
2	*S.K. Singh "**Industrial Instrumentation and Control**", 3rd Edition, McGraw Hill Companies, 2004.*

REFERENCES:

1	*Sudip Misra, Chandana Roy, Anandarup Mukherjee, “**Introduction to Industrial Internet of Things and Industry 4.0**”, CRC Press, 1st edition, 2021*
2	*Bela G Liptak, “**Process software and digital networks – Volume 3**”, 4th Edition, CRC press, 2012.*
3	*Romily Bowden, “**HART application guide and the OSI communication foundation**”,1999.*
4	*John.W. Webb Ronald A Reis, “**Programmable Logic Controllers - Principles and Applications**”, Prentice Hall Inc., 5th Edition, 2003.*
5	*M. P. Lukcas, “**Distributed Control Systems”**, Van Nostrand Reinhold Co., 1986.*

COURSE OUTCOMES Upon Completion of the course, the students will be able to		**Bloom’s Taxonomy Mapped**
CO1	Elaborate the basic architecture of automation systems and Industry 4.0.	K2
CO2	Describe the various automation components and industrial bus system involved in industrial automation	K2
CO3	Construct ladder logic diagram using PLC basic functions, timer and counter functions for simple applications	K3
CO4	Illustrate the functionary components and supervisory control of DCS with relevant diagrams	K2
CO5	Describe the basics of SCADA technology.	K2

COURSE ARTICULATION MATRIX

a) CO/PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	-	-	-	-	-	1	3	3
CO2	3	2	1	-	-	-	-	-	-	-	-	-	1	3	3
CO3	3	3	2	2	-	-	-	-	1	-	-	2	1	3	3
CO4	3	2	2	-	-	-	-	-	-	-	-	-	1	3	3
CO5	3	2	`1	-	-	-	-	-	-	-	-	-	1	3	3
22NOE$12	3	3	2	1	-	-	-	-	1	-	-	1	1	3	3

b) CO and Key Performance Indicators mapping	
CO1	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.4.3,3.1.1, 3.1.2, 3.1.3, 3.3.1,3.3.2.
CO2	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.4.3,3.1.1, 3.1.2, 3.1.3, 3.3.1,3.3.2.
CO3	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.4.3,3.1.1, 3.1.2, 3.1.3, 3.3.1,3.3.2, 4.1.1, 4.1.2, 4.2.1, 4.2.2, 9.1.1, 9.1.2, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2.
CO4	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.4.3,3.1.1, 3.1.2, 3.1.3, 3.3.1,3.3.2.
CO5	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.4.3,3.1.1, 3.1.2, 3.1.3, 3.3.1,3.3.2.

ASSESSMENT PATTERN - THEORY

Test/Bloom's Category	Remembering (K1)%	Understanding (K2) %	Applying (K3)%	Analyzing(K4)%	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20	-	-	-	100
CAT2	20	60	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	60	20	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	60	20	-	-	-	100
ESE	20	60	20	-	-	-	100

22SOE$13	**PROGRAMMING IN JAVA** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	The objective of this course is to provide students with the essential Java constructs necessary for developing an object-oriented program.	
UNIT – I	**FUNDAMENTALS OF JAVA PROGRAMMING**	**9Periods**
History and Evolution of Java- Overview of java– Operators- Control Structures– Methods- Classes and Objects– Inheritance- Packages and Interfaces- Exception Handling.		
UNIT – II	**THREADS , I/O AND STRING HANDLING**	**9 periods**
Multi threaded Programming– Enumeration- Auto boxing– Annotations- String Handling-Input/Output: Exploring java.io		
UNIT – III	**EVENT HANDLING**	**9 Periods**
Introducing the AWT: working with windows- graphics and text- Using AWT controls- Layout Manager - Menus - Introducing Swing		
UNIT – IV	**IMAGING AND DATABASE CONNECTIVITY**	**9 Periods**
Imaging: Creating- loading and displaying- Image observer- Double buffering- Media tracker- Image producer– consumer– filters– animation- Java Database Connectivity		
UNIT – V	**NETWORKING**	**9 Periods**
Networking – Remote Method Invocation – Java Beans –Java servlets		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS

1	*Herbert Schildt, "Java, **The Complete Reference** ", Tata McGrawHill, 12th Edition, 2022*

REFERENCES

1	*Deitel .H.M and Deitel.P.J, " **Java: How to Program** ", Pearson Education Asia, 9th Edition 2011*
2	*Lay.S&Horstmann Gary Cornell, " **Core Java Vol I** ", The Sun Microsystems & press Java Series, 9th Edition, 2012*
3	*NPTEL Course : **"PROGRAMMING IN JAVA"** **https://archive.nptel.ac.in/courses/106/105/106105191/***

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Write simple java programs using fundamental concepts of java like control structures, inheritance, packages, interfaces and exception handling	K4
CO2	Write java program using multithreading and string handling	K3
CO3	Write java programs for managing events and to access database	K4
CO4	Write java programs to display and manipulation of graphical images	K3
CO5	Develop client server programs using RMI and servlets	K3

COURSE ARTICULATION MATRIX:

COs / POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	1	0	0	0	0	2	0	0	1	2	2
CO2	2	1	2	2	1	0	0	0	0	2	0	0		2	3
CO3	2	1	2	2	1	0	0	0	0	2	0	0	1	2	3
CO4	2	1	2	2	1	0	0	0	0	2	0	0	1	2	3
CO5	2	1	2	2	1	0	0	0	0	2	0	2	1	2	3
22SOE$19	2	2	2	2	1	0	0	0	0	2	0	1	1	2	3

b) CO and Key Performance Indicators Mapping	
CO1	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.1, 2.2.3, 2.2.4, 2.4.3, 3.1.5, 3.1.6, 3.2.2, 3.3.1, 3.3.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.3.1, 4.3.2, 5.2.2,10.1.1,10.1.2,10.1.3
CO2	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.4.3, 3.1.5, 3.1.6, 3.2.2, 3.3.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.3.1, 4.3.2, 5.2.2,10.1.1,10.1.2,10.1.3
CO3	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.4.3, 3.1.5, 3.1.6, 3.2.2, 3.3.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.3.1, 4.3.2, 5.2.2,10.1.1,10.1.2,10.1.3
CO4	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.4.3, 3.1.5, 3.1.6, 3.2.2, 3.3.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.3.1, 4.3.2, 5.2.2,10.1.1,10.1.2,10.1.3
CO5	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.4.3, 3.1.5, 3.1.6, 3.2.2, 3.3.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.3.1, 4.3.2, 5.1.1, 5.2.2,10.1.1,10.1.2,10.1.3,12.1.1,12.2.1,12.2.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	30	40	30	-	-	100
CAT2	10	30	40	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	70	30	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	50	50	-	-	100
ESE	-	30	40	30	-	-	100

22SOE$14	NETWORK ESSENTIALS *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	The objective of the course is to understand the basics of networking and able to configure and troubleshoot switches and routers.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Introduction to Computer Networks - Goals and advantages of Computer Networks - Network Topologies – Basic networking devices – Protocols – the need for a layered architecture - The OSI Model and the TCP/IP reference model – the Ethernet LAN – Home Networking – Assembling an office LAN – Testing and Troubleshooting a LAN – Physical layer cabling: Twisted pair and Fiber optics		
UNIT – II	**WIRELESS NETWORKING**	**9 Periods**
Importance of Wireless Networking – IEEE 802.11 Wireless LANs – Bluetooth- WIMAX – RFIDs – Securing the Wireless LANs – Configuring a Point to Multipoint Wireless LAN – Interconnecting network LANs – Switch, Bridges and Routers. Interconnecting LANs with the router, Configuring the network interface-Auto negotiation		
UNIT – III	**ADDRESSING AND ROUTING FUNDAMENTALS**	**9 Periods**
IPv4 and IPv6 addressing – Subnet masks – CIDR blocks – configuration of a router – Console port connection - user EXEC mode – Privileged EXEC mode - Configuration of a switch – Static VLAN configuration - Spanning Tree protocol – Network Management – Power over Ethernet		
UNIT – IV	**ROUTING PROTOCOLS**	**9 Periods**
Static Vs Dynamic Routing Protocols – Distance vector Routing – Link State Routing – Hybrid Routing – Configuring RIP - Network Services – DHCP, DNS - Analyzing Internet Traffic.		
UNIT – V	**TROUBLESHOOTING AND NETWORK SECURITY**	**9 Periods**
Analyzing Computer Networks – FTP data packets – Analyzing Campus Network data traffic – Troubleshooting the router and switch interface, Troubleshooting fiber optics – Intrusion – DOS – Security software and hardware.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK :

1	*Jeffrey S.Beasley Piyasat Nilkaew "**Network Essentials**" 3 rd Edition, Pearson, 2018*
2	*Larry L. Peterson and Bruce S. Davie "**Computer Networks, A Systems Approach**" 5 th edition, Morgan Kaufmann Publishers Inc, 2014.*

REFERENCES :

1	*Behrouz A. Forouzan, "**Data Communications and Networking with TCP/IP Protocol Suite**", Sixth Edition TMH, 2022.*
2	*James F. Kurose, Keith W. Ross, "**Computer Networking, A Top-Down Approach Featuring the Internet**", Eighth Edition, Pearson Education, 2021.*
3	*Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, "**Computer Networks: An Open Source Approach**", McGraw Hill, 2012.*
4	*Nader F. Mir, "**Computer and Communication Networks",** Second Edition, Prentice Hall, 2014.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify topologies and types of Computer Networks and enumerate the layers of the OSI model and TCP/IP	K2
CO2	Explain the significance of wireless networks and configure a Wireless LAN	K3
CO3	Configure a switcher and a router	K3
CO4	Describe basic routing algorithms and network services	K3
CO5	Troubleshoot the router and switch interface	K3

a) CO and PO Mapping

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	3	-	-	-	1	-	-	-	-	-	-	1	2	-
CO2	2	3	-	-	-	1	-	-	-	-	-	-	1	2	-
CO3	2	3	-	2	2	1	-	-	-	-	-	-	1	2	-
CO4	2	3	-	2	2	1	-	-	-	-	-	-	1	2	-
CO5	2	3	-	2	2	1	-	-	-	-	-	-	1	2	-
22SOE$14	2	3	-	2	2	1	-	-	-	-	-	-	1	2	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.3.1, 1.4.1, 2.1.2, 2.2.2, 2.4.4, , 4.1.2, 5.1.1, 5.1.2,5.2.1, 5.2.2, 5.3.2, 6.1.1, 6.1.2
CO2	1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3,2.2.4, 4.1.2, 5.1.1, 5.1.2,5.2.1, 5.2.2, 5.3.2, 6.1.1, 6.1.2
CO3	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3,2.2.4, 4.1.1, 4.1.2, 5.1.1, 5.1.2,5.2.1, 5.2.2, 5.3.2, 6.1.1, 6.1.2
CO4	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3,2.2.4, 4.1.1, 4.1.2, 5.1.1, 5.1.2,5.2.1, 5.2.2, 5.3.2, 6.1.1, 6.1.2
CO5	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3,2.2.4, 4.1.1, 4.1.2, 5.1.1, 5.1.2,5.2.1, 5.2.2, 5.3.2, 6.1.1, 6.1.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	35	35	-	-	-	100
CAT2	10	45	45	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	10	40	50	-	-	-	100

22I0E$15	**VIDEO CREATION AND EDITING** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	Upon completion of the course the students will be familiar with the principles and techniques of video creation and editing, video production equipment and software, visual storytelling and video production, planning, executing, and editing video projects. also able to foster critical thinking and creativity in developing and executing video projects.	
UNIT – I	**INTRODUCTION TO VIDEO CREATION AND EDITING**	**9 Periods**
Overview of video creation and editing -Brief history of video and film production -Understanding visual storytelling: developing documentary and dramatic projects- introduction to digital and film systems		
UNIT – II	**PRE-PRODUCTION**	**9 Periods**
Developing a concept and idea - Scriptwriting and storytelling -The Digital image - Film systems and cameras -The film image - Case Study : Non linear editing system		
UNIT – III	**PRODUCTION**	**9 Periods**
Camera operation and techniques: The video camcorder- The Lens - Lighting and sound recording techniques - Directing actors and crew -Conducting interviews -Shooting the movie - Case Study : Professional video zoom lenses		
UNIT – IV	**POST-PRODUCTION**	**9 Periods**
Picture and Dialogue editing - Editing digital video -sound editing and mixing -Color grading and correction-Sound editing and mixing – working with film in post production Case Study : Digital Audio Recording		
UNIT – V	**DISTRIBUTION AND PROMOTION**	**9 Periods**
Presenting the project - funding sources - budgets- business arrangements- legal and copyright issues- distribution and marketing - publicity and the marketing campaigns-building and sustaining a career - Case Study : Creating a short movie.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	Steven Ascher and Edward Pincus,The Filmmaker's Handbook: A Comprehensive Guide for the Digital Age,Fifth edition Penguin Publishing Group, 2012

REFERENCES :

1	Walter Murch,In the Blink of an Eye: A Perspective on Film Editing", Silman-James Press,2001
2	Karel Reisz and Gavin Millar,The Technique of Film Editing",second edition ,Taylor and Francis Group 2017
3	Ken Dancyger, The technique of film and video editing , fifth edition , Elsevier 2011.
4	Chris Kenworthy,Digital video production cookbook, OReillyMedia ,2006
5	Mark Brindle, The Digital Filmmaking Handbook ,Quercus Publishing, 2014

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Demonstrate an understanding of the history and evolution of video production and editing.	2
CO2	Develop and execute a concept, script, and storyboard for a video project	3
CO3	Plan and prepare for a video shoot, including casting, location scouting, and budgeting.	3
CO4	Edit and assemble video footage using basic and advanced editing techniques.	2
CO5	Promote and distribute the final video on various platforms.	1

Course Articulation Matrix

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	1	1	1	0	0	0	0	0	0	0	0	1	1
CO2	1	2	3	2	3	0	0	0	0	0	0	0	1	1
CO3	1	2	1	3	3	0	1	0	3	1	2	0	1	1
CO4	1	2	2	2	3	3	0	0	3	1	2	0	1	1
CO5	1	2	2	2	3	3	1	3	3	3	2	0	1	1
22IOE $15	1	2	2	2	2	1	0	1	2	1	1	0	1	1

1– Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO	Key Performance Indicators
CO1	1.1.1,1.2.1,1.31,2.1.1,2.1.2,2.2.4,2.4.1,3.1.4,3.4.1,4.1.3,
CO2	1.1.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.4.3,3.1.1,3.1.2,3.1.3,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.3,4.2.1,4.3.1,4.3.2,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,
CO3	1.1.1,2.1.1,2.1.3,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.2,2.4.3,3.2.1,3.2.2,3.3.1,3.4.2,4.1.1,4.1.3,4.1.4,4.2.2,4.3.1,4.3.2,4.3.3,,5.1.1,5.1.2,5.2.1,5.2.2,5.3.2,7.1.1,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,10.1.1,11.2.1,11.3.1,11.3.2
CO4	1.1.1,2.1.1,2.1.3,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.2,2.4.3,3.2.1,3.2.2,3.3.1,,3.3.2,3.4.2,4.1.1,4.1.3,4.2.1, ,4.3.1,4.3.2,5.1.1,5.1.2,5.2.1,5.2.2,5.3.2,6.1.1,6.1.2,,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,10.1.1,11.3.1,11.3.2
CO5	1.1.1 , 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4 2.3.2, 2.4.3, 3.2.1, 3.2.3, 3.3.1, 3.3.2, 3.4.2, 4.1.1, 4.1.3, 4.3.1, 4.3.2, 4.3.3, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.12, 8.1.1, 8.2.1,8.2.2, , 9.1.1, 9.1.2, 9.2.1,9.2.2, 9.2.3,9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3,10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.2.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	40	-	-	-	100
CAT2	30	30	40	-	-	-	100
Assignment 1	30	30	40	-	-	-	100
Assignment 2	30	30	40	-	-	-	100
Other mode of internal assessments, if any	--	--	--	--	--	--	--
ESE	30	30	40	-	-	-	100

22IOE$16	DIGITAL MARKETING *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To give insight on the framework to analyze, strategies and plan digital marketing and communication activities for typical marketing situations. Familiarize with the key tools and techniques of digital marketing that are popularly used by professionals in the real world of digital marketing and help them develop the ability to formulate and analyze key metrics to evaluate the performance of typical digital marketing efforts.	
UNIT – I	**INTRODUCTION TO DIGITAL MARKETING**	**9 Periods**
Basics of Digital Marketing - online marketplace analysis: digital marketing environment - consumer choice and digital influence online consumer behavior-competitors -suppliers- new channel structures - rate of environment change - economic force-political force -legal force - social force- cultural force.		
UNIT – II	**DIGITAL MARKETING STRATEGY DEVELOPMENT**	**9 Periods**
Digital marketing strategy - The impact of digital media and technology on the marketing mix: product- price-place-promotion -people, process and physical evidence - relationship marketing using digital platforms: the challenge of customer engagement - customer lifecycle management		
UNIT – III	**DIGITAL MARKETING IMPLEMENTATION AND PRACTICE**	**9 Periods**
Delivering the online customer experience: planning website design and redesign projects - initiation of the website project - defining site or app requirement - designing the user experience - development and testing of content - site promotion or traffic building - campaign planning for digital media		
UNIT – IV	**MARKETING COMMUNICATIONS USING DIGITAL MEDIA CHANNELS**	**9 Periods**
Search engine marketing - online public relations - affiliated marketing - interactive display advertising -email marketing and mobile text messaging- social media and viral marketing - offline promotion techniques		
UNIT – V	**EVALUATION OF DIGITAL CHANNEL PERFORMANCE**	**9 Periods**
Create a performance management system - performance metric framework - tools and techniques for collecting metrics -customer experience and content management - online consumer behavior- online retailing - customer acquisition in B2B marketing -online inter-organizational trading		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	Dave Chaffey Fiona Ellis-Chadwick, Digital Marketing,sixth edition, 2016

REFERENCES :

1	Puneet singh Bhatia, Fundamentals of Digital Marketing , Pearson India Education services,2017
2	Mathur, Vibha, Arora, Saloni,"DigitalMarketing",PHI Learning Pvt. Ltd.,2020
3	Ian Dodson, The Art of Digital Marketing: The Definitive Guide to Creating Strategic, Targeted, and Measurable Online Compaigns, Wiley 2016
4	Dr.Shakti Kundu, Digital Marketing Trends and Prospects:Develop an effective Digital Marketing strategy with SEO, SEM, PPC, Digital Display Ads & Email Marketing techniques,BPB PUBN,2021
5	Seema Gupta , Digital Marketing,Third Edition, McGraw Hill 2022
6.	Simon Kingsnorth, Digital Marketing Strategy:An Integrated Approach to Online Marketing, Kogan page,2022

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the role and importance of digital marketing in a rapidly changing business landscape	K1
CO2	Discuss the key elements of a digital marketing strategy	K2
CO3	Demonstrate advanced practical skills in common digital marketing tools such as Social media and Blogs	K2
CO4	Demonstrate advanced practical skills in common digital marketing tools such as SEM	K2
CO5	understand online consumer behavior and influence the extent to which individuals are likely to engage with the digital marketplace	K2

Course Articulation Matrix

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	1	1	2	2	--	-	-	-	-	-	-	-	2	2
CO2	1	1	2	2	-	-	-	-	-	-	-	-	2	2
CO3	1	1	2	2	3	-	-	-	-	-	-	-	2	2
CO4	1	1	2	2	3	2	3	3	3	3	3	3	2	2
CO5	1	1	2	2	1		3	3	3	3	3	3	2	2
22IOE$16	1	1	2	2	1	1	1	1	1	1	1	1	2	2

1– Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO	Key Performance Indicators
CO1	1.1.1,2.1.1,2.1.2,3.1.1,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,4.1.1,4.1.3,4.2.1,4.3.3,
CO2	1.1.1,2.1.1,2.1.2,3.1.1,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,4.1.1,4.1.3,4.2.1,4.3.3,
CO3	1.1.1,2.1.1,2.1.2,3.1.1,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,4.1.1,4.1.3,4.2.1,4.3.3,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2
CO4	1.1.1,2.1.1,2.1.2,3.1.1,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,4.1.1,4.1.3,4.2.1,4.3.3, 5.1.1,5.1.2,5.2.1, 5.2.2,5.3.1,5.3.2,6.1.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.2.4,9.3.1,10.1.1, 10.1.2,10.1.3,10.2.1,10.2.2,10.3.1,10.3.2,11.1.1,11.1.2,11.2.1,11.3.1,11.3.2,12.1.1,12.1.2,12.2.1,12.2.2, 12.3.1,12.3.2
CO5	1.1.1,2.1.1,2.1.2,3.1.1,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,4.1.1,4.1.3,4.2.1,4.3.3, 5.1.1,5.1.2,5.2.1, 7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.2.4,9.3.1, 10.1.1,10.1.2,10.1.3,10.2.1,10.2.2,10.3.1,10.3.2,11.1.1,11.1.2,11.2.1,11.3.1,11.3.2,12.1.1,12.1.2,12.2.1, 12.2.2,12.3.1,12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	40	-	-	-	100
CAT2	30	30	40	-	-	-	100
Assignment 1	30	30	40	-	-	-	100
Assignment 2	30	30	40	-	-		100
Other mode of internal assessments, if any	--	--	--	--	--	--	--
ESE	30	30	40	-	-	-	100

22BOE$17	**PRINCIPLES OF FOOD TECHNOLOGY** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To learn about the various food constituents and its additives. To learn about various microbes associated with food. To learn about different food processing and preservation techniques.	
UNIT – I	**FOOD AND ENERGY**	**9 Periods**
Constituents of food – carbohydrates, lipids, proteins, water, vitamins and minerals, dietary sources, role and functional properties in food, contribution to organoleptic and textural characteristics.		
UNIT – II	**FOOD BORNE DISEASES**	**9 Periods**
Classification – food infections – bacterial and other types; food intoxications and poisonings– bacterial and non-bacterial; food spoilage – factors responsible for spoilage, spoilage of vegetable, fruit, meat, poultry, beverage and other food products.		
UNIT – III	**FOOD ADDITIVES**	**9 Periods**
Classification, intentional and non-intentional additives, functional role in food processing and preservation; food colourants – natural and artificial; food flavours; enzymes as food processing aids.		
UNIT – IV	**FOOD PRESERVATION**	**9 Periods**
Principles involved in the use of sterilization, pasteurization and blanching, thermal death curves of microorganisms, canning; frozen storage-freezing characteristics of foods, microbial activity at low temperatures, factors affecting quality of foods in frozen storage; irradiation preservation of foods.		
UNIT – V	**FOOD PACKAGING**	**9 Periods**
Types of packaging material and containers; Interactions between packaging and foods; Packing - meat, dairy, fresh fruits and vegetables, beverages and confectionaries; Food packaging closure and sealing system; Nutrition labelling and legislative requirements.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK

1	*T.P. Coultate ,* ***Food – The Chemistry Of Its Components****, 6th Edn. Royal Society,London, 2015.*
2	*W.C. Frazier And D.C. Westhoff ,* ***Food Microbiology****, 4th Ed., Mcgraw-Hill Book Co., NewYork 2013.*

REFERENCES

1	*Srinivasan Damodaran and Kirk L. Parkin., "Fennema's Food Chemistry", CRC Press, 5 thedition. 2017.*
2	*Fellows P.J, "Food Processing Technology: Principles and Practices", Woodhead Publishing 4 th edition,2016·*
3	*B. Sivasanker , Food Processing And Preservation, Prentice-Hall Of India Pvt. Ltd. New Delhi 2002.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	learn different constituents present in food and microorganism involved in processing of food.	K1
CO2	learn principles and different preservations techniques of food can also be known.	K1
CO3	learn techniques involved in modern food processing and impact of the process on food quality.	K2
CO4	Explain various preservation and packaging techniques for food product	K2
CO5	Describe the relationship between food and microorganism that basis for fermentation and preservation	K2

a) Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	1	-	-	-	-	2	3	-	-	1	3
CO2	1	-	-	-	-	-	-	-	-	3	-	-	1	3
CO3	1	-	-	2	-	2	-	-	-	3	-	-	1	3
CO4	1	-	1	-	-	-	-	-	-	3	-	-	1	3
CO5	1	-	2	-	-	-	-	-	-	3	-	-	1	3
22BOE$17	1	-	1	1	-	2	-	-	2	3	-	-	1	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.4.2, 2.1.3
CO2	1.4.1, 3.1.3
CO3	1.4.4, 2.1.4
CO4	1.4.1, 2.1.3,3.4.2
CO5	1.4.1,2.2.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	50	50	-	-	-	-	100
CAT2	60	40	-	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50	50	-	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	50	50	-	-	-	-	100
ESE	50	50	-	-	-	-	100

22BOE$18	**BIOLOGY FOR ENGINEERS** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	1. Understand and interpret commonly reported statistical measures published in healthcare research 2. Analyze the different type of data using appropriate statistical software 3. Demonstrate a good understanding of descriptive statistics and graphical tools 4. Explain fundamental concepts of estimation and hypothesis testing and be confident when interpreting P values and confidence intervals	
UNIT – I	**BASICS OF CELL BIOLOGY**	**9 periods**
An overview of cells – origin and evolution of cells-cell theory-classification of cells – prokaryotic cells and eukaryotic cells; Structure of prokaryotic and eukaryotic cells and their organelles comparison of prokaryotic and eukaryotic cells; Transport across membranes – diffusion - active and passive diffusion.		
UNIT – II	**BASICS OF MICROBIOLOGY**	**9 periods**
Classification of microorganism-microscopic examination of microorganisms; Structural organization and multiplication of bacteria-viruses-algae and fungi; Microorganism used for the production of penicillin-alcohol and vitamin B-12.		
UNIT – III	**HUMAN ANATOMY AND PHYSIOLOGY**	**9 periods**
Basics of human anatomy-tissues of the human body-epithelial-connective-nervous and muscular; Nervous system-Respiratory System-Circulatory system and Digestive system.		
UNIT – IV	**BIO MOLECULES AND IMMUNE SYSTEM**	**9 periods**
Introduction to Biochemistry-classification-structure and properties of carbohydrates- proteins- lipids and nucleic acids; Innate and acquired immunity; Types of immune responses.		
UNIT-V	**APPLIED BIOLOGY FOR ENGINEERS**	**9 periods**
Overview of biosensors - glucometer applications-medicine; Microarray analysis to diagnose the cancer; Microbial production of biofuels; Applications of stem cells.		
Contact Periods: 45 **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK

1	*Darnell J, Lodish H, Baltimore D.* ***"Molecular Cell Biology"****, W.H.Freeman; 8th Edition, 2016.*
2	*Pelczar MJ, Chan ECS and Krein NR,* ***"Microbiology",*** *Tata McGraw Hill, 5thEdition, New Delhi.2001.*
3	*Wulf Cruger and Anneliese Cruger,* ***"A Textbook of Industrial Microbiology",*** *Panima Publishing Corporation, 2nd Edition, 2000.*

REFERENCES

1	*David L. Nelson and Michael M Cox,* ***"Lehninger's Principles of Biochemistry",*** *Macmillan Worth Publisher, 4th edition, 2004.*
2	*Brain R.Eggins ,* ***"Chemical Sensors and Biosensors",*** *John Wiley & Sons, 2002.*
3	*Anton Moser,* ***"Bioprocess Technology, Kinetics and Reactors",*** *Springer, Berlin (Verlag),1st edition, 1998*
4	*Kuby J,* ***"Immunology",*** *WH Freeman & Co., 7th edition, 2013.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the functions of cell and their structural organization	K1
CO2	Describe the mechanisms and role of cell in immune system	K1
CO3	Get familiarized biomolecules and human anatomy system	K2
CO4	Illustrate the applications of microbes in industrial process	K3
CO5	Apply the engineering concepts in biology	K3

a) Course Articulation Matrix

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**
CO1	-	1	-	-	-	2	2	2	-	-	1	2	2	2
CO2	1	-	-	1	1	-	-	2	3	3	2	2	1	3
CO3	1	1	-	-	-	-	-	1	1	-	-	-	1	3
CO4	-	-	-	-	1	-	-	2	3	3	1	1	1	3
CO5	-	2	-	1	3	-	-	-	-	-	-	-	2	2
22BOE$18	1	1	-	1	2	2	2	2	3	3	2	2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	2.2.2, 6.1.1, 7.1.2, 8.1.1, 11.1.1, 12.1.2
CO2	1.1.1, 4.2.1, 5.2.1, 8.1.1, 9.1.1,9.2.1,10.1.1, 10.1.2, 11.1.1, 12.1.2
CO3	1.1.1, 2.1.1, 8.1.1, 9.1.1
CO4	5.2.1, 8.1.1, 9.1.1,9.2.1,10.1.1, 10.1.2, 11.1.1, 12.1.2
CO5	1.1.1,2.2.2, 4.2.1, 5.2.1, 6.1.1,7.1.2, 8.1.1, 9.1.1,9.2.1,10.1.1, 10.1.2, 11.1.1, 12.1.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creatin g (K6) %**	**Total %**
CAT1	50	10	10	10	10	10	100
CAT2	50	10	10	10	10	10	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	20	20	20	10	10	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	20	20	20	10	10	100
ESE	50	10	10	10	10	10	100

VALUE ADDED COURSES

22EVA$02	ELECTRICAL SAFETY					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**EEC**	**1**	**0**	**0**	**1**

Course Objectives	To develop skills in identifying the presence of electrical hazards, implementing measures to minimize risks and developing skills in investigative techniques for determining the cause of electrical accidents, fires and explosions.	
UNIT – I	**ELECTRICAL HAZARDS**	**5 Periods**
Primary and secondary hazards - Human safety in the use of electricity. Energy leakage - Clearances and insulation - Current surges- - Heating effects of current - Electromagnetic forces - Corona effect - Static electricity – Definition, sources, hazardous conditions, electrical causes offire and explosion - Ionization, spark and arc ignition energy		
UNIT – II	**PROTECTION SYSTEMS**	**5 Periods**
Fuse, circuit breakers and overload relays – Protection against over voltage and under voltage – Safe limits of amperage – Voltage – Safe distance from lines - Protection against Electric Shock - - Protection against Direct Contact - Protection against Thermal Effects –Earthing – EmergencySwitching - Protective devices :RCCB and ELCB-Installation of lightning arrestor		
UNIT – III	**ELECTRICAL SAFETY STANDARDS**	**5 Periods**
National electrical safety code ANSI. - Indian electricity act and rules - Statutory requirements from electrical inspectorate- Safety in handling hand held electrical appliances tools		
Contact Periods: **Lecture: 15 Periods** **Tutorial: 0 Periods** **Practical:0 Periods** **Total: 15 Periods**		

TEXT BOOK:

1	*W. Fordham Cooper "***Electrical Safety Engineering***" Third edition, Butterworth & Co., 1996*
2	*D.C. Winburn "***Practical Electrical Safety***" Marcel Dekker Inc., 1988*

REFERENCES

1	*John Cadick, Mary Capelli-Schellpfeffer, Dennis Neitzel, "***Electrical Safety Handbook"***, Fourth edition, McGraw-Hill, 2012.*
2	*J. Maxwell Adams, "***Electrical Safety - A Guide To The Causes And Prevention Of Electrical Hazards***", The Institution of Electrical Engineers, 1994.*
3	**Indian Electricity Act and Rules***, Government of India.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the hazards of electricity and effects.	K2
CO2	Select appropriate personal protective equipment for a variety of applications.	K3
CO3	Analyze electrical hazards and infer safety procedures using appropriate protective equipment.	K4
CO4	Assess and provide solutions to practical problems.	K5
CO5	Apply knowledge of safety standards	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	-	2	1	2	1	2	3	3	1	3	-	2	1	1	1
CO2	3	2	2	2	2	-	2	-	-	1	2	-	1	1	1
CO3	3	3	2	2	2	3	2	2	1	1	2	-	1	1	1
CO4	3	3	1	2	2	-	-	-	-	2	3	2	1	1	1
CO5	3	3	1	2	2	3	2	2	1	-	-	3	1	1	1
22EVA$02	3	3	1	2	2	3	2	2	1	2	2	2	1	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	2.2.1,2.2.2,2.2.3,2.2.4,2.4.4,3.1.4,3.1.5,3.2.3,3.4.1,4.1.1,4.2.1,4.3.3,4.3.4,5.3.1,5.3.2,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.2,9.2.1,9.2.2,10.1.1,10.1.2,10.1.3,10.2.1,10.2.2,12.2.1,12.2.2,12.3.1,12.3.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.3,2.2.4,2.4.2,2.4.3,2.4.4,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.3.1,4.1.2,4.1.4,4.2.1,5.1.2,5.2.2,5.3.2,7.1.1,7.2.2,10.1.1,10.3.1,11.2.1,11.1.2, 11.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.3,2.2.4,2.4.2,2.4.3,2.4.4,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.3.1,4.1.2,4.1.4,4.2.1,5.1.2,5.2.2,5.3.2,7.1.1,7.2.2,10.1.1,10.3.1,11.2.1,11.1.2, 11.3.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.3,2.2.4,2.4.2,2.4.3,2.4.4,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.3.1,4.1.2,4.1.4,4.2.1,5.1.2,5.2.2,5.3.2,7.1.1,7.2.2,10.1.1,10.3.1,11.2.1,11.1.2, 11.3.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.1,3.2.2,3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,8.2.2,9.1.2,7.2.1,7.2.2,6.2.1,6.1.1,5.3.2,5.3.1,5.3.2,12.1.2,12.2.2,12.3.2

22EVA$03	EMBEDDED SYSTEMS					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**EEC**	**1**	**0**	**0**	**1**
Course Objectives	To disseminate the expertise of embedded systems to develop control techniques for realistic applications.					
Course Content						**15 Periods**
Basic architecture - Programming techniques –PWM Generation, Motor Control, ADC/DAC and LCD and sensor–interfacing. 1. Design with Microcontrollers (PIC Microcontrollers) 2. Design with FPGA-based controllers using the system generator tool 3. Design with Digital signal processors(TMS320C2XXX)						
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: - Periods Total: 15 Periods**						

TEXT BOOK

1	***PIC 16F87X microcontroller, user manual microchip technology*** *Inc,2013.*
2	***TMS 320C28X DSP user manual****, Texas instruments, 2015.*
3	***Xilinx System Generator for DSP,*** *user guide, Xilinx Inc, 2012*

REFERENCES (Minimum 4 and Maximum 6):

1	*Peckol, "**Embedded system Design**", John Wiley & Sons, 2010.*
2	*Lyla B Das, "**Embedded Systems-An Integrated Approach**", Pearson, 2013.*
3	*Raj Kamal "**Embedded Systems**" Tata McGraw-Hill, Third Ed. 2017.*
4	*Tammy Noergaard, "**Embedded Systems Architecture**", Elsevier, Second Ed. 2012*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Review basic programming skills	K2
CO2	Choose a different tool for embedded software development	K3
CO3	Develop hardware components for diverse applications.	K3
CO4	Analyze the system for different operating conditions.	K4
CO5	Create a solution in real-time for societal problem	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	2	1	-	-	-	1	1	3	2	2
CO2	3	3	3	2	2	2	-	-	-	-	1	1	2	2	2
CO3	3	2	3	2	2	2	1	-	-	-	1	1	3	3	2
CO4	3	3	3	2	2	2	-	-	-	-	1	1	2	2	2
CO5	2	2	3	2	2	2	-	-	-	-	1	1	3	3	3
22EVA$03	3	2	3	2	2	2	1	-	-	-	1	1	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping (Times New Roman, Size 11)

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 6.1.1, 7.1.1, 11.1.1, 12.1.2, 12.2.1
CO2	1.1.1, 1.1.2, 1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 6.1.1, 11.1.1, 12.1.2, 12.2.1
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.2, 2.1.3, 2.2.2, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 6.1.1, 7.1.1, 11.1.1, 12.1.2, 12.2.1
CO4	1.1.1, 1.1.2, 1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 6.1.1, 11.1.1, 12.1.2, 12.2.1
CO5	1.1.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.2.1, 5.2.2, 6.1.1, 11.1.1, 12.1.2, 12.2.1

22EVA$04	ELECTRICAL WIRING AND MAINTENANCE OF HOUSEHOLD APPLIANCES

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objectives	To impart knowledge on the different conductor and wiring systems used in residential and commercial wiring in accordance with the codes and authorities for installation.

Course Content **15 Periods**

1. Conductors, Insulators & its types
2. Crimping & Crimping Tools, Soldering
3. Joints in Electrical Conductor
4. Concept of the gauge of wire, conductor
5. Determination of Fuse size according to the load of the circuit and its location
6. Study of different components used in house wiring.
7. Concept of earthing, purpose & types
8. Pipe earthing & Plate earthing
9. Earthing of domestic installation
10. Use of Megger & Test lamps in fault location
11. Energy meter installation
12. Repair and service technique of home appliances
13. Three Phase Selector Switch - Wiring Diagram
14. Online and Offline UPS

Contact Periods:

Lecture: 15 Periods **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**

TEXT BOOK (Maximum 2):(Times New Roman, Size 11, Italics, Book Name - BOLD, Sentence case)

1	*Phil Simons, "**Electrical Wiring Residential**", Cengage Learning,17th Ed., 2011*
2	*Stephen L Herman, "**Electrical Wiring Industrial Edition**", Cengage Learning,15th Ed.,2014*

REFERENCES (Minimum 4 and Maximum 6):

1	*Newton Harrison, "**Electric Wiring: Diagrams and Switch boards**", Nabu Press,2011*
2	*David W Rongey, "**Home Electric Wiring**",Guide,2013.*
3	*Black & Decker: "**Complete Guide to Wiring**" , 7th Ed, 2017.*
4	*"**Ultimate Guide: Wiring**", Creative Home Owner, 8th Ed., 2017*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Select appropriate electrical tools, wires, protective devices and wiring accessories.	K4
CO2	Prepare wiring diagrams using conduit system of wiring	K3
CO3	Employ IS standards for electrical wiring.	K3
CO4	Construct different types of wiring joints.	K3
CO5	Analyse and repair the house-hold appliance	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs /POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	3	3	2	1	-	-	-	1	1	3	2	2
CO2	3	3	3	3	3	2	-	-	-	-	1	1	2	2	2
CO3	3	2	3	3	3	2	1	-	-	-	1	1	3	3	2
CO4	3	3	3	3	3	2	-	-	-	-	1	1	2	2	2
CO5	2	2	3	3	3	2	-	-	-	-	1	1	3	3	3
22EVA$04	3	2	3	3	3	2	1	-	-	-	1	1	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 7.1.1, 11.1.1, 12.1.2, 12.2.1
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 11.1.1, 12.1.2, 12.2.1
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.2, 2.1.3, 2.2.2, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 7.1.1, 11.1.1, 12.1.2, 12.2.1
CO4	1.1.1, 1.1.2, 1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 11.1.1, 12.1.2, 12.2.1
CO5	1.1.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.3.1, 4.3.3, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 11.1.1, 12.1.2, 12.2.1

22EVA$05	PCB DESIGN AND FABRICATION

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	2	1

Course Objectives	To provide knowledge on circuit board design in assembling and testing of PCB-based electronics circuits and become familiar with the simulation software.
Course Content	**30 Periods**
1. Introduction to PCB Designing 2. Scope of PCB Designing 3. Hardware on Breadboard 4. Software Description 5. Design circuit on PCB software (Proteus, Express PCB, ARES) 6. Schematic Layout 7. Board creation 8. Fabrication Process 9. Design of single-sided PCB	
Contact Periods: **Lecture: 0 Periods** **Tutorial: 0 Periods** **Practical: 30 Periods** **Total: 30 Periods**	

TEXT BOOK (Maximum 2):

1	*R.S.Khandpur, " **Printed Circuit Boards: Design, Fabrication, Assembly and Testing**", Tata McGraw –Hill Education, 2005.*
2	*Jan Axelson, " **Making Printed Circuit Boards**", TAB Books, 1993.*

REFERENCES (Minimum 4 and Maximum 6):

1	*Simon Monk, "**Make your own PCBs**", McGraw Hill, 2014*
2	*Bruce R Archambeault, "**PCB design for real world EMI control**", Springer,2002*
3	*Greg Papandrew, "**PCB Basics for Buyers: A Quick Guide to the Printed Circuit Board Industry",** JMP Publishing,2019*
4	*Matthew F. Berger, "**Professional Electronic Design Best Practices",** Independently Published,2023*

COURSE OUTCOMES: On completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Demonstrate schematic electronic circuits in the software	K3
CO2	Interpret different terminology in PCB design.	K2
CO3	Design and develop the layout of PCB using PCB layout design tool with fabrication	K3
CO4	Construct simple electronic equipment prototype for demonstration, development and experimentation purposes	K3
CO5	Analyze and debug errors in PCB design	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping (Times New Roman, Size 11)

COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	2	3	3	-	-	3	-	-	-	2	2	2	1
CO2	3	3	2	3	3	-	-	3	-	-	-	2	2	2	1
CO3	3	3	2	3	3	-	-	3	-	-	-	2	3	2	1
CO4	3	3	2	3	3	-	-	3	-	-	-	2	2	2	1
CO5	3	3	2	3	3	-	-	3	-	-	-	2	2	1	2
22EVA$05	3	3	2	3	3	-	-	3	-	-	-	2	2	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.3,3.3.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,8.1.1,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.3,3.3.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,8.1.1,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.3,3.3.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,8.1.1,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.3,3.3.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,8.1.1,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3, 2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.3,3.3.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2, 4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,8.1.1,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2