NANDHA ENGINEERING COLLEGE
(Autonomous)

Affiliated to Anna University Chennai ❖ Approved by AICTE ❖ Accredited by NBA - New Delhi

Pitchandampalayam (P.O), Vaikkalmedu, Erode - Perundurai Road, Erode - 638 052

Phone : 04294 - 225585, 223711, 223722, 226393 Mobile : 73737 23722 Fax : 04294 - 224787

Website : www.nandhaengg.org E.mail : info@nandhaengg.org

1.1.2 Details of Courses where syllabus revision was carried out

B.E.- Electrical and Electronics Engineering

R-22 Curriculum

Course Code	Course Name	% of Change
22EEC14	Power System Analysis	5
22EEC15	Control Systems	5
22EEC16	Power Electronics	20
22EEP07	Control and Instrumentation Laboratory	10
22EEP08	Power Electronics Laboratory	10
22EEC17	Power System Protection and switch gear	80
22EEC18	Electric drives and Control	50
22EEP09	Power System Simulation Practices Laboratory	5
22GEA01	Universal Human Values	100
22GED02	Internship/Industrial training	80
22EED01	Project Work	-
22EEX01	Power Switching Converters	100
22EEX02	Special Electrical Machines	5
22EEX03	Design Of Electrical Machines	10

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22EEX04	Analysis Of Inverters	100
22EEX05	Wind And Solar Energy Systems	100
22EEX06	IOT For Smart Systems	100
22EEX07	Modern Power Electronic Converters	100
22EEX11	High Voltage Engineering	15
22EEX12	HVDC Transmission Systems	100
22EEX13	Power Quality	20
22EEX14	Power System Operation and Control	10
22EEX15	Fundamentals of electric Power utilization	100
22EEX16	Energy Auditing, Conservation and Management	20
22EEX17	Re structured power system	100
22EEX18	Fundamentals of Fibre Optics and Laser Instrumentation	-
22EEX21	Fundamentals of Electric Vehicles	100
22EEX22	Battery pack modeling and Charging of Electric Vehicle	100
22EEX23	Hybrid Electric Vehicles	100
22EEX24	Testing and Electric Vehicle Policy	100
22EEX25	EV Intelligent System	100
22EEX26	Electrical Vehicles in Smart grid	100
22EEX27	Design of motor and power converters for Electric Vehicles	100
22EEX28	Electric Vehicle Architecture	100
22EEX31	Embedded System design	100
22EEX32	Signals and Systems	100
22EEX33	Embedded control system	100

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22EEX34	Signal Processing	100
22EEX35	Embedded IoT	100
22EEX36	Embedded Networking	100
22EEX37	Embedded System for Automotive Applications	100
22EEX38	MEMS and NEMS	100
	Average	**71.12**

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(An Autonomous Institution affiliated to Anna University Chennai and approved by AICTE, New Delhi)
Erode-638 052, Tamilnadu, India, Phone: 04294 – 225585

Curriculum and Syllabi

for

B.E – Electrical and Electronics Engineering [R22]

[CHOICE BASED CREDIT SYSTEM]

[This Curriculum and Syllabi are applicable to Students admitted from the Academic year 2024-2025 onwards]

JULY 2024

INSTITUTE VISION AND MISSION	
VISION	• To be an Institute of excellence providing quality Engineering, Technology and Management education to meet the ever changing needs of the society.
MISSION	• To provide quality education to produce ethical and competent professionals with social Responsibility • To excel in the thrust areas of Engineering, Technology and Entrepreneurship by solving real- world problems. • To create a learner centric environment and improve continually to meet the changing global needs.

B.E – ELECTRICAL AND ELECTRONICS ENGINEERING	
VISION	• To foster academic excellence imparting knowledge in Electrical, Electronics and allied disciplines to meet the changing needs of the society.
MISSION	• To equip the students with leadership qualities for accepting the challenges in various engineering sectors • To excel in the thrust areas of Electrical and Electronics Engineering to solve real world problems • To empower the students to adapt the latest technologies by providing innovative learning environment
PROGRAMME EDUCATIONAL OBJECTIVES (PEO)	The graduates of Electrical and Electronics Engineering will be **PEO1: Core Competency:** A Successful professional with domain knowledge in Electrical and Electronics Engineering using emerging techniques. **PEO2: Research, Innovation and Entrepreneurship:** Able to demonstrate multi-disciplinary skills through innovation and research to meet the societal needs **PEO3: Ethics, Human values and Life-long learning:** Able to demonstrate ethical practices and managerial skills through continual learning.
PROGRAMME SPECIFIC OUTCOMES (PSO)	The students of Electrical and Electronics Engineering will be able to • Analyze, design and validate processes, products by applying knowledge and skills in Power system, Electrical Machines and Power Electronics. • Design and analyze the processes of smart grid and renewable energy systems using appropriate tools and techniques

PROGRAM OUTCOMES:

At the end of this programme the students will be able to

a-l	GRADUATE ATTRIBUTES	PO No.	PROGRAMME OUTCOMES
a	Engineering Knowledge	PO1	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
b	Problem Analysis	PO2	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c	Design and Development of Solutions	PO3	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
d	Investigation of Complex Problems	PO4	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
e	Modern Tool Usage	PO5	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.
f	The Engineer and Society	PO6	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g	Environment and Sustainability	PO7	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
h	Ethics	PO8	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
i	Individual and Team Work.	PO9	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
j	Communication	PO10	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k	Project Management and Finance	PO11	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l	Lifelong Learning	PO12	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.

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the Programme Educational Objectives and the outcomes is given in the following table

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES											
	A	B	C	D	E	F	G	H	I	J	K	L
1	3	3	3	3	3	2	2	1	2	2	3	2
2	2	3	3	2	3	3	2	2	3	2	3	2
3	3	2	1	1	2	2	2	3	3	3	2	3

MAPPING OF PROGRAM SPECIFIC OUTCOMES WITH PROGRAMME OUTCOMES

A broad relation between the Program Specific Objectives and the outcomes is given in the following table

PROGRAM SPECIFIC OUTCOMES	PROGRAMME OUTCOMES											
	A	B	C	D	E	F	G	H	I	J	K	L
1	3	3	3	3	2	2	2	2	2	2	2	3
2	3	3	2	3	3	2	2	2	2	2	2	3

Contribution 1: Reasonable 2: Significant 3: Strong

SEMESTER: I									
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE - REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
I	22MAN01	Induction Programme	MC	-	-	-	-	-	-
THEORY									
2	22EYA01	Professional Communication - I	HSMC	-	4	2	0	2	3
3	22MYB01	Calculus and Linear Algebra*	BSC	-	4	3	I	0	4
4	22CYB04	Engineering Chemistry	BSC	-	3	3	0	0	3
5	22CSC01	Problem Solving and C Programming	ESC	-	3	3	0	0	3
6	22MEC01	Engineering Graphics	ESC	-	4	2	0	2	3
7	22GYA01	தமிழர் மரபு/ Heritage of Tamils*	HSMC	-	I	I	0	0	I
PRACTICAL									
8	22GEP01	Engineering Practices Laboratory	ESC	-	4	0	0	4	2
9	22CSP01	Problem Solving and C Programming Laboratory	ESC	-	4	0	0	4	2
10	22CYP01	Chemistry Laboratory*	BSC	-	2	0	0	2	I
Mandatory Non Credit Courses									
11	22MAN03	Yoga - I*	MC	-	I	0	0	I	0
				TOTAL	**30**	**14**	**I**	**15**	**22**

*Ratified by Eleventh Academic council

SEMESTER: II									
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE - REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	22EYA02	Professional Communication- II	HSMC	22EYA01	4	2	0	2	3
2	22MYB03	Statistics and Numerical methods*	BSC	-	4	3	1	0	4
3	22PYB03	Solid State Physics	BSC	-	3	3	0	0	3
4	22CSC02	Data structures using C*	ESC	22CSC01	3	3	0	0	3
5	22EEC03	Electric Circuit Theory	PCC	-	3	2	1	0	3
6	22GYA02	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology*	HSMC	-	1	1	0	0	1
PRACTICAL									
7	22CSP02	Data Structures Laboratory*	ESC	22CSP01	4	0	0	4	2
8	22PYP01	Physics Laboratory	BSC	-	2	0	0	2	1
9	22EEP01	Electric Circuits Laboratory	PCC	-	4	0	0	4	2
Mandatory Non Credit Courses									
10	22MAN02	Soft /Analytical Skills - I	MC	-	3	1	0	2	0
11	22MAN05	Yoga - II*	MC	-	1	0	0	1	0
				TOTAL	**32**	**15**	**2**	**15**	**22**

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SEMESTER: III									
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE - REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	22MYB07	Probability and Complex functions	BSC	-	4	3	1	0	4
2	22EEC05	Electronic Devices and Circuits	PCC	-	3	3	0	0	3
3	22EEC06	Electrical Machines-I	PCC	22EEC03	3	3	0	0	3
4	22EEC07	Electromagnetic Fields	PCC	-	3	3	0	0	3
5	22ITC06	Java Programming	ESC	-	3	3	0	0	3
6	22EEC08	Digital Logic Circuits	PCC	-	3	3	0	0	3
PRACTICAL									
7	22EEP02	Electronic Devices and Circuits Laboratory	PCC	-	4	0	0	4	2
8	22EEP03	Electrical Machines-I Laboratory	PCC	-	4	0	0	4	2
9	22ITP04	Java Programming Laboratory	ESC	-	4	0	0	4	2
Mandatory Non Credit Courses									
10	22MAN04R	Soft / Analytical Skills - II	MC		3	1	0	2	0
11	22MAN09	Indian Constitution	MC		1	1	0	0	0
				TOTAL	**35**	**20**	**1**	**14**	**25**

SEMESTER: IV									
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE - REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	22EEC09	Electrical Machines-II	PCC	22EEC06	3	3	0	0	3
2	22EEC10	Analog Integrated circuits	PCC	22EEC05	3	3	0	0	3
3	22EEC11	Power Generation, Transmission and Distribution	PCC	22EEC03	3	3	0	0	3
4	22EEC12	Measurements and Instrumentation	PCC	-	3	3	0	0	3
5	22EEC13	Microprocessor and Microcontroller	PCC	22EEC08	3	3	0	0	3
6	22CYB06	Environmental Science and Sustainability	BSC	-	3	3	0	0	3
PRACTICAL									
7`	22EEP04	Electrical Machines-II Laboratory	PCC	22EEP03	4	0	0	4	2
8	22EEP05	Analog and Digital Integrated Circuits Laboratory	PCC	22EEP02	4	0	0	4	2
9	22EEP06	Microprocessor and Microcontroller Laboratory	PCC	-	4	0	0	4	2
Mandatory Non Credit Courses									
10	22MAN07R	Soft/Analytical Skills - III	MC	-	3	1	0	2	0
11	22GED01	Personality and Character Development	EEC	-	0	0	0	1	0
				TOTAL	**33**	**19**	**0**	**15**	**24**

SEMESTER: V									
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE - REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	22EEC14	Power System Analysis	PCC	22EEC11	4	3	1	0	4
2	22EEC15	Control Systems	PCC	22EEC06, 22EEC09	4	3	1	0	4
3	22EEC16	Power Electronics	PCC	22EEC05	3	3	0	0	3
4	E1	Elective (PEC)	PEC	-	3	3	0	0	3
5	E2	Elective (PEC)	PEC	-	3	3	0	0	3
6	E3	Elective (PEC)	PEC	-	3	3	0	0	3
PRACTICAL									
7`	22EEP07	Control and Instrumentation Laboratory	PCC	22EEP03, 22EEP04	4	0	0	4	2
8	22EEP08	Power Electronics Laboratory	PCC	22EEP02	4	0	0	4	2
Mandatory Non Credit Courses									
9	22MAN08R	Soft/Analytical Skills - IV	MC	-	3	1	0	2	0
				TOTAL	**31**	**19**	**2**	**10**	**24**

SEMESTER: VI									
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE - REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	22EEC17	Power System Protection and switch gear	PCC	22EEC11	3	3	0	0	3
2	22EEC18	Electric drives and Control	PCC	22EEC06, 22EEC09	3	3	0	0	3
3	E4	Elective (PEC)	PEC	22EEC16	3	3	0	0	3
4	E5	Elective (PEC)	PEC	-	3	3	0	0	3
5	E6	Elective (PEC)	PEC	-	3	3	0	0	3
6	E7	Elective (OEC)	OEC	-	3	3	0	0	3
PRACTICAL									
7	22EEP09	Power System Simulation Practices Laboratory	PCC	22EEC11, 22EEC14	4	0	0	4	2
				TOTAL	**22**	**18**	**0**	**4**	**20**

SEMESTER: VII									
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE - REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1	22GEA01	Universal Human Values	HSMC	-	2	2	0	0	2
2	E8	Elective (OEC)	OEC	-	3	3	0	0	3
3	E9	Elective (OEC)	OEC	-	3	3	0	0	3
4	E10	Elective (OEC)	OEC	-	3	3	0	0	3
5	EM1	Elective (Management)	HSMC	-	3	3	0	0	3
PRACTICAL									
6	22GED02	Internship/Industrial training	EEC	-	-	0	0	0	2
				TOTAL	**14**	**14**	**0**	**0**	**16**

SEMESTER: VIII									
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE - REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
PRACTICAL									
1	22EED01	Project Work*	EEC	-	20	0	0	20	10
				TOTAL	**20**	**0**	**0**	**20**	**10**

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HS, BS, ES, PC, EEC and Mandatory Courses									
(a) Humanities and Social Sciences (HS)									
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1.	22EYA01	Professional Communication - I	HSMC	-	4	2	0	2	3
2.	22GYA01	தமிழர் மரபு / Heritage of Tamils	HSMC	-	1	1	0	0	1
3.	22EYA02	Professional Communication- II	HSMC	22EYA01	4	2	0	2	3
4.	22GYA02	தமிழரும் தொழில்நுட்பமும் / Tamils and Technology	HSMC	-	1	1	0	0	1
5.	22GEA01	Universal Human Values	HSMC		2	2	0	0	2
6.	EM1	Elective (Management)	HSMC	-	3	3	0	0	3

(b) Basic Sciences (BS)									
S. NO.	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-REQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
1.	22MYB01	Calculus and Linear Algebra	BSC	-	4	3	1	0	4
2.	22CYB04	Engineering Chemistry	BSC	-	3	3	0	0	3
3.	22CYP01	Chemistry Laboratory	BSC	-	2	0	0	2	1
4.	22MYB03	Statistics and Numerical methods	BSC	-	4	3	1	0	4
5.	22PYB03	Solid State Physics	BSC	-	3	3	0	0	3
6.	22PYP01	Physics Laboratory	BSC	-	2	0	0	2	1
7.	22MYB07	Probability and Complex functions	BSC		4	3	1	0	4
8.	22CYB06	Environmental Science and Sustainability	BSC	-	3	3	0	0	3

(c) Engineering Sciences (ES)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
1.	22CSC01	Problem Solving and C Programming	ESC	-	3	3	0	0	3
2.	22MEC01	Engineering Graphics	ESC	-	4	2	0	2	3
3.	22GEP01	Engineering Practices Laboratory	ESC	-	4	0	0	4	2
4.	22CSP01	Problem Solving and C Programming Laboratory	ESC	-	4	0	0	4	2
5.	22CSC02	Data structures using C	ESC	22CSC01	3	3	0	0	3
6.	22CSP02	Data Structures Laboratory	ESC	22CSP01	4	0	0	4	2
7.	22ITC06	Java Programming	ESC	-	3	3	0	0	3
8.	22ITP04	Java Programming Laboratory	ESC	-	4	0	0	4	2

(d) Employability Enhancement Courses (EEC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
1.	22GED01	Personality and Character Development	EEC	-	0	0	0	1	0
2.	22GED02	Internship/Industrial training	EEC	-	0	0	0	0	2
3.	22EED01	Project Work	EEC	-	20	0	0	20	10

(e) Programme Core Courses (PC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
1.	22EEC03	Electric Circuit Theory	PCC	-	3	2	1	0	3
2.	22EEP01	Electric Circuits Laboratory	PCC	-	4	0	0	4	2
3.	22EEC05	Electronic Devices and Circuits	PCC	-	3	3	0	0	3
4.	22EEC06	Electrical Machines-I	PCC	22EEC03	3	3	0	0	3
5.	22EEC07	Electromagnetic Fields	PCC	-	3	3	0	0	3
6.	22EEC08	Digital Logic Circuits	PCC	-	3	3	0	0	3
7.	22EEP02	Electronic Devices and Circuits Laboratory	PCC	-	4	0	0	4	2
8.	22EEP03	Electrical Machines-I Laboratory	PCC	-	4	0	0	4	2
9.	22EEC09	Electrical Machines-II	PCC	22EEC06	3	3	0	0	3
10.	22EEC10	Analog Integrated circuits	PCC	22EEC05	3	3	0	0	3
11.	22EEC11	Power Generation, Transmission and Distribution	PCC	22EEC03	3	3	0	0	3
12.	22EEC12	Measurements and Instrumentation	PCC	-	3	3	0	0	3
13.	22EEC13	Microprocessor and Microcontroller	PCC	22EEC08	3	3	0	0	3
14.	22EEP04	Electrical Machines-II Laboratory	PCC	22EEP03	4	0	0	4	2
15.	22EEP05	Analog and Digital Integrated Circuits Laboratory	PCC	22EEP02	4	0	0	4	2
16.	22EEP06	Microprocessor and Microcontroller Laboratory	PCC	-	4	0	0	4	2
17.	22EEC14	Power System Analysis	PCC	22EEC11	4	3	1	0	4
18.	22EEC15	Control Systems	PCC	22EEC06, 22EEC09	4	3	1	0	4
19.	22EEC16	Power Electronics	PCC	22EEC05	3	3	0	0	3
20.	22EEP07	Control and Instrumentation Laboratory	PCC	22EEP03, 22EEP04	4	0	0	4	2
21.	22EEP08	Power Electronics	PCC	22EEP02	4	0	0	4	2

		Laboratory							
22.	22EEC17	Power System Protection and switch gear	PCC	22EEC11	3	3	0	0	3
23.	22EEC18	Electric drives and Control	PCC	22EEC06, 22EEC09	3	3	0	0	3
24.	22EEP09	Power System Simulation Practices Laboratory	PCC	22EEC11, 22EEC14	4	0	0	4	2

(f) Mandatory Non Credit Courses(MC)

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PRE-REQUISITE	CONTACT PERIODS	L	T	P	C
1	22MAN01	Induction Programme	MC	-	-	-	-	-	-
2	22MAN03	Yoga - I	MC	-	I	0	0	I	0
3	22MAN02	Soft /Analytical Skills - I	MC	-	3	I	0	2	0
4	22MAN05	Yoga - II	MC	-	I	0	0	I	0
5	22MAN04R	Soft / Analytical Skills - II	MC	-	3	I	0	2	0
6	22MAN09	Indian Constitution	MC	-	I	I	0	0	0
7	22MAN07R	Soft/Analytical Skills - III	MC	-	3	I	0	2	0
8	22MAN08R	Soft/Analytical Skills - IV	MC	-	3	I	0	2	0

PROGRAMME ELECTIVE COURSES

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	PRE-RQUISITE	CONTACT PERIODS	L	T	P	C
VERTCAL 0 (CONVERTERS AND DRIVES)									
1.	22EEX01	Power Switching Converters	PEC	-	3	3	0	0	3
2.	22EEX02	Special Electrical Machines	PEC	-	3	3	0	0	3
3.	22EEX03	Design of Electrical Machines	PEC	-	3	3	0	0	3
4.	22EEX04	Analysis of inverters	PEC	-	3	3	0	0	3
5.	22EEX05	Wind and Solar Electrical Systems	PEC	-	3	3	0	0	3
6.	22EEX06	IoT for smart grid	PEC	-	3	3	0	0	3

7.	22EEX07	Modern Power electronic converters	PEC	-	3	3	0	0	3
8.	22EEX08	Bio Medical Instrumentation and Its Applications	PEC	-	3	3	0	0	3
VERTCAL 1 (POWER SYSTEM ENGINEERING)									
9.	22EEX11	High Voltage Engineering	PEC	-	3	3	0	0	3
10.	22EEX12	HVDC Transmission Systems	PEC	-	3	3	0	0	3
11.	22EEX13	Power Quality	PEC	-	3	3	0	0	3
12.	22EEX14	Power System Operation and Control	PEC	-	3	3	0	0	3
13.	22EEX15	Fundamentals of electric Power utilization	PEC	-	3	3	0	0	3
14.	22EEX16	Energy Auditing, Conservation and Management	PEC	-	3	3	0	0	3
15.	22EEX17	Re structured power system	PEC	-	3	3	0	0	3
16.	22EEX18	Fundamentals of Fibre Optics and Laser Instrumentation	PEC	-	3	3	0	0	3
VERTCAL 2 (ELECTRIC VEHICLE)									
17.	22EEX21	Fundamentals of Electric Vehicles	PEC	-	3	3	0	0	3
18.	22EEX22	Battery pack modeling and Charging of Electric Vehicle	PEC	-	3	3	0	0	3
19.	22EEX23	Hybrid Electric Vehicles	PEC	-	3	3	0	0	3
20.	22EEX24	Testing and Electric Vehicle Policy	PEC	-	3	3	0	0	3
21.	22EEX25	EV Intelligent System	PEC	-	3	3	0	0	3
22.	22EEX26	Electrical Vehicles in Smart grid	PEC	-	3	3	0	0	3
23.	22EEX27	Design of motor and power converters for Electric Vehicles	PEC	-	3	3	0	0	3
24.	22EEX28	Electric Vehicle Architecture	PEC	-	3	3	0	0	3
VERTCAL 3 (EMBEDDED SYSTEM ENGINEERING)									
25.	22EEX31	Embedded System design	PEC	-	3	3	0	0	3
26.	22EEX32	Signals and Systems	PEC	-	3	3	0	0	3
27.	22EEX33	Embedded control system	PEC	-	3	3	0	0	3
28.	22EEX34	Signal Processing	PEC	-	3	3	0	0	3
29.	22EEX35	Embedded IoT	PEC	-	3	3	0	0	3

30.	22EEX36	Embedded Networking	PEC	-	3	3	0	0	3
31.	22EEX37	Embedded System for Automotive Applications	PEC	-	3	3	0	0	3
32.	22EEX38	MEMS and NEMS	PEC	-	3	3	0	0	3

MANAGEMENT ELECTIVES									
SL. NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-RQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1.	22GEA02	Principles of Management	HSMC	-	3	3	0	0	3
2.	22GEA03	Total Quality Management	HSMC	-	3	3	0	0	3
3.	22GEA04	Professional Ethics	HSMC	-	3	3	0	0	3

OPEN ELECTIVES									
SL. NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-RQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1.	22EEZ01	Smart Grid	OEC	-	3	3	0	0	3
2.	22EEZ02	Renewable Energy Technology	OEC	-	3	3	0	0	3
3.	22EEZ03	Electric Vehicle	OEC	-	3	3	0	0	3
4.	22EEZ04	Energy Management and Auditing	OEC	-	3	3	0	0	3

MINIOR DEGREE									
ELECTRICAL SYSTEMS									
SL. NO	**COURSE CODE**	**COURSE TITLE**	**CATEGORY**	**PRE-RQUISITE**	**CONTACT PERIODS**	**L**	**T**	**P**	**C**
THEORY									
1.	22EEM01	Electric Circuits	OEC	-	3	3	0	0	3
2.	22EEM02	Solid State Devices	OEC	-	3	3	0	0	3
3.	22EEM03	Power Semiconductor devices	OEC	-	3	3	0	0	3
4.	22EEM04	Electrical measurements and Instruments	OEC	-	3	3	0	0	3
5.	22EEM05	Basics of Electrical Machines	OEC	-	3	3	0	0	3
6.	22EEM06	Electric Drives	OEC	-	3	3	0	0	3

7.	22EEM07	Power Systems	OEC	-	3	3	0	0	3
8.	22EEM08	Renewable Energy Systems	OEC	-	3	3	0	0	3

SUMMARY											
B.E- ELECTRICAL AND ELECTRONICS ENGINEERING											
S. No	SUBJECT AREA	CREDITS AS PER SEMESTER								TOTAL CREDITS	Percentage (%)
		I	II	III	IV	V	VI	VII	VIII		
I	HSMC	4	4					5		13	7.9
2	BSC	8	8	4	3					23	14.1
3	ESC	10	5	5						20	12.2
4	PCC		5	16	21	15	8			65	39.8
5	PEC					9	9			18	11
6	OEC						3	9		12	7.3
7	EEC							2	10	12	7.3
	TOTAL CREDITS	22	22	25	24	24	20	16	10	163	100

22EEC14 - POWER SYSTEM ANALYSIS				
	L	T	P	C
	3	1	0	4
PRE-REQUISITE : 22EEC11				

Course Objective:	• Impact knowledge on need for operational studies and apply per unit analysis to obtain reactance diagram • To understand and apply iterative techniques for power flow analysis. • To model of carry out short circuit studies for power system during symmetrical fault. • To model of carry out short circuit studies for power system during unsymmetrical faults • To study about the various methods for analyzing power system stability

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply mathematical techniques to find per unit diagram and fault current in power system.	Ap	20%
CO2	Analyze faults, power flow and stability using complex mathematical transformations in power system.	An	30%
CO3	Estimate the fault currents in power system using Thevenin's theorem.	An	20%
CO4	Develop power flow algorithms, swing equation and bus matrix for power system.	Ap	30%
CO5	Engage in industrial visit to develop communication skills, teamwork, and professionalism through interactions with industry professionals and observing workplace dynamics and make an oral presentation and report on the visit.	Ap	Internal Assessment (Seminar, Assignment)

UNIT I – INTRODUCTION	(12)
Need for system planning and operational studies – Structure of a power system - Power system components, Representation-Single line diagram – Per unit analysis: P.U. impedance diagram, P.U. reactance diagram, Network graph Theory - Construction of Y-bus matrix using inspection method-Formation of Z - bus matrix.	
UNIT II - POWER FLOW ANALYSIS	(12)
Classification of buses – Development of power flow model in complex variable form – Solution of power flow equation using Gauss-Seidel method –Introduction to Newton Raphson method and Fast decoupled method.	

UNIT III - FAULT ANALYSIS – SYMMETRICAL FAULT ANALYSIS	(12)
Importance of short circuit study –IEEE standards for short circuit studies-Assumptions in fault analysis – Analysis using Thevenin's theorem – Computation of short circuit parameters – Symmetrical fault analysis through bus impedance matrix.	
UNIT IV - FAULT ANALYSIS – UNSYMMETRICAL FAULT ANALYSIS	(12)
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.	
UNIT V-STABILITY ANALYSIS	(12)
Importance of stability analysis in power system planning and operation –Classification of power system stability –Voltage stability –Swing equation – Equal area criterion – Determination of critical clearing angle and time-solution of swing equation by modified Euler method and Runge-Kutta method.	
TOTAL (L:45,T:15) = 60 PERIODS	

TEXT BOOKS:

1. Nagrath I.J. and Kothari D.P., "Modern Power System Analysis", Tata McGraw-Hill, 5th ed., 2022.
2. John J. Grainger and W.D. Stevenson Jr., " Power System Analysis", Tata McGraw-Hill, 2017.

REFERENCES:

1. Hadi Saadat, "Power System Analysis", Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2015.
2. C.L.Wadhwa, "Electrical Power Systems", New Age International (P) Ltd., 2010.
3. Olle. I. Elgerd, "Electric Energy Systems Theory – An Introduction, Tata McGraw Hill Publishing Company Limited, New Delhi, Second Edition, 2017.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2		3											3	
3		3											3	
4			3										2	1
5									2	2		2		
CO (W.A)	3	3	3						2	2		2	2.5	1

22EEC15 - CONTROL SYSTEMS				
	L	T	P	C
	3	1	0	4
PRE-REQUISITE: 22EEC06 & 22EEC09				
Course Objectives:	• To equip students with the knowledge and skills to apply mathematical concepts for deriving transfer functions and analyzing the performance of linear time-invariant systems in both time and frequency domains. • To develop students' ability to design stable linear control systems using various compensators and interpret system responses using modern tools. • To foster independent learning and effective communication skills by exploring and explaining technological advances and applications of control systems.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of mathematical concepts to obtain transfer function of various systems.	Ap	45%
CO2	Analyze the performance of linear time invariant system in time / frequency response.	An	25%
CO3	Design stable linear control systems using compensators.	C	10%
CO4	Interpret the response of a linear system using modern tools.	An	20%
CO5	Explain technological advances and applications of control systems through independent learning and effective presentation.	U	Internal Assessment (Seminar, Quiz)

UNIT I – SYSTEMS AND REPRESENTATION	(12)
Basic elements of Control Systems: Open and Closed-loop Control Systems – Transfer functions of Mechanical Translation and Rotational Systems – Electric Analogy of Mechanical Systems – Block Diagram Reduction Techniques – Signal Flow Graphs.	
UNIT II - TIME DOMAIN ANALYSIS	(12)
Typical Test Signals – Time Response of First Order and Second Order Systems for Unit Step Test Signals – Time Domain Specifications – Steady State Response – Static Error and Error Constants – Concept of stability – Root Locus.	
UNIT III - FREQUENCY DOMAIN ANALYSIS AND DESIGN	(12)
Frequency Domain Specifications – Bode Plot – Polar Plot – Nyquist Stability Criterion – Correlation between Frequency Domain and Time Domain Specifications.	

UNIT IV - STABILITY AND COMPENSATOR DESIGN	(12)
Stability of Linear Control Systems – Stability and Location of the Roots of the Characteristic Equation – Routh-Hurwitz Criterion – Design of Lag, Lead, Lag-lead, and Lead-Lag Compensator Design using Bode Plots Construction – Effects of P, PI, PID modes of Feedback Control.	
UNIT V - STATE SPACE ANALYSIS	(12)
Concept of State Variables – State Models for Linear and Time-Invariant Systems – Solution of State and Output Equation in Controllable Canonical Form – Concepts of Controllability and Observability – State space to Transfer Function.	
TOTAL (L:45)(T:15) = 60 PERIODS	

TEXT BOOKS:

1. Nagrath I J and Gopal M, "Control System Engineering", 7th ed, New Age International, New Delhi, 2021.
2. Farid Golnaraghi and Benjamin C Kuo, "Automatic Control Systems", 10th ed, McGraw-Hill, New Delhi, 2017.

REFERENCES:

1. Ogata K, "Modern Control Engineering", Prentice Hall of India, New Delhi, 2012.
2. Norman S Nise, "Control System Engineering", John Wiley & Sons, 6th ed, New Delhi, 2012.
3. Gopal M, "Control Systems – Principles and Design", 4th ed, Tata McGraw-Hill, New Delhi, 2012.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2		3											3	
3			3										3	
4			3		2									
5					2				3	3				2
CO (W.A)	**3**	**3**	**3**		**2**				**3**	**3**			**3**	**2**

22EEC16- POWER ELECTRONICS

L	T	P	C
3	0	0	3

PRE-REQUISITE : 22EEC05

Course Objective:

- To understand the characteristics of power semiconductor devices
- To understand the operation of AC-DC power converters
- To understand the operation of DC-DC power converters
- To understand the operation of DC-AC power converters
- To understand the operation of AC-AC power converters

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of various power semiconductor devices in power conversions and controls based on their applications.	Ap	30%
CO2	Analyze the operations and performance parameters of different types of power converters.	An	40%
CO3	Design and develop power electronic circuits including phase controlled rectifiers, DC-DC converters, inverters and AC-AC converters.	C	10%
CO4	Apply techniques for controlling power flow and improving efficiency in power electronic systems.	Ap	20%
CO5	Perform a mini project in a team or independent and develop a prototype with presentation and record them.	C	Internal Assessment (Mini Project)

UNIT I- POWER SEMICONDUCTOR DEVICES	(9)
Steady state operation and static V-I characteristics of SCR, TRIAC and IGBT- Switching characteristics of SCR, TRIAC, GTO, BJT, MOSFET and IGBT – Design of gate drive and snubber circuits – Wide band gap (SiC and GaN) power devices.	
UNIT II – AC-DC CONTROLLED CONVERTERS	(9)
Single phase half and fully controlled converters with R, RL (with and without Freewheeling diode), RLE loads - Three phase half and fully controlled converters – Performance parameters – Effect of source inductance – Dual converters – Principle of operation of PWM rectifier – Applications: Renewable energy systems.	
UNIT III – DC-DC CONVERTERS	(9)
Step-down and step-up chopper-control strategy– Types of choppers – Four quadrant operation - Switched mode regulators- Buck, Boost, Buck- Boost regulator - Applications: Battery operated vehicles.	
UNIT IV – DC-AC CONVERTERS	(9)
Single phase bridge inverters- Three phase voltage source inverters (both120 degree mode and180 degree mode) – Voltage control using PWM techniques: Single PWM, Multiple PWM, Sinusoidal PWM and Modified sinusoidal PWM - Introduction to space vector modulation - Single phase current source inverter - Applications: Induction heating and UPS.	

UNIT V – AC-AC CONVERTERS	(9)
Principle operation of AC voltage controller (phase control) – Control Strategy (Integral cycle control) – Single Phase AC Voltage Controllers – Introduction to Matrix converter – Applications: Welding.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. "Power Electronics" by Dr.P.S. Bimbhra, 7th Edition, Khanna Publishing, 1st January 2022.
2. "Power Electronics: Circuits Devices and Applications" by Muhammad H. Rashid, 4th Edition, Pearson Education, 28th November 2017.

REFERENCES:

1. "Power Electronics" by M.D Singh and K Khanchandani, 2nd Edition, McGraw-Hill Education, 1st July 2017.
2. 'Power Electronics: Converters, Applications and Design' by Robbins Mohan, Undeland, 3rd Edition, Wiley Publisher, 1st Jan 2007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2		3												2
3			3											
4	3		3											2
5									3	3		3		
CO (W.A)	3	3	3						3	3		3	3	2

22EEP07 - CONTROL AND INSTRUMENTATION LABORATORY				
	L	T	P	C
	0	0	4	2

PRE-REQUISITE: NIL

Course Objective:	• To provide knowledge on analysis and design of control systems along with basics of instrumentation. • To conduct experiments for determining the transfer function model of electromechanical systems. • To provide practical knowledge on the application of various types of bridges. • To provide knowledge on the linear variable differential transformer. • To study the procedure of transducers, calibration.

Course Outcomes The Student will be able to		**Cognitive Level**
CO1	Apply knowledge of mathematics and physics to obtain the results of various control systems and controllers.	Ap
CO2	Analyze the time response of linear invariant systems.	An
CO3	conduct experiments to demonstrate concepts related to control systems using the engineering tool like Matlab/ Simulink	Ap
CO4	Conduct investigations and analyze the performance of different bridges.	An
CO5	Perform individually in a team to demonstrate open ended experiments and document the same.	C

LIST OF EXPERIMENTS:

1. Design and verify the performance of an open and closed loop control system using Simulink.
2. Analyze the response of given first and second order system with step and impulse inputs.
3. Design and verify the performance of P, PI and PID controllers using MATLAB.
4. Effect of Addition of Poles and Zeros on System Stability using MATLAB.
5. Determination of the transfer function of an armature-controlled D.C. motor.
6. Measurement of Medium resistance using Wheatstone bridge.
7. Measurement of Low resistance using Kelvin's double bridge.
8. Measurement of inductance using Anderson bridge.
9. Measurement of capacitance using Schering bridge.
10. Measurement of displacement using LVDT.

ADDITIONAL EXPERIMENTS:

1. Logic Implementation for traffic control Application.
2. Measurement of the self-inductance using Maxwell's bridge in a virtual lab.

TOTAL (P:60) = 60 PERIODS

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3												3	
2		3											3	
3		3	3		3								3	
4		3			1									2
5									3	3				2
CO (W.A)	**3**	**3**	**3**		**2.3**				**3**	**3**			**3**	**2**

22EEP08 - POWER ELECTRONICS LABORATORY				
	L	T	P	C
	0	0	4	2

PRE-REQUISITE : 22EEP02

Course Objective:	• To understand the static V-I characteristics of SCR, TRIAC, MOSFET and IGBT. • To understand the switching characteristics of SCR and MOSFET • To provide hands on experience with power electronics converters (AC-DC and AC-AC) and testing. • To provide hands on experience with power electronics converters (DC-DC and DC-AC) and testing. • To simulate the single and three phase power electronics circuits using various loads.

Course Outcomes The Student will be able to		**Cognitive Level**
CO1	Implement standard laboratory procedures to build and test power electronic circuits.	Ap
CO2	Interpret data collected from experiments to understand circuit behavior and performance.	An
CO3	Analyze the impact of circuit parameters such as output voltage, switching frequency and duty cycle on the performance of power electronic systems.	An
CO4	Design and test the power electronics circuits and interpret the data.	C
CO5	Troubleshoot and debug power electronic circuits and systems by use of modern tools.	E

LIST OF EXPERIMENTS :

1. Experimental determination of VI characteristics of SCR & TRIAC.
2. Experimental determination of VI characteristics of MOSFET & IGBT.
3. Experimental determination of switching characteristics of SCR and MOSFET.
4. Experiment on Single-phase half and fully controlled Rectifiers with R and RL load.
5. Experimental verification on buck and boost converter circuit using power MOSFET.
6. Experiment on Single phase IGBT based PWM Inverter.
7. Experiment on Single phase AC voltage controllers.
8. Simulation of single phase and three phase AC-DC converters with R and RL loads in MATLAB.
9. Simulation of three phase Inverter in 180 degree conduction mode with R load in MATLAB.
10. Design of gate drive circuit for DC- DC converter.

ADDITIONAL EXPERIMENTS:

1. Experiment on Three phase half and fully controlled bridge converter.
2. Experimental study of Series Resonant DC to DC converter.

TOTAL (P:60) = 60 PERIODS

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3													
2		3	3											
3													2	
4				3										1
5					3				3			3		
CO (W.A)	**3**	**3**	**3**	**3**	**3**				**3**			**3**	**2**	**1**

22MAN08R - SOFT/ANALYTICAL SKILLS – IV (Common to All Branches)					
		L	T	P	C
		1	0	2	0
PREREQUISITE : Nil					
Course Objective:	• To enhance the ability to communicate coherently and effectively across contexts • To develop quantitative aptitude and analytical reasoning skills				

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in Continuous Assessment Test**
CO1	Develop proficiency to communicate accurately, fluently, and appropriately in various academic, professional and social contexts.	U	40%
CO2	Solve quantitative aptitude problems with more confidence.	Ap	30%
CO3	Draw valid conclusions, identify patterns, and solve problems.	An	30%

UNIT I – VERBAL ABILITY	**(15)**
Grammar - Sentence Completion – Sentence Improvement - Error Spotting - **Listening** - TOEFL Listening Practice Tests - **Speaking** – Interview Skills - **Reading** - GRE Reading Passages - **Writing** - Paragraph Writing.	
UNIT II – APTITUDE	**(15)**
Probability - Permutations and Combinations - Data Interpretation on Multiple Charts - Mensuration - Area, Shapes, Perimeter - Races and Games.	
UNIT III - REASONING	**(15)**
Data Sufficiency - Mathematical Operations - Pattern Completion - Cubes - Embedded Images.	
TOTAL(L:45) = 45 PERIODS	

REFERENCES:

1. Rizvi, M.Ashraf. *Effective Technical Communication.* Tata McGraw-Hill Education, 2017.
2. Aggarwal R S. *Quantitative* Aptitude for Competitive Examinations. S.Chand Publishing Company Ltd(s)., 2022.
3. Sharma, Arun. *How to Prepare for Quantitative Aptitude for the CAT*. Tata McGraw – Hill Publishing, 2022.
4. Praveen R V. *Quantitative Aptitude and Reasoning.* PHI Learning Pvt. Ltd., 2016.

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1									2	3				
2		2		2										
3		2		2										
CO (W.A)		**2**		**2**					**2**	**3**				

22EEC17 POWER SYSTEM PROTECTION AND SWITCHGEAR *(For EEE Branch only)*				
	L	**T**	**P**	**C**
	3	**0**	**0**	**3**
PRE-REQUISITE : 22EEC11				
Course Objective:	• To impact knowledge about the need for protective relays in power systems, protective relays used for the protection of Generators, Transmission line, and Transformers. • To describe the various types of circuit breakers and advanced relays used in power system.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the protective schemes for generator, motor, transformer and transmission line protections.	Ap	40%
CO2	Describe the types and applications of switchgear including circuit breakers, fuses and relays.	An	20%
CO3	Analyze the phenomenon of arc, interruption and restriking voltages.	An	15%
CO4	Select and specify appropriate switchgear and protection devices for various power system.	An	25%
CO5	Compare the different type of Fuses and circuit breakers performances in a team and give an oral presentation with relevant applications	Ap	Internal Assessment (Assignment, Online Quiz)

UNIT I- INTRODUCTION	(9)
Protection Schemes : Need for Protection – Zones of Protection – Power System Earthing –Types of Earthing – Relays : Classification of Relays, Electromagnetic Relays, Over Current Relays – Distance Relay: Impedance, Reactance, Mho Relay – Differential Relays – Negative Phase Sequence Relay	
UNIT II – EQUIPMENTS PROTECTION	(9)
Transformer protection: Differential protection and Buchholz's relay - Alternator protection: Differential protection, Earth fault protection and Negative sequence protection. Bus bars protection: Frame leakage protection and Differential circulating current protection. Transmission line protection: Distance and Differential protection, Carrier protection	
UNIT III – THEORY OF CIRCUIT INTERRUPTION	(9)
Physics of arc Phenomena and arc Interruption – Methods of arc Extinction – Theories of arc Interruption – Arc Voltage – Restriking Voltage and Recovery Voltage – Expression for Restriking Voltage and Rate of Rise of Restriking Voltage – Current Chopping – Interruption of Capacitive Currents – Resistance Switching	
UNIT IV – FUSES AND CIRCUIT BREAKER	(9)
Fuses: Types - HRC Fuses – Characteristics and Applications. Circuit Breakers - Types – Air, oil, SF6 and Vacuum circuit breakers- Comparative Merits of Different Circuit Breakers-Rating of circuit Brakers	

UNIT V – STATIC RELAYS AND NUMERICAL PROTECTION	(9)
Static Relays – Phase, Amplitude Comparators – Synthesis of Various Relays using Static Comparators – Block Diagram of Numerical Relay – Numerical Over Current Protection – Numerical Transformer Differential Protection – Numerical Distance Protection of Transmission Line – Arc Flash Relays – Shielded Solid Insulation Switchgear – Green Switchgear.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Badri Ram & Vishwakarma D.N, "Power System Protection and Switchgear", 2nd Edition, Tata McGraw Hill, New Delhi, 2017.
2. Gupta J.B, "A Course in Power Systems", 11th Edition, S.K.Kataria & Sons, New Delhi, 2021.

REFERENCES:

1. Uppal, "Electrical Power" Khanna Publisher, 13th Edition., 2008.
2. Y.G Paithankar and S.R Bhide, "Fundamentals of power system protection", Prentice Hall of India, 2nd ed., Learning private limited, 2010.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2	3												3	
3		2											3	
4	3													
5									3		3	3		
CO (W.A)	3	2							3		3	3	3	

22EEC18 - ELECTRIC DRIVES AND CONTROL				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : 22EEC06, 22EEC09

Course Objective:	• To provide knowledge on the process of learning fundamental concept of various electrical drive systems to the students. • To Apply power electronic converters to control the speed of DC motors. • To give exposure to understand the various speed control techniques and converter topologies for induction motor drives. • To acquire knowledge on digital control and the selection of drives for industrial drive applications. • To understand Transfer function for DC motor / load and analyze current and speed controllers

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the essential concept of electric drives to load and predict the speed of DC and induction motor with different power electronic converters.	Ap	30%
CO2	Analyze the speed control of DC and induction motor drive with different converter topologies used to achieve desired speed and torque characteristics.	An	20%
CO3	Apply electric drive systems with scalar and vector control technique with appropriate braking systems and control the motor speed with recent digital techniques.	Ap	30%
CO4	Design and develop the transfer function for DC motor / load, current, speed controllers and equation for motor load dynamics considering factors such as inertia, damping, and friction.	Ap	20%
CO5	Perform in independent or team and make an oral presentation on selection drive for industrial application based on technical, economic, and operational criteria, demonstrating analytical skills and decision-making ability.	U	Internal Assessment(Seminar, On Line Quiz)

UNIT I- INTRODUCTION TO DRIVES	(9)
Electrical drives: Basic Elements, Types, Factors influencing the choice of electrical drives- Multiquadrant operation -Equations governing motor load dynamics - Components of load torque – Nature and classification of load torque – Modes of operation -Classes of motor duty – Determination of motor rating- Braking.	
UNIT II - UNIT II – CONVENTIONAL AND SOLID STATE SPEED CONTROL OF D.C. DRIVES	(9)
Speed control of DC series and shunt motors – Armature and field control- Ward-Leonard control system – Steady state analysis of the single and three phase converter fed separately excited DC motor drive –4 quadrant operations of converter / chopper fed drive.	

UNIT III – CONVENTIONAL AND SOLID STATE SPEED CONTROL OF A.C. DRIVES	(9)
Speed control of three phase induction motor – Voltage control- voltage / frequency control – Constant airgap flux – Field weakening mode –AC voltage Regulator- Voltage / current fed inverter – Rotor control – Rotor resistance control and slip power recovery schemes- vector control of induction motor drives.	
UNIT IV – DIGITAL CONTROL TECHNIQUES IN SPEED CONTROL OF DRIVES AND SELECTION OF DRIVES	(9)
Digital techniques in speed control - Advantages and limitations - Microcontroller based control of drives – Microprocessor based control of drives-PLC Based drives. Selection of drives for textile mills, cement mills, steel rolling mills and paper mills-Case study.	
UNIT V – DESIGN OF CONTROLLERS FOR DRIVES	(9)
Transfer function for DC motor / load and converter – Closed loop control with Current and speed feedback– Design of controllers; current controller and speed controller- converter selection and characteristics.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Dubey G.K., "Fundamentals of Electrical Drives", Second Edition, Narosa Publishing House, New Delhi, 2015
2. Bose, B.K., —Modern Power Electronics and AC Drives", Pearson Education (Singapore) Pvt.. Ltd, New Delhi, 2016.

REFERENCES:

1. Vedam Subramanyam, - Electric Drives: Concepts and Applications, Second Edition, Tata McGraw hill Pvt. Ltd, New Delhi, 2011.
2. Krishnan R, — Electric Motor Drives: Modeling, Analysis and Control, Prentice Hall of India, Pvt. Ltd, New Delhi,2015.
3. S.K.Pillai, "A First Course on Electrical Drives", Third Edition, New Age International Publishers, 2013.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	1
2	3	3											2	1
3	3												2	1
4			3											
5						3			2	2		2	2	
CO (W.A)	**3**	**3**	**3**			**3**			**2**	**2**		**2**	**2**	**1**

22EEP09 - POWER SYSTEM SIMULATION LABORATORY

L	T	P	C
0	0	4	2

PRE-REQUISITE : 22EEC11, 22EEC14

Course Objective:	• To acquire the capability to develop programs proficiently for the formation of bus admittance and impedance matrices in the power system. • To develop proficiency in programming techniques to computation line parameters and stability of the power systems. • To gain the ability of computational programs for load flow analysis utilizing the Gauss-Seidel, Newton-Raphson, and fast decoupled methods.

Course Outcomes The Student will be able to		**Cognitive Level**
CO1	Apply the mathematical approach for the solution of bus and impedance matrices.	Ap
CO2	Analyze and provide the solution for symmetrical and unsymmetrical faults.	An
CO3	Analyze and solve the sudden disturbance for power system stability.	An
CO4	Analyze and solve the problem by using load flow analysis iterative methods.	An
CO5	Implement the programming skill in industry-standard simulation software.	C

LIST OF EXPERIMENTS :

1. Formation of bus admittance Matrices and solution of networks.
2. Computation of parameters and modeling of transmission lines.
3. Formation of Bus Impedance Matrices and Solution of Networks.
4. Transient stability analysis of single-machine infinite bus system.
5. Transient stability analysis of multi-machine power systems.
6. Electromagnetic transients in power systems.
7. Fault analysis – symmetrical short circuit analysis.
8. Fault analysis – unsymmetrical short circuit analysis.
9. Solution of load flow problems using Gauss-Seidel method.
10. Solution of load flow related problems using Newton-Raphson and fast-decoupled methods.

ADDITIONAL EXPERIMENTS:

1. Development of 11KV/433 V substation automation scheme using programmable logic controller for normal load operation.
2. Relay coordination using Arduino.

TOTAL (P:60) = 60 PERIODS

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1				3	3								2	
2				3	3								2	
3			3	3	3								2	
4			3	3	3								2	
5				3	3							3	2	
CO (W.A)			**3**	**3**	**3**							**3**	**2**	

22GEA01 UNIVERSAL HUMAN VALUES (For Common To All Branches)				
	L	T	P	C
	2	0	0	2
PRE-REQUISITE : NIL				
Course Objective:	• To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity. • To facilitate the development of a holistic perspective among students towards life and profession. • To highlight plausible implications of holistic understanding in terms of ethical human conduct. • To understand the nature and existence. • To understand human contact and holistic way of living			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Evaluate the significance of value inputs in formal education and start applying them in their life and profession.	E	Internal Assessment
CO2	Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual.	Ap	
CO3	Analyze the value of harmonious relationship based on trust and respect in their life and profession.	An	
CO4	Examine the role of a human being in ensuring harmony in society and nature.	Ap	
CO5	Apply the understanding of ethical conduct to formulate the strategy for ethicallife and profession.	Ap	

UNIT I: Introduction-Basic Human Aspiration, its fulfillment through All-encompassing Resolution	(6)
The basic human aspirations and their fulfillment through Right understanding and Resolution, Right understanding and Resolution as the activities of the Self, Self being central to Human Existence; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution	
UNIT II: Right Understanding (Knowing)- Knower, Known & the Process	(6)
The domain of right understanding starting from understanding the human being (the knower, the experiencer and the doer) and extending up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).	

UNIT III: Understanding Human Being	(6)
Understanding the human being comprehensively as the first step and the core theme of this course; human being as co-existence of the self and the body; the activities and potentialities of the self; Basis for harmony/contradiction in the self	
UNIT IV: Understanding Nature and Existence	(6)
A comprehensive understanding (knowledge) about the existence, Nature being included; the need and process of inner evolution (through self-exploration, self- awareness and self-evaluation), particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).	
UNIT V: Understanding Human Conduct, All-encompassing Resolution and Holistic Way of Living	(6)
Understanding Human Conduct, different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with All- encompassing Resolution covering all four dimensions of human endeavor viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from Self to Nature and entire Existence	
TOTAL (L:30) : 30 PERIODS	

TEXT BOOKS

1. R R Gaur, R Asthana, G P Bagaria, 2019 (2nd Revised Edition), A Foundation Course inHuman Values and Professional Ethics. ISBN 978-93-87034-47-1, Excel Books, New Delhi

REFERENCES:

1. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins,USA
2. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986, 1991
4. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III,1972, Limits to Growth – Club of Rome's report, Universe Books.
5. A Nagraj, 1998, Jeevan Vidya EkParichay, Divya Path Sansthan, Amarkantak.
6. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
7. A N Tripathy, 2003, Human Values, New Age International Publishers
8. E G Seebauer& Robert L. Berry, 2000, Fundamentals of Ethics for Scientists &Engineers, Oxford University Press
9. M Govindrajran, S Natrajan& V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
10. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati
11. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books
12. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008.

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1						2	2	3	2	2		3		
2						2	2	3	2	2		3		
3						2	2	3	2	2		3		
4						2	2	3	2	2		3		
5						2	2	3	2	2		3		
CO (W.A)						**2**	**2**	**3**	**2**	**2**		**3**		

22GED02 – INTERNSHIP / INDUSTRIAL TRAINING				
	L	T	P	C
	0	0	0	2

PRE-REQUISITE : NIL

Course Objective:	• To obtain a broad understanding of the emerging technologies in Industry • To gain knowledge about I/O models.

Course Outcomes The Student will be able to		**Cognitive Level**
CO1	Engage in Industrial activity which is a community service.	U
CO2	Prepare the project report, three minute video and the poster of the work.	Ap
CO3	Identify and specify an engineering product that can make their life comfortable.	An
CO4	Prepare a business plan for a commercial venture of the proposed product, together with complying to relevant norms.	Ap
CO5	Identify the community that shall benefit from the product.	E

During semester breaks, students are encouraged to engage in industrial training or undergo internship in an industry related to the field of study. The duration of the activity shall be of 4 to 6 weeks. The work carried out in the semester break is assessed through an oral seminar accompanied by a written report. It is expected that this association will motivate the student to develop simple Electronic (or other) products to make their life comfortable and convert new ideas into projects.

Every student is required to complete 12 to 16 weeks of internship (with about 40 hours per week), during the Summer/Winter semester breaks. The Internships are evaluated through Internship Reports and Seminars during the VI and VIII semesters. The internships can be taken up in an industry, a government organization, a research organization or an academic institution, either in the country or outside the country, that include activities like:

- Successful completion of Internships/ Value Added Programs/Training
- Programs/ workshops organized by academic Institutions and Industries
- Soft skill training by the Placement Cell of the college
- Active association with incubation/ innovation /entrepreneurship cell of the
- institute;
- Participation in Inter-Institute innovation related competitions like Hackathons
- Working for consultancy/ research project within the institutes

- Participation in activities of Institute's Innovation Council, IPR cell, Leadership
- Talks, Idea/ Design/ Innovation contests
- Internship with industry/ NGO's/ Government organizations/ Micro/ Small/
- Medium enterprises
- Development of a new product/ business plan/ registration of a start-up

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1						2								
2										3				
3		1												
4							2	3			2			
5						2								
CO (W.A)		**1**				**2**	**2**	**3**		**3**	**2**			

22EED01- Project Work - I					
		L	T	P	C
		0	0	20	10
PRE-REQUISITE : NIL					
Course Outcomes The Student will be able to		**Cognitive Level**		**Weightage of COs in End Semester Examination**	
CO1	Engage in independent study to research literature in the identified area and consolidate the literature search to identify and formulate the engineering problem.	Ap		20 % - First Review (Internal)	
CO2	Prepare the Gantt Chart for scheduling the project , engage in budget analysis, and designate responsibility for every member in the team and identify the community that shall benefit through the solution to the identified research work and also demonstrate concern for environment	Ap, E		20 % - Second Review (Internal)	
CO3	Identify, apply the mathematical concepts, science concepts, and engineering concepts necessary to implement the identified engineering problem, select the engineering tools /components required to reproduce the identified project, design, implement, analyze and interpret results of the implemented project	Ap, An, C		20 % - Third Review (External)	
CO4	Engage in effective written communication through the project report, the one-page poster presentation, and preparation of the video about the project and the four page IEEE format of the work and effective oral communication through presentation of the project work and demonstration of the project.	E		20 % - Third Review (External)	
CO5	Perform in the team, contribute to the team and mentor/lead the team, demonstrate compliance to the prescribed standards/ safety norms and abide by the norms of professional ethics and clearly specify the outcome of the project work (leading to start-up/ product/ research paper/ patent)	Ap, An		20 % - Third Review (External)	

DESCRIPTION
Project work may be allotted to a single student or to a group of students not exceeding 3 per group. The title of project work is approved by head of the department under the guidance of a faculty member and student(s) shall prepare a comprehensive project report after completing the work to the satisfaction of the guide. The Head of the department shall constitute a review committee for project work. There shall be three reviews during the semester by the committee to review the progress. Student(s) shall make presentation on the progress made by him / her / them before the committee and evaluation is done as per Rules and Regulations
TOTAL (P: 120) = 120PERIODS

Mapping of COs with POs / PSOs														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1		3										3	3	3
2						3	3				3		3	3
3	3	3	3	3	3								3	3
4								3		3			3	3
5									3		3	3	3	3
CO (W.A)	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

22EEX01- POWER SWITCHING CONVERTERS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE: NIL

Course Objectives:	• To equip students with the knowledge and skills to apply the operation and performance of converters and inverters in power switching applications. • To develop students' ability to analyze DC-DC converters and calculate performance parameters of modern inverters under various operating modes. • To enable students to apply concepts of single-phase and three-phase converters and inverters effectively.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the operation and performance of converters and inverters in power switching applications.	Ap	30%
CO2	Analyze the DC-DC converters and calculate performance parameters of modern inverters under various operating modes.	An	25%
CO3	Apply the concept of single and three phase converters and inverters.	Ap	25%
CO4	Design and simulate the power converters.	An	20%
CO5	Achieve as an independent learner in a team to build an authentic application of power converter paradigm model using discrete components and make an effective oral presentation.	U	Internal Assessment (Seminar)

UNIT I - SINGLE PHASE & THREE PHASE CONVERTERS	(9)
Principle of phase-controlled converter operation – Single-phase full converter and semi-converter (RL, RLE load) – Single phase dual converter – Three phase operation full converter and semi converter (R, RL, RLE load) – Power factor improvement techniques – PWM rectifiers.	
UNIT II - DC-DC CONVERTERS	(9)
Limitations of linear power supplies – Switched mode power conversion – Non-isolated DC- DC converters: Operation and analysis of Buck, Boost, Buck-Boost, Cuk and SEPIC – Under continuous and discontinuous operation – Isolated converters: Basic operation of Flyback, Forward and Push pull topologies.	
UNIT III - DESIGN OF POWER CONVERTER COMPONENTS	(9)
Introduction to magnetic materials- Hard and soft magnetic materials – Design of transformer –Inductor design equations – Examples of inductor design for buck/flyback converter-selection of output filter capacitors – Selection of ratings for devices – Input filter design.	

UNIT IV - THREE PHASE INVERTERS	(9)
180-degree and 120-degree Conduction Mode Inverters with Star and Delta-Connected Loads – Voltage Control of Three-phase Inverters: Single, Multi-pulse, Sinusoidal, and Space Vector Modulation Techniques – AC Drive System – Current Source Inverters.	
UNIT V - MODERN INVERTERS	(9)
Multilevel Concept and Types; Diode Clamped, Flying Capacitor, and Cascaded - Comparison of Multilevel Inverters - Application of Multilevel Inverters – PWM Techniques for MLI – Single-phase & Three-phase Impedance Source Inverters – Filters.	
TOTAL (L:45)= 45 PERIODS	

TEXT BOOKS:

1. Rashid M.H., "Power Electronics Circuits, Devices and Applications", Pearson, Fourth Edition, 10th Impression 2021.
2. Philip T. Krein, "Elements of Power Electronics" Indian edition Oxford University Press-2017.

REFERENCES:

1. Jai P. Agrawal, "Power Electronics System Theory and Design", Pearson Education, First Edition, 2015.
2. Ned Mohan, T.M. Undeland and W.P. Robbins, "Power Electronics: Converters, Application and Design", 3rd edition Wiley, 2007.
3. P.C. Sen, "Modern Power Electronics", S. Chand Publishing 2005.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2												1	
2	3												1	
3		3											1	
4			3										1	
5									3	3		3		
CO (W.A)	2.5	3	3						3	3		3	1	

22EEX02- SPECIAL ELECTRICAL MACHINES				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To understand the construction, working principle, types and torque prediction of synchronous reluctance motor, stepper motor, switched reluctance motor, permanent magnet brushless DC motor and synchronous motor with applications. • To analyze the movement of motors step by step using microprocessor and power controllers.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the torque prediction theory in various motors with different features, phasor diagram, driver circuits and operations of special electrical machines.	Ap	40%
CO2	Apply the various types of special electrical machines in real time applications.	Ap	20%
CO3	Analyze the ideas about the performance characteristics of various special electrical machines and examine the closed loop operation.	An	15%
CO4	Design a power controller circuit for a given parameters to evaluate the characteristics.	Ap	25%
CO5	Achieve as an independent learner in a team to build an authentic applications of special electrical machines paradigm model using different controllers and make an effective oral presentation.	C	Internal Assessment (Seminar)

UNIT I - SYNCHRONOUS RELUCTANCE MOTORS	(9)
Constructional features – Types: Axial and Radial flux motors – Operating principles – Variable Reluctance and Hybrid motors – Voltage and Torque equations – Phasor diagram – Characteristics – Applications.	
UNIT II - STEPPING MOTORS	(9)
Constructional features – Principle of operation – Types – Theory of torque predictions – Modes of excitations – Characteristics – Drive circuits – Microprocessor control of stepping motors – Closed-loop control – Applications.	
UNIT III - SWITCHED RELUCTANCE MOTORS	(9)
Constructional features – Principle of operation – Torque prediction – Power converters and their controllers – Methods of rotor position sensing – Closed-loop control of SRM – Characteristics – Applications.	

UNIT IV - PERMANENT MAGNET BRUSHLESS D.C. MOTORS	(9)
Permanent Magnet materials and it's characteristics – Principle of operation – Types – EMF and Torque equations – Electronic commutator – Power controllers – Motor characteristics and control – Applications.	
UNIT V - PERMANENT MAGNET SYNCHRONOUS MOTORS	(9)
Principle of operation – EMF and Torque equations – Sine wave motor with practical windings – Phasor diagram – Torque/Speed characteristics – Power controllers – Converter Volt-Ampere requirements – Applications.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Bilgin, Berker Emadi, Ali Jiang, James Weisheng - Switched reluctance motor drives: fundamentals to applications- CRC 2019.
2. R. Krishnan - Switched Reluctance Motor Drives Modeling, Simulation, Analysis, Design, and Applications - CRC Press 2017.

REFERENCES:

1. E.G. Janardanan, "Special Electrical Machines," PHI learning Private Limited, Delhi, 2014.
2. R. Krishnan, "Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application," CRC Press, New York, 2014.
3. T. Kenjo, "Stepping Motors and Their Microprocessor Controls," 3rd Edition, Oxford University Press, New Delhi, 2009.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2	2												3	
3		2											3	
4	3													
5									3		3	3		
CO (W.A)	2.6	2							3		3	3	3	

22EEX03- DESIGN OF ELECTRICAL MACHINES				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To study Design considerations, Electrical engineering materials and rating of various electrical machines. • To realize the design procedures of armature and field systems for DC machines. • To understand the design procedures of yoke, core and windings, tank and cooling systems of transformers. • To grasp the design procedures of stator and rotor of induction motors. • To comprehend the design procedures of stator and rotor of synchronous machines.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the general concepts and constraints in the design of electrical DC and AC machines including economic aspects considerations.	Ap	20%
CO2	Apply the knowledge of fundamental principles, factors, electrical engineering materials and use of existing tools for the design of electrical machines.	Ap	20%
CO3	Analyze the effect of dimensions of the different parts of various electrical machines on the output and losses.	An	20%
CO4	Design the dimensions of different parts and details of winding of electrical DC and AC machines.	C	40%
CO5	Collaborate with team members and learn independently to create solutions using effective engineering tools and develop mini projects that meet requirements of real-world Electrical machine design applications.	C	Internal Assessment (Industry Person)

UNIT I- FUNDAMENTAL ASPECTS OF ELECTRICAL MACHINE DESIGN	(9)
Major considerations in Electrical Machine Design – Electrical Engineering Materials – Space factor –Choice of Specific Electrical and Magnetic loadings – Thermal considerations - Heat flow – Temperature rise-Rating of machines – Standard specifications – Introduction to Computer Aided Design.	
UNIT II – DC MACHINES	(9)
Output Equations – Main Dimensions - Magnetic circuit calculations – Carter's Coefficient –Net Length of Iron – Real & Apparent flux densities – Selection of number of poles - Design of Armature - Design of Commutator and brushes - Design of Field.	

UNIT III – TRANSFORMERS	(9)
Output Equations – Main Dimensions – KVA output for single and three phase transformers–Window space factor – Design of yoke, core and winding for core and shell type transformer – Estimation of No load current –Temperature rise in Transformers–Design of Tank and cooling tubes.	
UNIT IV – THREE PHASE INDUCTION MOTORS	(9)
Output equation of Induction motor – Main dimensions – Design of Stator – Length of Air gap – Design of squirrel cage rotor and wound rotor – Operating Characteristics: Magnetizing current and Short circuit current.	
UNIT V – THREE PHASE SYNCHRONOUS MACHINES	(9)
Output equations – choice of loadings – Design of salient pole machines – Runaway speed - Short circuit ratio –shape of pole face – Armature design – Estimation of Air gap length – Design of rotor –Design of damper winding – Determination of full load field MMF – Design of field windings – Design of Turbo alternators.	
TOTAL = 45 PERIODS	

TEXT BOOKS:

1. "A Course in Electrical Machine Design" by A.K. SAWHNEY, Dhanpat Rai & Co. (P) LTD, 6th Edition, Educational and Technical Publishers, Reprint: 2019.
2. "Design of Electrical Machines" by K.G.Upadhaya, New Age International Publishers, New Delhi 2017.

REFERENCES:

1. "Electrical Machine Design" by R.K.Agarwal, S.Kataria & Sons, 5th Edition, New Delhi Reprint, 2014.
2. "Design of Electrical Machines" by Mittle V N, Mittle A, Standard Publishers Distributors, 5th Edition, New Delhi, 2013.
3. "Principles of Electrical machine Design" by S.K.Sen, 3rd Edition, Oxford & IBH publishing Co. Pvt. Ltd., 13th September 2014.

Mapping of COs with POs / PSOs

COs	Pos												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2													
2	3				2									
3		3												
4			3										3	2
5					2				2			2		2
CO (W.A)	**2.5**	**3**	**3**		**2**				**2**			**2**	**3**	**2**

22EEX04-ANALYSIS OF INVERTERS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To understand the various operating modes of different configurations of power converters • To impart knowledge on voltage source and current source inverter • To Understand the topology of Z-source networks in power electronic systems. • To explore different resonant pulse inverter topologies and configurations • To impart knowledge on multilevel inverters and modulation techniques

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Analyze the concept of various types of inverters and sketch their characteristics.	An	30%
CO2	Apply problem- solving skills in addressing challenges related to Z- source inverter design and operation and evaluate the performance and efficiency of resonant pulse inverters in various operating conditions	Ap, E	20%
CO3	Analyze the operation of single-phase circuit and harmonics in the inverter circuits.	An	30%
CO4	Design the inverters for generic loads and machine loads	C	20%
CO5	Perform as an independent learner in a team to build an authentic application of inverters paradigm model using discrete components and make an effective oral presentation.	C	Internal Assessment (Assignment/Seminar)

UNIT I- SINGLE PHASE INVERTERS	(9)
Introduction – principle of operation – performance parameters – single phase half bridge inverters – single phase full bridge inverter – single phase series inverter – single phase parallel inverter - modified McMurray inverter– McMurray bedford half bridge and full inverter-voltage control of single phase inverters	
UNIT II – THREE PHASE VOLTAGE SOURCE AND CURRENT SOURCE INVERTER	(9)
Three phase bridge inverter with 180° and 120° mode of operation – voltage control of three phase inverters - analysis of single phase and three phase auto sequential current source inverter - current source bridge inverter–harmonic elimination techniques	

UNIT III - Z-SOURCEINVERTERS	(9)
Comparison with VSI and CSI-principle of operation, equivalent circuit and analysis. Introduction to Quasi Z- source inverter-basic topology-Extended boost quasi Z- source inverter topologies	
UNIT IV - RESONANT PULSE INVERTERS	(9)
Introduction – series resonant inverters with unidirectional and bidirectional switches – parallel resonant inverters– class e resonant inverter - zero current switching resonant converter – zero voltage switching resonant converter– two quadrant ZVS resonant converter – resonant dc link inverter	
UNIT V – MULTILEVEL INVERTERS	(9)
Multilevel concept – types – diode clamped – flying capacitor – cascade h bridge multilevel inverters- 3 level- 5 level - comparison of multi-level inverters - applications of multilevel inverters	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Rashid M.H, „Power Electronics – Circuits, Devices & Applications", 4th edition, Pearson Education, 2017.
2. P.S.Bimbra, "Power Electronics", Khanna Publishers, 7th Edition, 2022.

REFERENCES:

1. Fang Lin luo, Hong Ye, "Advanced DC/AC Inverters: Applications in Renewable Energy" CRC press, Taylor and Francis Group, 2013.
2. Mohan .N, Undeland & Robbins, "Power Electronics – Converters, Application & Design", John Wiley & Sons, Inc, 3rd Edition, Newyork, 2002.
3. P.C Sen, "Modern Power Electronics", S.Chand Ltd., 2nd Edition, 2005.
4. M.D. Singh & K.B. Khanchandani, "Power Electronics", Tata Mc Graw Hill Publishing Company Limited, 2nd edition, 2017.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1		3											2	2
2	2			2									3	
3		3											2	3
4			2										3	2
5				2					2	2		1		
CO (W.A)	2	3	2	2					2	2		1	2.5	2.3

22EEX05- WIND AND SOLAR ENERGY SYSTEMS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To study the concepts of wind energy system • To understand the new developments in solar energy system • To motivate the students to design solar based projects. • To provide students with a solid foundation in mathematical, scientific and engineering fundamentals required to solve wind and solar energy problems

Course Outcomes The student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Analyze the nature, occurrence, and characteristics of wind and solar energy system	An	30%
CO2	Apply optimization techniques such as Maximum Power Point Tracking (MPPT) in PV system design	Ap	30%
CO3	Analyze the performance of PV models and equivalent circuits, under different environmental conditions	An	20%
CO4	Design basic photovoltaic systems for power generation, including power conditioning and storage.	C	20%
CO5	Use advanced tools to simulate the performance of photovoltaic systems, adhere to ethical standards in the development and deployment of PV systems, work collaboratively to address technical issues and optimize the performance of hybrid wind and PV systems	Ap	Internal Assessment (Assignment/Quiz)

UNIT I – WIND ENERGY CONVERSION	(9)
Wind resources – Nature and occurrence of wind – Power in the wind – Wind characteristics – Principles of wind energy conversions – Components of wind energy conversion system (WECS) – Classification of WECS – Advantages and disadvantages of WECS.	
UNIT II – WIND ELECTRIC GENERATORS	(9)
Characteristics of Induction generators – Permanent magnet generators – Single phase operation of induction generators – Doubly fed generators – Grid connected and standalone systems – Controllers for wind driven self-excited systems and capacitor excited isolated systems – Synchronized operation with grid supply – Real and reactive power control.	
UNIT III - PHOTO VOLTAIC MODELS	(9)
Solar cells and panels – Structure of PV cells – Semiconductor materials for PV cells – I-V characteristics of PV systems – PV models and equivalent circuits- Effects of irradiance and temperature on PV characteristics.	

UNIT IV - PHOTO VOLTAIC ENERGY CONVERSION SYSTEM	(9)
Introduction to PIC microcontrollers-Overview and features-PIC 16FXX architecture- Memory organization - Register File Structure-Timer module-CCP module – Addressing Modes-Classification of instructions.	
UNIT V – RECENT ADVANCEMENTS IN WIND AND PV SYSTEMS	(9)
Wind farms and grid connections – Grid related problems on absorption of wind – Grid interfacing arrangement – Operation, control and technical issues of wind generated electrical energy – Interconnected operation – Hybrid systems. Recent Advances in PV Applications: Building Integrated PV systems, Grid Connected PV systems, Hybrid systems, Solar cars, Solar energy storage system and their economic aspects.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Ashish Chandra and Taru Chandra, Non-conventional Energy Resources, 2nd Edn., Khanna Publishers, 2021.
2. B.H. Khan, "Non-conventional Energy Resources", Tata McGraw Hill Education India Pvt. Ltd., Third Edition, 2017.

REFERENCES:

1. G.N. Tiwari, "Solar Energy: Fundamentals, Design, Modeling & Application", Narosa Publishing House, 2013.
2. D.S.Chauhan, S.K. Srivastava, "Non – Conventional Energy Resources", 3rd Ed.,New Age Publishers, 2012.
3. D.P.Kothari and K.C.Singhal,"RenewableEnergy Sources and Emerging Technologies", P.H.I. 2nd Ed., 2011.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1		3											1	3
2	3												1	2
3		2											1	2
4			2										1	2
5	3				2			1	1				1	3
CO (W.A)	3	2.5	2		2			1	1				1	2.4

22EEX06- IoT FOR SMART SYSTEMS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To familiarize the accessories and communication techniques of Internet of Things for smart systems. • To provide insight about the embedded processor and sensors required for Internet of Things.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the architecture, different protocols and communication technologies used in IoT in smart systems.	Ap	30%
CO2	Apply different platforms, protocols and technologies available for IoT in smart grids.	Ap	30%
CO3	Analyze the concepts of IoT and the big data analytic and programming of IoT	An	20%
CO4	Develop the various wireless technologies, architecture and processors in IoT with case study.	Ap	20%
CO5	Implement IoT solutions for smart applications and give a presentation in a team.	U	Internal Assessment (Seminar, Quiz)

UNIT I - INTRODUCTION TO INTERNET OF THINGS	(9)
Introduction - Hardware and software requirements for IOT - Sensor and actuators - Technology drivers - Business drivers - Typical IoT applications - Trends and implications.	
UNIT II - IOT ARCHITECTURE	(9)
IoT reference model and architecture: Node Structure, Sensing, Processing, Communication, Powering, Networking – Topologies - Layer/Stack architecture - IoT standards - Cloud computing for IoT – Bluetooth: Bluetooth Low Energy beacons.	
UNIT III - PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT	(9)
PROTOCOLS: NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell. **Wireless technologies for IoT:** WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN.	

UNIT IV - IOT PROCESSORS	(9)
Services/ Attributes: Big data Analytics for IoT, Dependability, Interoperability, Security, Maintainability. **Embedded Processor for IoT:** Introduction to python programming – Building IoT with RASPERRY PI and Ardunio	
UNIT V - CASE STUDIES	(9)
Industrial IoT, Home Automation, Smart cities, Smart Grid.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Oliver Hersent , David Boswarthick and Omar Elloumi " The Internet of Things", Wiley,2016.
2. Lingyang Song/DusitNiyato/ Zhu Han/ Ekram Hossain," Wireless Device-to-Device Communications and Networks, CAMBRIDGE UNIVERSITY PRESS,2015.
3. Samuel Greengard, "The Internet of Things", The MIT press, 2015.

REFERENCES:

1. ArshdeepBahga and VijaiMadisetti : A Hands-on Approach "Internet of Things", Universities Press 2015.
2. Vijay Madisetti , ArshdeepBahga, "Internet of Things (A Hands on-Approach)", 2014.
3. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and sons, 2014.
4. Lars T.Berger and Krzysztof Iniewski, "Smart Grid applications, communications and security", Wiley, 2015.
5. UpenaDalal,"Wireless Communications & Networks,Oxford,2015.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2	3												3	
3		2											3	
4	2												3	
5									3			3		
CO (W.A)	**2.6**	**2**							**3**			**3**	**3**	

22EEX07 - MODERN POWER ELECTRONIC CONVERTERS

	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To impart knowledge about Switched mode DC power supplies and design of converter • To acquire knowledge on AC – DC converters Performance indices with design examples • To understand the multilevel inverter and its classification • To impart knowledge about matrix converter and its modulation techniques • To gain knowledge on soft switched converters

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Examine the different converters concept related to real time applications.	Ap	20%
CO2	Apply knowledge of mathematics, physics and electronics to obtain Switched mode DC power supplies design and AC-DC converters Performance indices with examples	AP	30%
CO3	Analyze the different multilevel inverter and matrix converter and its modulation techniques and arrive at suitable conclusions	An	30%
CO4	Build the converter using soft switching techniques to meet given specification using suitable power electronic components/ Engineering Tool	Ap	20%
CO5	Engage in independent study as a member of a team and make an effective oral presentation on the research article	U	Internal Assessment (Seminar, Assignment)

UNIT I - UNIT I- SWITCHED MODE POWER SUPPLIES (SMPS)	(9)
DC Power supplies and Classification - Switched mode dc power supplies: with and without isolation, single and multiple outputs - Closed loop control and regulation - Design examples on converter and closed loop performance.	
UNIT II - AC-DC CONVERTERS	(9)
Switched mode AC-DC converters - synchronous rectification - single and three phase topologies – switching techniques - high input power factor - reduced input current harmonic distortion - improved efficiency-with and without input-output isolation - Performance indices design examples.	

UNIT III - DC-AC CONVERTERS	(9)
Multi-level Inversion - concept, classification of multilevel inverters, Principle of operation, main features and analysis of Diode clamped, Flying capacitor and cascaded multilevel inverters; Modulation schemes.	
UNIT IV - AC-AC CONVERTERS WITH AND WITHOUT DC LINK	(9)
Matrix converters. Basic topology of matrix converter; Commutation – current path; Modulation techniques - scalar modulation, indirect modulation; Matrix converter as only AC-DC converter; AC-AC converter with DC link - topologies and operation - with and without resonance link - converter with dc link converter, Performance comparison with matrix converter with DC link converters.	
UNIT V – SOFT-SWITCHING POWER CONVERTERS	(9)
Soft switching techniques: ZVS, ZCS, quasi resonance operation - Performance comparison hard switched and soft switched converters - AC-DC converter -DC-DC converter - DC-AC converter - Resonant DC power supplies.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. M.H.Rashid, "Power Electronics Handbook", Academic press, New york, 2000.
2. Fang Lin Luo and Fang Lin Luo, "Advanced DC/DC Converters", CRC Press, NewYork, 2nd Edition,2017.
3. Marian P.Kazmierkowski, R.Krishnan and Frede Blaabjerg, "Control in Power Electronics- Selected Problem", Academic Press (Elsevier Science), 2002.

REFERENCES:

1. Issa Batarseh, "Power Electronic Circuits", John Wiley and Sons, Inc.2014.
2. Frede Blaabjerg and Zhe Chen, "Power Electronics for Modern Wind Turbines" Morgan & Claypool Publishers series, United States of America, 2006.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2												1	
2	3												1	1
3		3											2	1
4			3										2	1
5						1				1		1	1	1
CO (W.A)	2.5	3	3			1				1		1	1.4	1

22EEX11 - HIGH VOLTAGE ENGINEERING

L	T	P	C
3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To motivate students to learn about overvoltage and breakdown mechanisms • To Understand about the Generation and measurement of high voltage and high current

Course Outcomes The Student will be able to			**Weightage of COs in End Semester Examination**
CO1	Identify the various measurement techniques of high voltage and high currents.	Ap	20%
CO2	Apply the knowledge to comprehend high voltage and identify suitable dielectrics in various HV applications.	An	20%
CO3	Analyze the breakdown phenomenon and factors affecting HVAC and HVDC measurements.	An	40%
CO4	Develop and specify the suitable testing methods for the electrical power system equipment.	An	20%
CO5	Engage in independent study to make an effective presentation on real time applications of HVE concepts in power systems domain.	C	Internal Assessment (Seminar, Online Quiz)

UNIT I- OVER VOLTAGES IN ELECTRICAL POWER SYSTEM	**(9)**
Causes of over voltages and its effects on power system –Corona and its effects -Lightning Surges. Switching over voltages-Protection against over voltages, protection gaps, surge arresters	
UNIT II - DIELECTRIC BREAKDOWN	**(9)**
Gaseous breakdown in uniform and non-uniform fields – Corona discharges – Vacuum breakdown – Conduction and breakdown in pure and commercial liquids-Maintenance of oil Quality– Breakdown mechanisms in solid and composite dielectrics.	
UNIT III - GENERATION OF HIGH VOLTAGES AND HIGH CURRENTS	**(9)**
Generation of high AC voltages - Cascaded transformers -resonant transformer and tesla coil - Generation of high DC voltages -Rectifier - Cockroft Walton voltage multiplier circuit - Van de Graff Generator - Generation of impulse and switching surges – Marx circuit-generation of high impulse current - Tripping and control of impulse generators.	
UNIT IV - MEASUREMENT OF HIGH VOLTAGES AND HIGH CURRENTS	**(9)**
High Resistance with series ammeter – Dividers, Resistance, Capacitance and Mixed dividers – Peak Voltmeter, Generating Voltmeters - Capacitance Voltage Transformers-Electrostatic Voltmeters – Sphere Gaps - High current shunts- High voltage measurement using CRO	

UNIT V – HIGH VOLTAGE TESTING & INSULATION COORDINATION	(9)
High voltage testing of electrical power apparatus as per Indian standards – Power frequency, impulse voltage, Partial discharge and DC testing of Insulators-Circuit breakers –Bushing-Isolators and Transformers-Insulation Coordination	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. S.Naidu and V. Kamaraju, —High Voltage Engineering, Tata McGraw Hill, 6th ed., 2020
2. E. Kuffel and W.S. Zaengl, J.Kuffel, —High voltage Engineering fundamentals, Newnes 2nd ed., Elsevier, New Delhi, 2008.

REFERENCES:

1. L.L. Alston, High Voltage Technology, Oxford University Press, First Indian Edition, 2011.
2. C.L. Wadhwa, High voltage engineering, New Age International Publishers, 3rd ed., 2012.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2													
2		2											1	
3		3											1	
4		2											1	
5									3			3	1	
CO (W.A)	2	2.3							3			3	1	

22EEX12 - HVDC TRANSMISSION SYSTEMS

L	T	P	C
3	0	0	3

PRE-REQUISITE : NIL

Course Objective:

- To introduce students with the concept of HVDC Transmission system.
- To familiarize the students with the HVDC converters and their control system
- To expose the students to the harmonics and faults occur in the system and their prevention
- To learn the components used and role of power electronics involved for regulating the voltage angle and frequency for power flow and interconnection
- To enhance their learning domain by distinguishing the requirement of HVDC system over HVAC system.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Identify the fault and protection schemes in HVDC converters.	Ap	20%
CO2	Apply the knowledge of transmission technology for HVDC transmission over conventional AC transmission.	U	20%
CO3	Analyze the rectifier and inverter control methods for operation of conversion and obtain the control strategies of HVDC converter and its in systems.	An	40%
CO4	Demonstrate the appropriate protection schemes and Implement the multiterminal DC system in HVDC transmission system.	U	20%
CO5	Engage in self learning and work well as a team, giving an effective presentation related to HVDC converters.	U	Internal Assessment (Seminar, Online Quiz,)

UNIT I – INTRODUCTION (9)

Introduction of DC power transmission technology - comparison of AC and DC transmission- limitation of HVDC transmission, reliability of HVDC systems - application of DC transmission - description of DC transmission system - planning for HVDC transmission - modern trends in DC transmission.

UNIT II - ANALYSIS OF HDVC CONVERTERS (9)

Three-phase AC–DC Conversion, six pulse converter operation - Effect of Delaying the Firing Instant - The Commutation Process - Analysis of the Commutation Circuit - Analysis neglecting commutation overlap, Rectifier Operation - Inverter Operation - Power Factor and Reactive Power - Characteristic Harmonics, DC Side Harmonics - AC Side Harmonics - Twelve Pulse Converters operation - AC/DC side voltage and current waveforms - Expressions for average dc voltage.

UNIT III – CONTROL OF HVDC CONVERTER & SYSTEMS	(9)
HVDC system control, necessity of control in HVDC link - power reversal, Basic controllers - constant current and constant extinction - power control, high level controllers - Firing angle control- Individual phase control and equidistant firing angle control - Summary of converter control.	
UNIT IV – FAULT AND PROTECTION SCHEMES IN HVDC SYSTEMS	(9)
Nature and types of faults - faults on AC side of the converter stations - converter faults, fault on DC side of the systems - protection against over currents and over voltages - protection of filter units.	
UNIT V - MULTITERMINAL HVDC SYSTEMS	(9)
Types of multiterminal (MTDC) systems - parallel operation aspect of MTDC - Control of power in MTDC - Multilevel DC systems - Power upgrading and conversion of AC lines into DC lines - Parallel AC/DC systems - FACTS and FACTS converters.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Padiyar, K.R., 'HVDC transmission systems', New Age International Publisher , New Delhi, 4th edition 2023.
2. Kamakshaiah, S and Kamaraju, V, 'HVDC Transmission', 2nd Edition, McGraw Hill Education (India), New delhi 2020.

REFERENCES:

1. Arrilaga, J., 'High Voltage Direct Current Transmission', 2nd Edition, Institution of Engineering and Technology, London, 1998.
2. Vijay K. Sood, 'HVDC and FACTS Controllers', Kluwer Academic Publishers, New York, 2004.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1		2											1	
2	3												1	
3		3											1	
4			3										1	
5						1			1			1		
CO (W.A)	3	2.5	3			1			1			1	1	

22EEX13 - POWER QUALITY				
		L	T	P	C
		3	0	0	3
PRE-REQUISITE : NIL				
Course Objective:	• To provide knowledge on analysis of power quality and harmonic phenomena in electric power systems • To study various methods of power quality monitoring and impact on Harmonics			

Course Outcomes The Student will be able to			**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge to comprehend issues and concerns of power quality, classify, sketch and identify various power quality phenomena normal as well as abnormal	Ap	20%
CO2	Analyze power quality issues and interpret data presented through case studies for power quality issues and suggest suitable remedial measures.	An	20%
CO3	Identify the harmonic problems and design circuits to mitigate harmonic issues	An	40%
CO4	Measure using specialized equipment and collate data on loads that cause power quality problem	An	20%
CO5	Engage in independent study to make effective presentation and submit report on power quality issues	U	Internal Assessment (Seminar, Online Quiz)

UNIT I –INTRODUCTION	(9)
Power quality-Voltage quality- Overloading - Under voltage - Sustained interruption - Sags and swells - Waveform distortion - Total Harmonic Distortion (THD) - Computer Business Equipment Manufacturers Associations (CBEMA) curve– ITI curves.	
UNIT II - VOLTAGE SAGS AND INTERRUPTIONS	(9)
Sources of sags and interruptions - Estimating voltage sag performance - Motor starting sags - Estimating the sag severity - Mitigation of voltage sags - Active series compensators - Static transfer switches and fast transfer switches.	
UNIT III - OVERVOLTAGES	(9)
Sources of Transient Over voltages - Principles of Over voltage Protection - Capacitor switching - Lightning- Ferro resonance - Mitigation of voltage swells - Surge arresters - Low pass filters - Power conditioners – Lightning protection – Shielding - Line arresters - Protection of transformers and cables.	
UNIT IV - HARMONICS	(9)
Introduction –harmonics indices, inter harmonics, notching – voltage Vs current distortion – harmonics Vs transients – sources and effects of harmonic distortion – mitigation and control techniques– passive and active filters for harmonic reduction	

UNIT V – POWER QUALITY MONITORING	(9)
Monitoring considerations – Applications of expert systems for power quality monitoring - Assessment of power quality measurement data and power conditioning equipment's – Harmonic / Spectrum analyzer, Flicker meters and Disturbance analyzer.	
TOTAL = 45 PERIODS	

TEXT BOOKS:

1. Roger C. Dugan, Mark F. McGranaghan, H. Wayne Beaty, "Electrical Power Systems Quality", 3rd Edition, McGraw-Hill, New York, Reprint 2017.
2. Sankaran.C, "Power Quality", 1st Edition CRC Press, Washington, D.C., 2017.

REFERENCES:

1. J. Arrillaga, N.R. Watson, S. Chen, "Power System Quality Assessment", New York: Wiley, 2014.
2. M.H.J Bollen,"Understanding Power Quality Problems: Voltage Sags and Interruptions", New York: IEEE Press, 2011.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2												1	
2		2											1	
3		3												
4		2											1	
5									3	3		3		
CO (W.A)	3	2.3							3	3		3	1	

22EEX14 - POWER SYSTEM OPERATION AND CONTROL				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To apply the tools like load curve, load duration curve and load factor to estimate the future demand and to predict the reserve capacity. • To explain the hardware components required to design frequency control, voltage control, economic load dispatch and SCADA system for power system monitoring and control.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply various strategies of frequency and voltage control schemes to control real & reactive power.	Ap	20%
CO2	Model and analyze the control actions that are implemented to meet the minute-to minute variation of system real power demand.	An	20%
CO3	Analyze the operation and model static & dynamic characteristics of LFC and AVR of power system.	An	40%
CO4	Design the control area schemes to find the efficient economic dispatch problem for smooth operation of power system.	Ap	20%
CO5	Employ in updating the technical knowledge of power system control using modern tools & deliver the skills to the team whenever and wherever necessary to develop the societal needs.	U	Internal Assessment (Seminar, Assignment)

UNIT I - INTRODUCTION	(9)
Power scenario in Indian grid, Need for voltage and frequency regulation in power system, System load characteristics, load curves, Load-duration curve, load factor and diversity factor – Reserve requirements – Overview of power system operation: Load forecasting, unit commitment and load dispatching – Overview of power system control – Plant level and System level controls (block diagram approach only).	
UNIT II – REAL POWER – FREQUENCY CONTROL	(9)
Basics of speed governing mechanism and modeling – Speed-load characteristics – Load sharing in parallel operation – Control area concept – LFC control of a single-area system – Static and dynamic analysis of uncontrolled and controlled cases.	

UNIT III – REACTIVE POWER–VOLTAGE CONTROL	(9)
Generation and absorption of reactive power – Automatic Voltage Regulator (AVR): brushless AC excitation system - Block diagram representation of AVR loop – Static and dynamic analysis - Methods of voltage control: tap changing transformer, SVC (TCR + TSC).	
UNIT IV - UNIT COMMITMENT AND ECONOMIC DISPATCH	(9)
Statement of unit commitment problem – Constraints – Priority-list method – Forward dynamic programming, Formulation of economic dispatch problem – Input and output characteristics of thermal plant - Incremental cost curve – Coordination equations without and with loss (No derivation of loss coefficients) – Solution by direct method and λ-iteration method.	
UNIT V – COMPUTER CONTROL OF POWER SYSTEMS	(9)
Need for computer control of power systems – Concept of energy control centre – Functions – System monitoring – Data acquisition and control – System hardware configuration – SCADA and EMS functions – Various operating states – State transition diagram.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. V.Ramanathan, P.S.Manoharan, 'Power System Operation and Control' Third Edition, 2015, Charulatha Publications, Chennai.
2. Allen J Wood, Bruce F Wollenberg, Gerald B Sheble, "Power Generation Operation and Control", 2014, 3rd Edition, John Wiley Publication.

REFERENCES:

1. Olle. I. Elgerd, "Electric Energy Systems Theory – An Introduction", 2nd Edition, 46th reprint, McGraw- Hill Education, 2017
2. John J. Grainger, William D. Stevenson, Gary W. Chang, "Power System Analysis", 2016, McGraw-Hill Education.
3. Kundur, Prabha S, "Power System Stability and Control", 3rd edition, CRC Press, 2017

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2												
2		1											1	
3	1	3	1	2									3	3
4	2		3	2									3	3
5					2	1			2			2		2
CO (W.A)	2	2	2	2	2	1			2			2	2.3	2.6

22EEX15- FUNDAMENTALS OF ELECTRIC POWER UTILIZATION

L	T	P	C
3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To familiarize the students with the concept of electrical energy for heating and welding. • To enhance their learning domain by electric traction systems and their performance

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of electric drives concept in different traction effort.	Ap	20%
CO2	Analyze the illumination system for energy saving.	An	20%
CO3	Identify the processes, types, applications and characteristics of electric power utilization.	An	20%
CO4	Demonstrate the utilization of electrical energy for heating and welding purposes and Develop an energy efficient domestic appliance like fans and pumps for a specific household application.	Ap	40%
CO5	Hire in apprising the technical knowledge power utilization using modern tools & deliver the skills to the team to progress the societal needs.	U	Internal Assessment (Seminar)

UNIT I – ELECTRIC HEATING	(9)
Electric Heating – Advantages- Modes of heat transfer -Methods of Electric heating – Resistance heating – requirement of a heating element – design of heating element – Arc furnaces – Induction heating- Core type Induction Furnace and Coreless Induction furnace – Eddy current Heating	
UNIT II – ILLUMINATION	(9)
Introduction – Definition and meaning of terms used in illumination engineering – Laws of illumination, lighting calculations -Classification of light sources – Incandescent lamps, mercury vapour lamps, fluorescent lamps – Design of illumination systems – Indoor lighting schemes – Factory lighting halls – Outdoor lighting schemes – Flood lighting – Street lighting – Energy saving lamps, LED.	
UNIT III – WELDING	(9)
Welding – Welding processes – Types – Resistance welding – Arc welding – Power supply for arc welding - Electrodes for metal arc welding – Arc Welding machines – VI characteristics – DC welding machine with motor-generator set – AC Welding Machines, Types of Welding – TIG, MIG, MAG, resistance Welding, Spot Welding, Butt Welding, Projection Welding and Electron Beam Welding	

UNIT IV – ELECTRIC TRACTION	(9)
Traction system – Speed– Time characteristics – Series and parallel control of D.C motors – Open circuited, shunt and bridge transitions – Traction effort calculation – Electric braking – Tramways and trolley bus – A.C traction and its recent trends.	
UNIT V – FANS AND PUMPS	(9)
Fans – Types, Characteristics and Typical applications, Fan curves – Fan Laws – Flow Control Strategies – Energy Saving Opportunities in fans – Pumps: Types, System Characteristics, Pump curves – Flow control strategies – Energy Conservation opportunities in Pumps	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. J.B.Gupta, "Utilisation Electric power and Electric Traction", S.K.Kataria and Sons, Newdelhi 10th edition, 2019.
2. "Energy Efficiency in Electrical Utilities", Guide Book for National Certification Examination for energy managers and Auditors, 4th Edition, Bureau of Energy Efficiency,2015.

REFERENCES:

1. Taylor E. Openshaw, "Utilization of Electrical Energy", Universities Press, Hyderabad, 2012.
2. Partab.H, "Art and Science of Utilisation of Electrical Energy", Dhanpat Rai and Co, New Delhi, 2017.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2												1	
2		2											1	
3		2											1	
4	3												1	
5					3	3			3			3		
CO (W.A)	2.5	2			3	3			3			3	1	

22EEX16-ENERGY AUDITING CONSERVATION AND MANAGEMENT				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To Understand the fundamental principles and components of energy systems • To equip students with the knowledge and skills necessary to optimize the performance of electric motors • To provide the students with a comprehensive understanding of technologies involved in the management of energy in lighting systems • To gain a thorough knowledge of the basic principles of energy audit

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the fundamental energy scenario and energy management in electric motors, lighting system	Ap	30%
CO2	Apply and implement energy-efficient technologies in electrical systems	Ap	30%
CO3	Analyze and quantify energy consumption patterns in electric motor systems and optimize the performance of electric motors and drives	An	20%
CO4	Analyze energy audit processes including types of audits, methodology, energy costs, benchmarking, and performance optimization,	An	20%
CO5	Engage in self-learning, uphold ethical standards in the implementation of energy-efficient technologies and propose sustainable solutions to address energy challenges	U	Internal Assessment (Assignment/Seminar)

UNIT I- ENERGY SCENARIO	(9)
Introduction – primary and secondary energy – commercial and non-commercial Energy – renewable and non- renewable Energy – world renewable energy scenario, renewable energy scenario in India, energy needs of growing economy, energy and environment, energy conservation act 2001 and its importance, energy security, BEE star ratings-introduction to energy trading- electrical load analysis	

UNIT II - ENERGY MANAGEMENT IN ELECTRIC MOTORS	(9)
Introduction - losses in electric motors – motor efficiency – factors affecting motor performance – rewinding and motor replacement issues – energy saving opportunities with energy efficient motors – motor efficiency management.	

UNIT III - ENERGY MANAGEMENT IN LIGHTING	(9)
Light source, choice of lighting – luminance requirements – energy conservation methods – lighting energy management – day lighting – energy efficiency in lighting	
UNIT IV - ENERGY EFFICIENT TECHNOLOGIES IN ELECTRICAL SYSTEMS	(9)
Maximum demand controllers – automatic power factor controllers – energy efficient motors – soft starters with energy saver – variable speed drives – energy efficient transformers – electronic ballast – occupancy sensors, energy efficient lighting controls. energy saving potential of each technology- hybrid energy systems	
UNIT V – ENERGY AUDIT	(9)
Energy audit – necessity of energy audit – types of energy audit, methodology of energy audit - energy costs – benchmarking – energy performance and maximizing system efficiency, energy audit instruments – energy monitoring and targeting.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Stephen A. Roosa, Steve Doty, Wayne C. Turner, Energy Management Handbook, River Publisher, 9th Edition 2018.
2. Sonal Desai, Handbook of Energy Audit, McGraw-Hill Education, 2017.

REFERENCES:

1. Barney L. Capehart, Wayne C. Turner, and William J. Kennedy, "Guide to Energy Management", 8th Edition, River Publishers, Inc., 2016.
2. Amit K. Tyagi, "Handbook on Energy Audits and Management", The Energy and Resources Institute, 2003.
3. Larry C. Witte, Philip S. Schmidt & David R. Brown, "Industrial Energy Management & Utilization", Hemisphere Pub. Corp., 1988.

Mapping of COs with POs / PSOs

	POs												PSOs	
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3													
2	3												1	1
3		2											2	2
4		2											2	2
5						2	2	1				2		
CO (W.A)	**3**	**2**				**2**	**2**	**1**				**2**	**1.7**	**1.7**

22EEX17 - RESTRUCTURED POWER SYSTEM				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To understand the behavior of deregulated markets in power system. • To acquire knowledge the technical and non- technical issues in deregulated power industry. • To identify the methods of Local Marginal prices calculation in transmission and the function of financial transmission rights. • To Analyze the energy and ancillary services management in deregulated power industry • To Discriminate the restructuring framework US and Indian power sectors

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the various restructured power markets in congestion management and financial transmission networks.	Ap	30%
CO2	Predict the requirement for deregulation of the electricity market and the principles of market models in power systems.	Ap	20%
CO3	Analyze the methods of congestion management in deregulated power system and the locational marginal pricing and financial transmission rights and also the ancillary services management	An	30%
CO4	Propose the restructuring framework of US and Indian power sectors	Ap	20%
CO5	Engage in independent study as a member of a team and make an effective oral presentation on the applications of Restructured Power System concepts	U	Internal Assessment (Seminar, Assignment)

UNIT I- INTRODUCTION	(9)
Reasons for restructuring - Understanding the restructuring process - objectives of deregulation of various power systems across the world - Consumer behavior - Supplier behavior - Market equilibrium - Short-run and Long-run costs - Various costs of production. The Philosophy of Market Models: Market models based on contractual arrangements - Market architecture.	
UNIT II - TRANSMISSION CONGESTION MANAGEMENT	(9)
Importance of congestion management in deregulated environment - Classification of congestion management methods - Calculation of ATC - 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)
Fundamentals of locational marginal pricing - Lossless DCOPF model for LMP calculation - Loss compensated DCOPF model for LMP calculation - ACOPF model for LMP calculation - Risk Hedging Functionality of financial Transmission Rights - FTR issuance process - Treatment of revenue shortfall - Secondary trading of FTRs - Flow Gate rights - FTR and market power.	
UNIT IV- ANCILLARY SERVICE MANAGEMENT AND PRICING OF TRANSMISSION NETWORK	(9)
Types of ancillary services -Load-generation balancing related services - Voltage control and reactive power support services - Black start capability service - Mandatory provision of ancillary services - Markets for ancillary services - Co-optimization of energy and reserve services - International comparison. Pricing of transmission network: wheeling - principles of transmission pricing - transmission pricing methods - Marginal transmission pricing paradigm - Composite pricing paradigm - loss allocation methods.	
UNIT V – MARKET EVOLUTION	(9)
US markets: PJM market - The Nordic power market - Reforms in Indian power sector: Framework of Indian power sector - Reform initiatives - availability based tariff (ABT) - The Electricity Act 2012 - Open Access issues - Power exchange.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Mohammad Shahidehpour, Muwaffaq Alomoush,, "Restructured electrical power systems: operation, trading and volatility", Marcel Dekker Pub., 2001,. 1st Edition.
2. Kankar Bhattacharya, MathH.J.Boolen, and Jaap E.Daadler, "Operation of restructured power systems", Kluwer Academic Pub.,2001, 1st Edition.

REFERENCES:

1. Paranjothi, S.R., "Modern Power Systems The Economics of Restructuring", New Age International Publishers, First Edition: 2017.
2. Sally Hunt, "Making competition work In electricity", John Willey and Sons Inc.2002.

Mapping of COs with POs / PSOs

	POs												PSOs	
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2												2	1
2	3												2	1
3		3											2	1
4			3										2	1
5						1				1		1	1	1
CO (W.A)	**2.5**	**3**	**3**			**1**				**1**		**1**	**2**	**1**

22EEX18- FUNDAMENTALS OF FIBRE OPTICS AND LASER INSTRUMENTATION				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				

Course Objectives:	• To equip students with the knowledge and skills to apply the concepts of optical fibres, analyze their properties, and understand laser fundamentals with industrial applications. • To develop students' ability to analyze the theory and classification of fibre optics, evaluate fibre characteristics, and apply methods of Holographic Interferometry. • To demonstrate the application of laser instruments in medical surgeries, ensuring students understand the principles and safety considerations involved. • To foster independent learning and teamwork, encouraging students to give effective presentations and submit detailed reports on assigned topics related to fibre optics, laser instrumentation, and energy-saving opportunities in lighting systems.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the concepts of optical fibres with the properties and analyze about the laser fundamentals with industrial applications.	Ap	35%
CO2	Analyze the theory and classification of fiber optics and fibre characteristics with methods of Holographic interferometry.	An	25%
CO3	Demonstrate the application of laser instruments in medical surgeries.	Ap	20%
CO4	Describe the lighting systems, lighting design and appraise the energy saving opportunities in them.	An	20%
CO5	Engage in self-directed learning and work well as a team, giving an effective presentation and submitting a report on an assigned topic related to fibre optics and laser instrumentation.	U	Internal Assessment (Seminar)

UNIT I - OPTICAL FIBRES AND THEIR PROPERTIES	(9)
Theory and classification of fiber optics: Principles of light propagation through a fibre - Different types of fibres and their properties, fibre characteristics – Absorption losses – Scattering losses – Dispersion – Connectors and splicers – Optical sources – Optical detectors	
UNIT II - INDUSTRIAL APPLICATION OF OPTICAL FIBRES	(9)
Fibre optic sensors — Different types of modulators - fibre optic communication set up- Interferometric method of measurement of length – Moire fringes – Measurement of pressure, temperature, voltage, liquid level and strain.	

UNIT III - LASER FUNDAMENTALS	(9)
Fundamental characteristics of lasers – Three level and four level lasers – Properties of laser – Laser modes – Resonator configuration – Q-switching and mode locking – Cavity damping –-Types of lasers – Gas lasers, solid lasers, liquid lasers, semiconductor lasers.	
UNIT IV - INDUSTRIAL APPLICATION OF LASERS	(9)
Laser for measurement of velocity and Atmospheric effect – Material processing – Laser heating – Welding - Melting and trimming of material – Removal and vaporization.	
UNIT V - HOLOGRAM AND MEDICAL APPLICATIONS	(9)
Holography – Basic principle - Methods – Holographic Interferometry and application, Holography for non-destructive testing – Holographic components – Medical applications of lasers - Laser and tissue interactive – Laser instruments for surgery, removal of tumors of vocal cards, brain surgery, plastic surgery, gynaecology and oncology.	
TOTAL (L:45)= 45 PERIODS	

TEXT BOOKS:

1. R.P.Khare, Fiber Optics and Optoelectronics, Oxford university press, 2008.
2. J. Wilson and J.F.B. Hawkes, Introduction to Opto Electronics, Prentice Hall of India, 2001.

REFERENCES:

1. Asu Ram Jha, Fiber Optic Technology Applications to commercial, Industrial, Military and Space Optical systems, PHI learning Private limited, 2009.
2. M. Arumugam, Optical Fibre Communication and Sensors, Anuradha Agencies, 2002.
3. John F. Read, Industrial Applications of Lasers, Academic Press, 1978.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	2												
2	3												1	
3		3												
4			3											
5						1			1			1		
CO (W.A)	2.5	2.5	3			1			1			1	1	

22EEX21- FUNDAMENTALS OF ELECTRIC VEHICLES				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To familiarize the students with the concept of hybrid electric vehicle • To expose the students to acquire knowledge on the fundamentals of the vehicles • To enhance their learning domain by electric traction systems and their performance

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	To enhance their learning domain by electric traction systems and their performance	Ap	40%
CO2	Apply the distinct attributes of different motor drives in electric vehicles.	An	20%
CO3	Analyze the importance of energy storage systems in EVs.	An	15%
CO4	Design an electric vehicle based on the requirement	An	25%
CO5	Involve in a team to share the skills to develop a product required for the upliftment of society using the modern tools	Ap	Internal Assessment (Assignment, Online Quiz)

UNIT I - INTRODUCTION TO ELECTRIC VEHICLES	**(9)**
Importance of Different Transportation Development Strategies to Future Oil Supply – History of EVs- Components of Electric Vehicle- General Layout of EV-EV classification- Comparison with Internal combustion Engine: Technology, Advantages & Disadvantages of EV. Performance of EVs: Traction Motor Characteristics - Tractive Effort and Transmission Requirement - Vehicle Performance - Tractive Effort in Normal Driving - Energy Consumption.	
UNIT II – HYBRID ELECTRIC VEHICLES	**(9)**
Introduction to HEV- History-Concept of Hybrid Electric Drive Trains - Architectures of Hybrid Electric Drive Trains: Series Hybrid Electric Drive Trains (Electrical Coupling) - Parallel Hybrid Electric Drive Trains (Mechanical Coupling) - Hybrid Drive Trains with Both Torque and Speed Coupling	
UNIT III – POWER SOURCES AND ENERGY STORAGES	**(9)**
Electrochemical Batteries: Electrochemical Reactions - Thermodynamic Voltage - Specific Energy - Specific Power - Energy Efficiency - Battery Technologies - Lead–Acid Battery - Nickel-Based Batteries - Lithium-Based Batteries – Ultracapacitors - Ultra-High-Speed Flywheels - Hybridization of Energy Storage.	
UNIT IV – ELECTRIC PROPULSION SYSTEMS	**(9)**
Induction Motor Drives: Basic Operation Principles of Induction Motors - Power Electronic Control – Field Orientation Control - Voltage Source Inverter for FOC - Permanent Magnetic BLDC Motor Drives: Basic Principles of BLDC Motor Drives - BLDC Machine Construction and Classification - SRM Drives: Basic Magnetic Structure - Modes of Operation - Sensorless Control.	

UNIT V – DESIGN CONSIDERATION FOR ELECTRIC VEHICLE	(9)
Aerodynamic Considerations-Consideration of Rolling Resistance-Transmission Efficiency-Consideration of Vehicle Mass- Electric Vehicle Chassis and Body Design	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Iqbal Hussain., "Electric and Hybrid Vehicles: Design Fundamentals", 3rd Edition, CRC press, Taylor & Francis Group, Florida,United States, 2021.
2. MehrdadEhsani, YimiGao, Sebastian E. Gay, Ali Emadi, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design", 3rd Edition, CRC Press, 2018.

REFERENCES:

1. James Larminie, John Lowry, "Electric Vehicle Technology Explained", 2nd Edition, Wiley, 2012.
2. L.Ashok Kumar, and S.Albert Alexander, "Power Converters for Electric Vehicles", First Edition, CRC Press, 2020.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1														
2	3												3	
3		2											3	
4	3													
5									3		3	3		
CO (W.A)	**3**	**2**							**3**		**3**	**3**	**3**	

22EEX22 - BATTERY PACK MODELING AND CHARGING OF ELECTRIC VEHICLE

	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To introduce the fundamental principles of battery technology, including chemistry, components, and types commonly used in EVs. • To familiarize the functions, components, and architecture of Battery Management Systems. • To analyze and optimize battery pack design and performance.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply various technologies in charging infrastructure, protocols, efficiency and optimization in electric vehicles.	Ap	20%
CO2	Identify the factors influencing charging efficiency and the differences between series, parallel, and hybrid battery pack configurations and their applications in electric vehicles.	U	20%
CO3	Analyze the different technologies in the modeling of battery pack.	An	40%
CO4	Demonstrate knowledge of different battery chemistries used in electric vehicles and their respective advantages and limitations.	U	20%
CO5	Perform in team and make effective presentation on the topic related to real world challenges and requirements in battery pack modeling and charging electric vehicles.	U	Internal Assessment (Seminar, Online Quiz,)

UNIT I – INTRODUCTION TO ELECTRIC VEHICLES AND BATTERY TECHNOLOGY	(9)
Overview of electric vehicles: history, types, and applications - Basics of battery technology: chemistry, components, and types - Comparison of battery chemistries used in EVs - Introduction to battery pack architecture and design considerations.	
UNIT II - BATTERY PACK CONFIGURATION AND MANAGEMENT	(9)
Battery pack configuration: series, parallel, and hybrid configurations - Battery Management System (BMS): functions, components, and architecture - Cell balancing techniques and algorithms - State-of-Charge (SOC) and State-of-Health (SOH) estimation methods.	

UNIT III – CHARGING INFRASTRUCTURE AND PROTOCOLS	(9)
Overview of charging infrastructure: residential, public, and fast-charging networks - AC charging: principles, standards, and charging rates - DC fast charging: principles, standards (CHAdeMO, CCS), and high-power charging - Wireless charging technologies and standards.	
UNIT IV – CHARGING EFFICIENCY AND OPTIMIZATION	(9)
Charging efficiency: factors affecting charging efficiency and losses - Impact of charging on battery life: charge rate, temperature, and depth of discharge - Charging optimization techniques: peak/off-peak charging, smart charging algorithms - Vehicle-to-Grid (V2G) and Vehicle-to-Home (V2H) integration for energy management.	
UNIT V - BATTERY PACK MODELING AND ADVANCES IN BATTERY TECHNOLOGY	(9)
Mathematical modeling of battery cells and packs: equivalent circuit models, thermal models – Predictive modeling for charging time estimation and battery performance optimization - Emerging battery technologies: solid-state batteries, lithium-sulfur batteries - Battery pack design for specific applications of electric buses, commercial vehicles, drones - Future trends and developments in EV battery technology.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Christopher D. Rahn and Dan M. Ionel, "Battery Systems Engineering", Wiley-IEEE Press, 1st edition, 2013.
2. Sandeep Dhameja, "Electric Vehicle Battery Systems", CRC Press, 1st edition, 2015.

REFERENCES:

1. H.J. Bergveld, P.H.L. Notten, and P.H.L. Notten, "Battery Management Systems for Large Lithium-Ion Battery Packs", Artech House, 2010.
2. H.A. Kiehne, "Battery Technology Handbook", CRC Press, 2nd edition, 2018.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												1	3
2	1	2											1	1
3		3											1	
4			3										1	
5									1	1		1		
CO (W.A)	2	2.5	3						1	1		1	1	2

22EEX23 - HYBRID ELECTRIC VEHICLES

L	T	P	C
3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To provide an understanding of sustainable transportation, focusing on the history, interdisciplinary nature, challenges and key technologies of hybrid electric vehicles (HEVs). • To provide a comprehensive understanding of vehicle fundamentals, including conventional components, propulsion loads, drive cycles and the concepts of Electric Vehicles (EVs), Hybrid Electric Vehicles (HEVs) and Fuel Cell Vehicles (FCV). • To understand Plug-in Hybrid Electric Vehicles (PHEVs) and Extended Range Electric Vehicles (EREVs) including their architectures, electric range, fuel economy, power management, end-of-life battery utilization for grid support, vehicle-to-grid technology and PHEV battery charging. • To understand rectifiers, converters, regenerative braking and battery chargers utilized in Hybrid Electric Vehicles (HEVs), along with associated concepts like voltage ripples and power management. • To explore energy storage parameters and various technologies including Lead acid Batteries, ultra capacitors, flywheels, magnetic Storage Systems, pumped hydroelectric Energy Storage, compressed air energy storage and heat Storage.

Course Outcomes At the end of the course, the students will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the concepts of hybrid electric vehicle in the development of sustainable transportation Solutions.	Ap	20%
CO2	Analyze the types of hybrid electric vehicle in contribution towards transportation and energy management	An	40%
CO3	Interpret different power converter topologies used for electric vehicle application	An	20%
CO4	Design the energy storage solution using power electronics in hybrid electric vehicle for diverse application in the development of sustainable energy system	C	20%
CO5	Perform in team and make effective presentation on the topic related to real world challenges and requirements in hybrid electric vehicles.	U	Internal Assessment (Seminar)

UNIT I - INTRODUCTION TO HYBRID ELECTRIC VEHICLES	(9)
Sustainable transportation-History of hybrid vehicles-Inter disciplinary nature of HEVs -Challenges and key technology of HEVs -Architecture of HEVs-Series and parallel HEVs-Complex HEVs.	

UNIT II - HYBRIDIZATION OF AUTOMOBILE	(9)
Fundamentals of vehicle-Components of conventional vehicle and propulsion load-Drive cycles and drive terrain- Concept of Electric vehicle and Hybrid Electric vehicle - Comparison of EV and HEV-Fuel Cell vehicles and its constituents.	
UNIT III - PLUG-IN HYBRID ELECTRIC VEHICLE	(9)
PHEVs and EREVs blended PHEVs- PHEV Architecture-Equivalent electric range of blended PHEVs- Fuel economy of PHEVs- Power management of PHEVs- End-of-life battery for electric power grid support- Vehicle to grid technology-PHEV battery charging.	
UNIT IV - POWER ELECTRONICS IN HEVs	(9)
Rectifiers used in HEVs- Voltage ripples- Buck converter used in HEVs- Non-isolated bidirectional DC-DC converter-Regenerative braking-Voltage source inverter-Current source inverter- Isolated bidirectional DC- DC converter-PWM rectifier in HEVs- EV and PHEV battery chargers.	
UNIT V - BATTERY AND STORAGE SYSTEMS	(9)
Energy Storage Parameters-Lead Acid Batteries- Ultra capacitors-Flywheels - Magnetic Storage System-Pumped Hydroelectric Energy Storage-Compressed Air Energy Storage – Heat Storage.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Teresa Donateo , "Hybrid Electric Vehicles", Published by ExLi4EvA, 2017
2. NoshirwanK.medora, "Electric and Hybrid Vehicles Power Sources, Models, Sustainability, Infrastructure and the Market "Gianfranco Pistoia Consultant, Rome, Italy, Elsevier Publications, 2017.
3. Jack Erjavec and Jeff Arias, "Hybrid, Electric and Fuel Cell Vehicles", Cengage Learning, 2012.

REFERENCES:

1. Wei Liu , "Hybrid Electric Vehicle System Modeling and Control ", USA, John Wiley & Sons, Inc., 2017.
2. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 2014.
3. Iqbal Hussein, " Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2003
4. H. Partab, "Modern Electric Traction", DhanpatRai & Co, 2007.

Mapping of COs with POs / PSOs

	POs												PSOs	
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3												1	
2		3											1	
3		1	1	1									1	
4			3										1	
5									1	1		1		
CO (W.A)	**3**	**2**	**2**	**1**					**1**	**1**		**1**	**1**	

22EEX24 - TESTING AND ELECTRIC VEHICLES POLICY				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To Gain knowledge in the field of E-vehicle certification. • To familiarize the students with the concept of static testing of E-vehicle • To Gain the insight of charging station and policy for Electric Vehicle.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	To expose the students to acquire knowledge on the fundamentals of dynamic testing of E-vehicle.	Ap	40%
CO2	Analyze the safety cycle and need for functions safety for EVs	An	20%
CO3	Analyze the importance of dynamic testing of E-vehicle.	An	15%
CO4	Design the concept of E-vehicle component testing.	An	25%
CO5	Involve in a team to share the skills to develop a product required for the upliftment of society using the modern tools	Ap	Internal Assessment (Assignment, Online Quiz)

UNIT I - INTRODUCTION	(9)
Specification & Classification of Vehicles (including M, N and O layout) - Homologation & its types, Regulations overview (EEC, ECE, FMVSS, AIS, CMVR) - Type approval Scheme - Homologation for export - Conformity of Production - various Parameters - Instruments and Types of test tracks - Hardware in The Loop (HIL) concepts for EV/HEVs.	
UNIT II – STATIC TESTING OF VEHICLE	(9)
Photographs - CMVR physical verification - Tyre Tread Depth Test - Vehicle Weightment - Horn installation - Rear view mirror installation - Tell Tales - External Projection - Wheel Guard, Arrangement of Foot Controls for M1 Vehicle - Angle & Dimensions Measurement of Vehicle - The requirement of temporary cabin for drive– away – Chassis, electric vehicle – Safety norms - Energy consumption and power test.	
UNIT III – DYNAMICS TESTING OF VEHICLE	(9)
Hood Latch - Gradeability - Pass-by Noise, Interior Noise - Turning Circle Diameter & Turning Clearance Circle Diameter -Steering Effort - Constant Speed Fuel Consumption - Cooling Performance - Speedo-meter Calibration - Range Test - Maximum Speed - Acceleration Test - Coast-down test - Brakes Performance ABS Test - Broad band / Narrow band EMI Test, Electric vehicle – Range Test.	
UNIT IV – VEHICLE COMPONENT TESTING	(9)
Horn Testing, Safety Glasses Test: Windscreen laminated and toughened safety glass - Rear View Mirror Test - Hydraulic Brakes Hoses Fuel Tank Test: Metallic & Plastic - Hinges and Latches Test - Tyre & Wheel Rim Test - Bumper Impact Test, Side Door Intrusion - Crash test with dummies - Demist test, Defrost Test - Interior Fittings - Steering Impact test (GVW<1500 kg) - Body block test - Head form test - Driver Field of vision - Safety belt assemblies - Safety belt anchorages, Seat anchorages & head restraints test - Airbag Test - Accelerator Control System - Motor power - Safety Requirements of Traction Batteries - EMI-EMC (CI, BCI, RE,RI and CTE).	

UNIT V – GOVERNMENT RULES, POLICY & OPPORTUNITY	(9)
Technology Scenario - Market Scenario - Policies and Regulations - Payback and commercial model - Polices in India – opportunities-Safety provisions of all A.C. charging stations in accordance with IEC 61851-1, IEC 61851- 21, IEC 61851-22 and IEC 61851-24 standards.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Michael Plint & Anthony Martyr, "Engine Testing & Practice", Butterworth Heinmenn, 3rd ed, 2007
2. "Vehicle Inspection Handbook", American Association of Motor Vehicle Administrators

REFERENCES:

1. Proceedings- Automotive Testing & Certification held on 20th to 24th July 2010 at ARAI, PUNE, Bosch Automotive Handbook, Robert Bosch, 7th Edition, 2007
2. James Larminie, John Lowry, "Electric Vehicle Technology Explained", 2nd Edition, Wiley, 2012
3. L.Ashok Kumar, and S.Albert Alexander,"Power Converters for Electric Vehicles", First Edition, CRC Press, 2020

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2													3	
3		2											3	
4	3													
5									3		3	3		
CO (W.A)	3	2							3		3	3	3	

22EEX25- EV INTELLIGENT SYSTEM

	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To learn mathematical model of a BLDC motor and its characteristics. • To study the different speed control for Electric drives. • To learn the fundamentals of fuzzy logic Control. • To study the essentials of FPGA & VHDL. • To execute fuzzy logic control of BLDC motor in real time.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge of appropriate electric motor, and diverse speed control methods to realize the intelligent systems in electric vehicles.	Ap	30%
CO2	Analyze the various control techniques with their characteristics used in EV.	An	30%
CO3	Implement of fuzzy logic control scheme for BLDC motor using FPGA in real time.	Ap	30%
CO4	Design the electric vehicle for a given intelligent technique.	C	10%
CO5	Engage in an independent study, to perform in a team, effectively use an engineering tool and present a technical report on intelligent systems of electric vehicle.	An	Internal Assessment (Seminar)

UNIT I- MATHEMATICAL MODEL AND CHARACTERISTICS ANALYSIS OF BLDC MOTOR	(9)
Structure and Drive Modes - Basic Structure - General Design Method-Drive Modes. Mathematical Model-Differential Equations -Transfer Functions - State-Space Equations - Characteristics Analysis-Starting Characteristics-Steady-State Operation- Dynamic Characteristics- Load Matching Commutation Transients.	
UNIT II – SPEED CONTROL FOR ELECTRIC DRIVES	(9)
Introduction -PID Control Principle- Anti windup Controller-Intelligent Controller- Vector Control-Control applied to BLDC motor.	
UNIT III – FUZZY LOGIC CONTROL	(9)
Membership functions: features, fuzzification and methods of membership value assignments, Defuzzification: lambda cuts - methods - fuzzy arithmetic and fuzzy measures: fuzzy arithmetic - extension principle -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 – FPGA AND VHDL BASICS	(9)
Introduction – FPGA Architecture-Advantages-Review of FPGA family processors- Spartan 3, Spartan 6 and Spartan 7. VHDL Basics- Fundamentals-Instruction set-data type-conditional statements- programs like arithmetic, sorting, PWM generation, Speed detection.	

UNIT V – REAL TIME IMPLEMENTATION	(9)
Inverter design- identifying rotor position via hall effect sensors-open loop and fuzzy logic control of 48 V BLDC motor uses FPGA.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Electric Power train Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, John G. Hayes, G. Abas Goodarzi, Wiley 1st Edition 2018.
2. VHDL Primer, A (3rd Edition), Jayaram Bhasker, Prentice Hall, 1st Edition 2015.
3. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Third Edition" CRC Press, Taylor & Francis Group, 1st Edition, 2021.

REFERENCES:

1. Chang-liang, Permanent Magnet Brushless DC Motor Drives and Controls, Xia Wiley,1st Edition,2012.
2. M.N. Cirstea, A. Dinu, J.G. Khor, M. McCormick, Neural and Fuzzy Logic Control of Drives and Power Systems, Newnes publications, 1st Edition, 2002.
3. Wei Liu, Hybrid Electric Vehicle System Modeling and Control, 2nd Edition, Wiley 2017.
4. Electric and Plug-in Hybrid Vehicle Networks Optimization and Control, Emanuele Crisostomi, Robert Shorten, Sonja Stüdli, Fabian Wirth, CRC Press, 1st Edition. 2018..

Mapping of COs with POs / PSOs

COs	Pos												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2		2												
3		2		1	1									
4			1											
5					1				1	1	1	1		
CO (W.A)	3	2	1	1	1				1	1	1	1	2	

22EEX26 - ELECTRIC VEHICLES IN SMART GRID				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To learn the impact of charging strategies and smart charging technologies • To know the influence of EVs on power system • To acquire knowledge on frequency control reserves & voltage support from EVs • To learn about smart grid and ICT solutions to support EV deployment • To acquire knowledge on centralized charging, decentralized charging schemes and energy storage integration into microgrid

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Predict vehicle electrification and impact of charging strategies and influence of EVs on power system	Ap	30%
CO2	Demonstrate the impact of EV on smart grid and renewable energy system	Ap	20%
CO3	Analyze frequency control reserves & voltage support from EVs and ICT solutions to support EV deployment	An	30%
CO4	Propose centralized charging, decentralized charging schemes and energy storage integration into microgrid	Ap	20%
CO5	Engage in independent study and make an oral presentation on the applications	U	Internal Assessment (Seminar, Online Quiz)

UNIT I- INTRODUCTION	(9)
Basics of EV- Impact of charging strategies- EV charging options and infrastructure - Energy, economics and environmental considerations- Impact of EV charging on power grid- Effect of EV charging on generation and load profile - Smart charging technologies- Impact on investment.	
UNIT II – INFLUENCE OF EVs ON POWER SYSTEM	(9)
Identification of EV demand - EV penetration level for different scenarios- Classification based on penetration level - EV impacts on system demand- Charging: dumb, multiple tariff and smart charging- Case studies.	
UNIT III – FREQUENCY CONTROL RESERVES & VOLTAGE SUPPORT FROM EVs	(9)
Introduction- Power system ancillary services -Electric vehicles to support wind power integration- Electric vehicle as frequency control reserves and tertiary reserves - Voltage support and electric vehicle integration - Properties of frequency regulation reserves - Control strategies for EVs to support frequency regulation.	

UNIT IV – ICT SOLUTIONS TO SUPPORT EV DEPLOYMENT	(9)
Architecture model for smart grid & EV - ICT players in smart grid - Smart metering, information & communication models- Functional and logical models - Technology and solution for smart grid: interoperability, communication technologies.	
UNIT V – EV CHARGING FACILITY PLANNING	(9)
Energy generation scheduling, - Different power sources, fluctuant electricity- Centralized charging schemes- Decentralized charging schemes - Energy storage integration into microgrid - Design of V2G Aggregator.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Canbing Li, Yijia Cao, YonghongKuang and Bin Zhou, "Influences of Electric Vehicles on Power System and Key Technologies of Vehicle-to-Grid", Springer-Verlag Berlin Heidelberg, 2016.
2. Qiuwei Wu, "Grid Integration of Electric Vehicles in Open Electricity Markets", John Wiley & Sons, Ltd, 2013.

REFERENCES:

1. Harald Naunheimer, Bernd Bertsche, Joachim Ryborz , Wolfgang Novak "Automotive Transmission: Fundamentals, Selection, Design and Application", 2nd Edition, Springer, 2011.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	2
2	2												2	
3		3											2	2
4			3										2	2
5						1				1		1	1	
CO (W.A)	2.5	3	3			1				1		1	2	2

22EEX27- DESIGN OF MOTOR AND POWER CONVERTERS FOR ELECTRIC VEHICLES

	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To analyze and design the various motor by use of power converters for electric vehicles. • To understand the motor transfer function by use of simulation in control systems and DC-DC converters.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply appropriate electric motors for electric vehicles application and compute a power stage transfer functions for DC-DC converters	Ap	30%
CO2	Analysis the Dynamics of Electric Vehicles and compute transfer function with factors such as constant, integral, differential, first order factor and second order factor (both numerators & denominators)	An	30%
CO3	Design the advanced motors for electric vehicles with speed control and simulate converter based PWM modelling.	Ap	20%
CO4	Develop the modeling of DC-DC converter and model the transfer function of DC-DC converters and in control systems.	Ap	20%
CO5	Accomplish in team and make effective presentation on the topics related to real world challenges and requirements in power converters for electric vehicles.	U	Internal Assessment (Seminar, Quiz)

UNIT I - ELECTRIC VEHICLE DYNAMICS	(9)
Standard drive cycles-Dynamics of Electric Vehicles-Tractive Force-Maximum Speed-Torque-Power-Energy requirements of EVs	
UNIT II - ADVANCED MOTORS FOR ELECTRIC VEHICLES	(9)
Speed and Torque control of above and below rated speed - Speed control of EV in the constant power region of electric motors. Switched Reluctance Motors (SRMs) - Synchronous Reluctance Machines - Choice of Electric Machines for EVs.	
UNIT III - CONTROL SYSTEMS SIMULATION	(9)
Transfer Function: Poles & zeros- bode plot : Bode Plots for Multiplication Factors, Constant, Single and Double Integration Functions, Single and Double Differentiation Functions, Single Pole and Single Zero Functions -Transfer function of state space Model.	

UNIT IV - MODELLING OF DC-DC CONVERTERS	(9)
Overview of PWM Converter Modelling -Power Stage Modelling - PWM Block Modelling – Voltage Feedback Circuit and Small-Signal Model of PWM Converter - Averaging Power Stage Dynamics - Average Models for buck/boost Converter - Frequency Response of Converter	
UNIT V - POWER STAGE TRANSFER FUNCTIONS OF DC –DC CONVERTERS	(9)
Power Stage Transfer Functions of buck-boost Converter in CCM Operation, Input-to-Output Transfer Function, Duty Ratio-to-Output Transfer Function and Load Current-to-Output Transfer Function.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Emerging Power Converters for Renewable Energy and Electric Vehicles Modeling, Design, and Control, Md. Rabiul Islam,Md. Rakibuzzaman Shah, Mohd. Hasan Ali, CRC Press,2021, 1st Edition.
2. Electrical Machine Fundamentals with Numerical Simulation using MATLAB/SIMULINK, Atif Iqbal, Shaikh Moinoddin, Bhimireddy Prathap Reddy, Wiley,2021, 1st Edition.

REFERENCES:

1. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals, Second Edition" CRC Press, Taylor & Francis Group, Third Edition 2021.
2. Power Electronic Converters, Teuvo Suntio, Tuomas Messo, Joonas Puukko, First Edition 2017.
3. Fundamentals of Power Electronics with MATLAB, Randall Shaffer, 2nd Edition, 2013, Lakshmi publications.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2		3											3	
3	2												3	
4	2												3	
5									3	3		3		
CO (W.A)	2.3	3							3	3		3	3	

22EEX28 - ELECTRIC VEHICLE ARCHITECTURE				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To learn the structure of Electric Vehicle, Hybrid Electric Vehicle • To study about the EV conversion components • To know about the details and specifications for Electric Vehicles • To understand the concepts of Plug-in Hybrid Electric Vehicle • To model and simulate all types of DC motors

Course Outcomes At the end of the course, the students will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the concepts related in the Plug-In Hybrid Electric Vehicles and control strategies.	Ap	20%
CO2	Analyze the details and Specifications for the various EVs developed.	An	20%
CO3	Analyse the details and Specifications for the various EVs developed.	An	40%
CO4	Design the various EV components and brakes.	C	20%
CO5	Make an effective oral & technical presentation relevant to the electric vehicle architecture.	U	Internal Assessment (Seminar, Assignment)

UNIT I - VEHICLE ARCHITECTURE AND SIZING	(9)
Electric Vehicle History, and Evolution of Electric Vehicles. Series, Parallel and Series parallel Architecture, Micro and Mild architectures. Mountain Bike - Motorcycle- Electric Cars and Heavy Duty EVs. -Details and Specifications.	
UNIT II - VEHICLE MECHANICS	(9)
Vehicle mechanics- Roadway fundamentals, Laws of motion, Vehicle Kinetics, Dynamics of vehicle motion, propulsion power, velocity and acceleration, Tire –Road mechanics, Propulsion System Design.	
UNIT III - POWER COMPONENTS AND BRAKES	(9)
Power train Component sizing- Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Example.	
UNIT IV - HYBRID VEHICLE CONTROL STRATEGY	(9)
Vehicle supervisory controller, Mode selection strategy, Modal Control strategies.	

UNIT V - PLUG-IN HYBRID ELECTRIC VEHICLE	(9)
Introduction-History-Comparison with electrical and hybrid electrical vehicle-Construction and working of PHEV-Block diagram and components-Charging mechanisms-Advantages of PHEVs.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Heavy-duty Electric Vehicles from Concept to Reality, Shashank Arora, Alireza Tashakori Abkenar, Shantha Gamini Jayasinghe, Kari Tammi, Elsevier Science, 2021
2. Electric Vehicles Modern Technologies and Trends, Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen Springer, 2020

REFERENCES:

1. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
2. Build Your Own Electric Vehicle,Seth Leitman , Bob Brant, McGraw Hill, 3rd Edition 2013.
3. Advanced Electric Drive Vehicles, Ali Emadi, CRC Press, 1st edition 2017.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												1	
2	2		2					1						
3		3											1	
4			3											
5									1	1		1		
CO (W.A)	2.5	3	2.5					1	1	1		1	1	

22EEX31- EMBEDDED SYSTEMS DESIGN				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To introduce the Building Blocks of an embedded System and Software Tools. • To emphasize the role of Input/output interfacing with Bus Communication Protocol and embedded system application and development. • To illustrate the ISR and scheduling for the multitasking process and explain the basics of a Real-time operating system.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the functioning and features of processors, memory and I/O system in developing Embedded systems.	Ap	30%
CO2	Apply the applications based on embedded design approaches	Ap	30%
CO3	Analyze the embedded OS functionality and device driver used in multitasking embedded applications.	An	20%
CO4	Design embedded applications using given specifications and concepts of communication protocols and modules.	Ap	20%
CO5	Make an independent technical presentation using embedded system design tools.	U	Internal Assessment (Seminar)

UNIT I - INTRODUCTION TO EMBEDDED SYSTEMS	(9)
Embedded Systems: Structural units in Embedded processor- Selection of processor & memory devices-DMA- Memory management methods -Timer and Counting Devices-Real Time Clock- In-circuit Emulator-Hardware Debugging.	
UNIT II - EMBEDDED NETWORKING	(9)
Introduction-I/O Device-Ports-Buses– Serial Bus communication protocols:RS232 standard, RS485, CAN Bus, Serial Peripheral Interface (SPI)& Inter Integrated Circuits (I2C)-Standard single purpose processor's peripherals interfacing: Timers, Stepper motor controller, PWM, LCD, ADC and RTC-Interfacing.	
UNIT III - INTERRUPT SERVICE MECHANISM AND DEVICE DRIVER	(9)
Programmed I/O bus-Wait approach without interrupt service mechanism-ISR concept-Interrupt sources – Multiple interrupts – Context and context switching - Interrupt latency deadline – Introduction to Device Driver.	

UNIT IV - RTOS BASED EMBEDDED SYSTEM DESIGN	(9)
Introduction to RTOS-Task, Process & threads, interrupt routines in RTOS, Multiprocessing and Multitasking- Preemptive and non-preemptive scheduling-Task communication-Shared memory, message passing- Interprocess Communication- Introduction to process synchronization using semaphores.	
UNIT V - EMBEDDED SYSTEM APPLICATION DEVELOPMENT	(9)
Objective- Need-different Phases & Modelling of the EDLC-choice of Target Architectures for Embedded Application Development for Control Dominated & Data Dominated Systems-Case studies on Digital Camera- Adaptive Cruise control in a Car- Mobile Phone software for key inputs.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Rajkamal, 'Embedded system-Architecture, Programming, Design, McGraw-Hill Edu, 3rd edition 2017.
2. Peckol, "Embedded system Design", John Wiley & Sons, 2010.

REFERENCES:

1. Shibu. K.V, "Introduction to Embedded Systems", TataMcgraw Hill, 2nd edition 2017
2. Parag H.Dave,Himanshu B.Dave," Embedded Systems-Concepts ,Design and Programming, Pearson Education, 2015, 1st edition.
3. Lyla B Das, "Embedded Systems-An Integrated Approach", Pearson 2013.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	2
2	2												1	1
3		3											3	
4			3											
5					2				1	2		1		2
CO (W.A)	2.5	3	3		2				1	2		1	2.3	1.7

22EEX32 - SIGNALS AND SYSTEMS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To acquire knowledge on the fundamentals of continuous time LTI systems using Fourier and Laplace Transforms • To analyze the design Considerations for discrete time LTI systems using Z transform and DTFT

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply various transformation techniques in signals & systems to reveal its functionality behaviors.	Ap	20%
CO2	Apply the various standard digital signals in LTI and DTFT systems.	Ap	20%
CO3	Analyze the importance of continuous & discrete time signals and systems used in real time applications.	An	40%
CO4	Design a system that accepts all periodic & non periodic signals to perform a realistic operations	Ap	20%
CO5	Involve in a team to share the skills to develop a product required for the upliftment of society using the modern tools	U	Internal Assessment (Seminar)

UNIT I - CLASSIFICATION OF SIGNALS AND SYSTEMS	(9)
Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids- Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals - Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable.	
UNIT II – ANALYSIS OF CONTINUOUS TIME SIGNALS	(9)
Fourier series for periodic signals - Fourier Transform – Inverse Fourier Transform – properties.	
UNIT III – LINEAR TIME INVARIANT- CONTINUOUS TIME SYSTEMS	(9)
Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.	
UNIT IV - ANALYSIS OF DISCRETE TIME SIGNALS	(9)
Sampling Theorem-Reconstruction of a signal from its samples-Aliasing- Fourier Series representation of Discrete Time Periodic Signals- Properties-Discrete Time Fourier Transform-Properties.	

UNIT V – LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS	(9)
Convolution sum- Difference equations -Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Oppenheim, Willsky and Hamid, Signals and Systems, 2nd Edition, Pearson Education, New Delhi, 2015.
2. Simon Haykin, Barry Van Veen, Signals and Systems, 2nd Edition, Wiley, 2007

REFERENCES:

1. B. P. Lathi, "Principles of Linear Systems and Signals", 2nd Edition, Oxford, 2009.
2. M. J. Roberts, "Signals and Systems Analysis using Transform methods and MATLAB", McGraw- Hill Education, 2018.
3. John Alan Stuller, "An Introduction to Signals and Systems", Thomson, 2007

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													2
2	3													2
3		3											3	2
4			3										2	
5						1				1		1		
CO (W.A)	3	3	3			1				1		1	2.5	2

22EEX33 - EMBEDDED CONTROL SYSTEMS				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To learn the basics of sensors and actuators in embedded platform. • To know the interfacing techniques using communication Buses and developments of embedded system • To learn various software tools for controlling embedded based applications.

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the basic tools and concepts to interface with embedded real-time applications.	Ap	30%
CO2	Analyze various interfaces, protocols embedded with software tools and techniques.	An	30%
CO3	Design and develop a complete application system including hardware and software components.	C	20%
CO4	Apply modern software tools and protocols for analysis of embedded control systems.	An	20%
CO5	Implement and test a specific protocol or algorithm on an embedded platform.	AP	Internal Assessment (Assignment)

UNIT I – INTRODUCTION	(9)
Embedded control systems - Interfacing a microprocessor to the analog world-Position and Velocity measurements - The world of sensors-Actuators-Motor control - Feedback systems - Haptic interfaces and Virtual environments Applications of embedded control systems.	
UNIT II - EMBEDDED SYSTEM ORGANIZATION	(9)
Embedded computing – Characteristics of embedded computing & applications–Embedded system design challenges - Build process of real-time embedded system – Selection of processor – Memory - I/O devices -RS 485 - MODEM-Bus communication system using I2C- CAN- USB -ISA- EISA.	
UNIT III - INTERFACE WITH COMMUNICATION PROTOCOLS	(9)
Design methodologies and tools – Design flow – Designing hardware and software interface – System integration – SPI - High speed data acquisition and interface - SPI read/write protocol - RTC interfacing and programming.	

UNIT IV - DESIGN OF SOFTWARE MACHINE EMBEDDED CONTROL SYSTEM	(9)
Software abstraction using Mealy - Moore FSM controller - Layered software development - Basic concepts of developing device driver – SCI – Interfacing & porting using Embedded C - Functional and performance debugging with benchmarking- Real-time software – Survey on basics of contemporary RTOS – VXWorks - UC/OS-II	
UNIT V - CASE STUDIES WITH EMBEDDED CONTROLLER	(9)
Programmable interface with A/D & D/A Converter, Digital voltmeter- Control of Robot system- PWM motor speed controller-Serial communication interface.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Embedded Systems- Architecture, Programming and Design, 3rd Edition, 2017
2. Chattopadhyay, "Embedded System Design", PHI Learning, 2011.
3. Steven F. Barrett, Daniel J. Pack, "Embedded Systems – Design and Applications with the 68HC 12 and HCS12", Pearson Education, 2008.

REFERENCES:

1. Marian Andrzej Adamski, Andrei Karatkevich and Marek Wegrzyn, " Design of Embedded control systems" Springer Science + Busciness Media, 2005.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	2
2		3											1	1
3			2										2	
4		2			2									
5									2	1	2	1		2
CO (W.A)	3	2.5	2		2				2	1	2	1	2	1.7

22EEX34 - SIGNAL PROCESSING				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To analyze various types of Fourier transform techniques AND design of Finite & Infinite Impulse Response filters • To gain the knowledge about the digital signal processors

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply discrete Fourier transform for frequency domain signals to enhance the quality of signals	Ap	20%
CO2	Analyze different kinds of FIR and IIR filters to process the real-time signals.	An	20%
CO3	Design a digital FIR filter using window techniques and predict the different architecture processors.	An	40%
CO4	Design various filters by using approximations and window techniques to change the dimension of the signals with the help of signal processors.	An	20%
CO5	Engage in updating the knowledge on new techniques employed in processing of signals with modern tools and sharing the knowledge to others through which a product or application is developed.	U	Internal Assessment (Online Test, Assignment)

UNIT I - INTRODUCTION TO SIGNALS AND SYSTEMS	(9)
Energy and power signals- Continuous and discrete time signal-Continuous and discrete amplitude signals-System properties: linearity: additivity and homogeneity, shift-invariance, causality, stability, reliability-Effects of sampling and quantization in discrete domain.	
UNIT II – DISCRETE FOURIER TRANSFORM	(9)
DTFT - frequency domain sampling-DFT: properties, frequency analysis, Radix-2 FFT algorithms, applications, Realization of filter structures: Direct forms I and II, cascades.	
UNIT III – DESIGN OF IIR FILTERS	(9)
Design techniques for analog low pass filter - Butterworth and Chebyshev approximations - frequency transformation - approximation of derivatives - Bilinear transformation and impulse invariant technique.	

UNIT IV - DESIGN OF FIR FILTERS	(9)
FIR Filter Design: Phase and group delay, design characteristics of FIR filters with linear phase, frequency response -FIR filters using window functions: Rectangular, Hamming.	
UNIT V – DIGITAL SIGNAL PROCESSORS	(9)
Digital signal processor architectures: TMS320C series - General purpose processors: fixed point and floating point, MAC, pipelining, addressing modes.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. John G. Proakis, D. G. Manolakis, Digital Signal Processing Principles, Algorithms and Applications, 4th edition, Pearson Education, 2016
2. Oppenheim V.A.V and Schaffer R.W, Discrete – time Signal Processing, 3rd Edition, Pearson, 2014

REFERENCES:

1. Lawrence R Rabiner and Bernard Gold, Theory and Application of Digital Signal. Processing Pearson Education, 2016
2. Steven W Smith, Digital Signal Processing: A Practical Guide for Engineers and Scientists, Newnes, 2014
3. Sanjit K. Mitra, Digital Signal Processing, 2013, 4th edition, Tata McGraw Hill.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													
2		3	1										1	3
3			2		1								1	1
4	1	2	3										3	1
5					2				2	1	1			1
CO (W.A)	2	2.5	2		1.5				2	1	1		1.6	1.5

22EEX35 - EMBEDDED IoT				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To understand IOT architecture and components, focusing on sensors, actuators, embedded computation units, communication interfaces and Arduino processors. • To acquire the knowledge in fundamentals of internet communication, including IP addresses, MAC addresses, TCP and UDP, along with insights into the IEEE 802 family of protocols and Ether CAT • To gain the knowledge in recent trends and societal benefits of IoT across various domains, including healthcare, smart transportation, smart homes, smart cities, and smart grids • To understand the array of communication technologies and protocols enabling IOT applications including RFID, NFC, BLE, LiFi, 6LowPAN, ZigBee, Z-Wave, LoRa, HTTP, Web Socket, MQTT, and CoAP. • To learn cloud architecture fundamentals and their application in IoT deployments, including security considerations, cloud services and specialized IoT-related services

Course Outcomes At the end of the course, the students will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the knowledge in configuring the network communication, selecting the appropriate protocols for different applications.	Ap	20%
CO2	Apply the recent trends in IoT related to societal benefits using internet communication and security control by use of embedded system.	Ap	20%
CO3	Analyze the IOT technologies and communication protocols to face the future societal challenges and opportunities.	An	40%
CO4	Design the cloud Infrastructure with security model to meet needs of various real time systems.	C	20%
CO5	Perform in a team and make an effective presentation on the topics related to embedded system IoT.	U	Internal Assessment (Seminar, Online Quiz)

UNIT I - INTRODUCTION TO IoT	(9)
Architecture-Functional Characteristics and Requirements-Components of IoT-Sensors- Actuator-Embedded Computation Units - Communication Interfaces - Software Development-Introduction to arduino processor.	

UNIT II - COMMUNICATION PRINCIPLES	(9)
Introduction-Internet Communication: IP Addresses, MAC Addresses - TCP and UDP - IEEE 802 Family of Protocols-Introduction to Ether CAT.	
UNIT III - APPLICATIONS OF IoT	(9)
Recent Trends in IoT - Societal Benefits of IoT- Health Care -Smart Transportation- Smart Home -Smart Cities- Smart Grid.	
UNIT IV - COMMUNICATION INTERFACE WITH IoT	(9)
IoT Enabling Technologies: Communications, RFID, NFC (Near- Field Communication), Bluetooth Low Energy (BLE), LiFi, 6LowPAN, ZigBee, Z-Wave, LoRa, HTTP, Web Socket, MQTT and CoAP Protocols.	
UNIT V - CLOUD SYSTEMS AND SECURITY	(9)
Introduction-Fundamentals of Cloud architecture-Types of Cloud-IOT Cloud Security Architecture-Cloud services-Service related to IOT-Cloud IOT Security Controls.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Adrian McEwen and Hakim Cassimally, "Designing the Internet of Things", John Wiley and Sons Ltd, UK, 2014.
2. Olivier Hersent, David Boswarthick and Omar Elloumi,"The Internet of Things: Key Applications and Protocols", John Wiley and Sons Ltd., UK 2012.
3. Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things", Springer, New York, 2011.

REFERENCES:

1. Johnny Cache, Joshua Wright and Vincent Liu," Hacking Exposed Wireless: Wireless Security Secrets and Solutions", Tata McGraw Hill, New Delhi, 2010
2. Vijay Madisetti, Arshdeep Bahga, "Internet of Things (A Hands-on Approach)", Universities Press, 2015.
3. Tim Mather, Subra Kumaraswamy, ShahedLatif, "Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance" O'Reilly Media; 1 edition [ISBN: 0596802765], 2009.

Mapping of COs with POs / PSOs

	POs												PSOs	
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3												1	1
2	2					2	1						1	1
3		3											1	1
4			3										1	1
5									1	1		1	1	1
CO (W.A)	**3**	**3**	**3**			**2**	**1**		**1**	**1**		**1**	**1**	**1**

22EEX36 - EMBEDDED NETWORKING				
	L	T	P	C
	3	0	0	3

PRE-REQUISITE : NIL

Course Objective:	• To understand the principles of serial and parallel communication protocols for digital system implementation. • To learn the USB and CAN bus protocols along with communication mechanism in programming and implementation. • To understand network design choices, assess network speed, focusing on Ethernet controllers and Internet Protocol. • To learn UDP and TCP message exchange, dynamic web page serving, email integration with FTP and network security for embedded systems. • To understand and apply advanced concepts in wireless sensor networks, including network topology, localization, time synchronization, energy-efficient MAC protocols, routing and data-centric routing for diverse applications.

Course Outcomes At the end of the course, the students will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the appropriate protocols and CAN bus system for diverse digital system design.	Ap	20%
CO2	Identify and distinguish the various communication protocols and ethernet of embedded system.	Ap	20%
CO3	Analyze the wireless network elements, ethernet control system used in embedded applications.	An	40%
CO4	Design an embedded application by exchange of message using UDP.TCP, email integration using FTP and secondary control.	C	20%
CO5	Perform in a team and make a effective presentation in the topics related to real world challenges and requirement in wireless embedded network.	U	Internal Assessment (Seminar, Assignment)

UNIT I - EMBEDDED COMMUNICATION PROTOCOLS	(9)
Introduction – Serial/Parallel Communication – Serial communication protocols: RS232 standard, RS485. Synchronous serial protocols, Serial Peripheral Interface (SPI) and Inter Integrated Circuits (I2C) – Parallel communication protocols: ISA/PCI Bus protocols and Firewire.	
UNIT II - USB AND CAN BUS	(9)
USB bus: Speed Identification, USB States and USB bus Communication (Packets, Data flow types, Enumeration and Descriptors) –PIC18 Microcontroller USB Interface – C Programs - CAN Bus : Frames, Bit stuffing, Types of errors, Nominal bit timing – application of CAN.	

UNIT III - ETHERNET BASICS	(9)
Elements of a network-network building: Design Choices, Selecting Components, Connections and network speed -Ethernet Controllers – Ethernet Communication - Internet Protocol.	
UNIT IV - EMBEDDED ETHERNET	(9)
Exchanging messages using UDP and TCP – Serving web pages with dynamic Data – Email for embedded Systems Using FTP – network security.	
UNIT V - WIRELESS EMBEDDED NETWORKING	(9)
Introduction -Network topology - Localization -Time synchronization- Energy efficient MAC Protocols – SMAC-Energy efficient and robust routing -Data centric routing-Application	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Jan Axelson, "Parallel Port Complete, Programming, Interfacing and Using the PC's Parallel Printer Port", Jan Axelson Series, 2012
2. Dogan Ibrahim, "Advanced PIC microcontroller projects in C", Elsevier 2011.

REFERENCES:

1. Jan Axelson, "Embedded Ethernet and Internet Complete: Designing and Programming Small Devices for Networking" Jan Axelson Series, 2007.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	2
2		2			1								2	2
3		3											2	2
4			3										2	
5									1	1		1		
CO (W.A)	3	2.5	3		1				1	1		1	2	2

22EEX37- EMBEDDED SYSTEM FOR AUTOMOTIVE APPLICATIONS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : NIL				
Course Objective:	• To expose the students to the fundamentals and building of Electronic Engine Control systems. • To discuss on programmable controllers for vehicles management systems. • To introduce the embedded system concepts & communication techniques for automotive applications			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the fundamental ideas and core components of automotive embedded system.	Ap	20%
CO2	Analyze the Embedded concepts for vehicle management and control systems using various diagnostics.	An	20%
CO3	Apply the need, selection of sensors and actuators to interfacing with embedded applications.	Ap	30%
CO4	Design and implement in-vehicle communication system of varied capabilities and capacities as electronic embedded systems.	C	30%
CO5	Analyze and deliver a clear concise presentation on recent trends and advancements in automotive systems.	An	Internal Assessment (seminar)

UNIT I - BASICS OF ELECTRONIC ENGINE CONTROL SYSTEMS	(9)
Overview of Automotive systems- fuel economy- air-fuel ratio, emission limits and vehicle performance- Automotive microcontrollers- Electronic control Unit- Hardware & software selection and requirements for Automotive applications - Introduction to Society SAE- Functional safety ISO 26262.	
UNIT II - SENSORS AND ACTUATORS FOR AUTOMOTIVES	(9)
Review of sensors- sensors interface to the ECU, conventional sensors and actuators-Modern sensor and actuators - LIDAR sensor- smart sensors- MEMS/NEMS sensors and actuators for automotive applications.	
UNIT III - VEHICLE MANAGEMENT SYSTEM	(9)
Electronic Engine Control :Engine mapping, fuel control and electronic ignition - Adaptive cruise control - speed control-Antilocking braking system-Electronic suspension - Electronic steering, Automatic wiper control- body control system - Vehicle system schematic for interfacing with EMS&ECU - Electrically assisted power steering system Adaptive lighting system - Safety and Collision Avoidance.	

UNIT IV - ONBOARD DIAGONSTICS AND TELEMATICS	(9)
On board diagnosis of vehicles - Vehicle communication protocols Bluetooth, CAN, LIN, FLEXRAY, MOST and KWP2000 and recent trends in vehicle communication-Navigation-Tracking-Security for data communication- Dashboard display and Virtual Instrumentation - Role of IOT in Automotive system.	
UNIT V - AUTOMOTIVE APPLICATIONS IN EMBEEDED SYSTEM	(9)
Navigation- Autonomous car- Role of IoT in Automotive systems. Case Study: Embedded Rain-Sensing System. Automotive Night Vision System. Airbag Control Unit.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. William B. Ribbens," Understanding Automotive Electronics", Elseiver,2017.
2. Automotive Electricals / Electronics System and Components, Tom Denton, 5th Edition, 2017.

REFERENCES:

1. Automotive Electricals / Electronics System and Components, Tom Denton, 5 th Edition, 2017.
2. Automotive Electricals Electronics System and Components, Robert Bosch Gmbh, 5 th Edition, 2014.
3. Automotive Hand Book, Robert Bosch, Bently Publishers, 10 th Edition, 2018.

Mapping of COs with POs / PSOs

	POs												PSOs	
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3												3	2
2		2											1	1
3	3												2	1
4			3											
5									2	2	1	1		
CO (W.A)	**3**	**2**	**3**						**2**	**2**	**1**	**1**	**2**	**1.4**

22EEX38- MEMS AND NEMS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : NIL				
Course Objective:	• To introduce the diverse technological and functional approaches of MEMS/NEMS and applications. • To provide an insight of micro and nano sensors, actuators and real time applications of MEMS and NEMS technology • To emphasise the need for NEMS technology and understand the microstructures and fabrication methods.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply the concepts of MEMS and NEMS to models, simulate and process the sensors and actuators.	Ap	30%
CO2	Analyze the material properties and the significance of MEMS and NEMS for industrial automation.	An	20%
CO3	Apply the fabrication mechanism for MEMS sensor and actuators	Ap	20%
CO4	Analyze the operation of micro devices, nano devices technology and their applications.	An	30%
CO5	Evaluate the ability to apply concepts and principles to solve problems.	E	Internal Assessment (Quiz)

UNIT-I INTRODUCTION TO MEMS and NEMS	(9)
Overview of Micro electro mechanical systems and Nano Electro mechanical systems-Devices and technologies- Laws of scaling- Survey of materials- Smart Sensors - Applications of MEMS and NEMS.	
UNIT-II MICRO-MACHINING AND MICROFABRICATION TECHNIQUES	(9)
Photolithography- Film deposition, Etching Processes- wafer bonding- Bulk micro machining, silicon surface micro machining- LIGA process.	
UNIT-III MICRO SENSORS AND MICRO ACTUATORS	(9)
Transduction mechanisms in different energy domain-Micromachined capacitive, Piezoelectric, piezoresistive and Electromechanical and thermal sensors/actuators and applications.	
UNIT-IV NEMS TECHNOLOGY	(9)
Atomic scale precision engineering- Nano Fabrication techniques - NEMS in measurement, sensing, actuation and systems design.	

UNIT-V MEMS and NEMS APPLICATION	(9)
Introduction to Micro/Nano Fluids and applications- Bio MEMS- Optical NEMS- Micro and Nano motors- Recent trends in MEMS and NEMS.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Chang Liu, "Foundations of MEMS", Pearson International Edition, 2006.
2. Marc F madou" Fundamentals of micro fabrication" CRC Press 2002 2nd Edition Marc Madou.
3. M.H.Bao "Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes", Elsevier, Newyork, 2000.

REFERENCES:

1. Maluf, Nadim "An introduction to Micro Electro-mechanical Systems Engineering "AR Tech house, Boston 2000.
2. Tai-.Ran Hsu, "MEMS and Microsystems: design , manufacture, and Nanoscale"- 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey, 2008.

Mapping of COs with POs / PSOs

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	1
2		2											1	
3	2												2	
4		3												
5									2	1		1		
CO (W.A)	2.5	2.5							2	1		1	2	1

22GEA02- PRINCIPLES OF MANAGEMENT				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE: NIL				
Course Objective:	• To provide with a foundational understanding of management concepts and practices. • To equip students with the knowledge and skills necessary to manage and lead organizations effectively, understanding both theoretical frameworks and practical applications in management. • To learn about various planning tools and decision-making processes crucial for organizational success. • To gain insights into human resource management functions. • To study effective communication strategies and the impact of information technology on communication and how effective control can lead to improved productivity and organizational performance.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply key management theories and practices to real-world business scenarios, demonstrating the ability to implement management functions.	Ap	20%
CO2	Analyze human resource management practices, evaluating how recruitment, training, performance appraisal, and employee relations contribute to organizational success.	An	30%
CO3	Evaluate strategic decisions and their impacts on organizational performance, the effectiveness of communication strategies and the use of information technology in facilitating efficient and effective communication within organizations.	E	30%
CO4	Create comprehensive strategic plans and organizational policies and design control systems to ensure continuous improvement in productivity and organizational performance.	C	20%
CO5	Engage in independent study as a member of a team and develop higher-order thinking skills that are crucial for effective management and leadership in complex organizational settings with assignments or case studies.	Ap	Internal Assessment

UNIT I - INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS	**(9)**
Definition of Management - Science or Art - Manager Vs Entrepreneur - types of managers -managerial roles and skills - Evolution of Management - Scientific, human relations, system and contingency approaches - Types of Business organization- Organization culture and Environment - Current trends and issues in Management.	

UNIT II - PLANNING	**(9)**
Nature and purpose of planning - planning process - types of planning - objectives - setting objectives - policies - Planning premises - Strategic Management - Planning Tools and Techniques - Decision making steps and process.	
UNIT III - ORGANISING	**(9)**
Nature and purpose - Formal and informal organization - organization chart - organization structure - types - Line and staff authority - departmentalization -delegation of authority - centralization and decentralization -Job Design - Human Resource Management - HR Planning, Recruitment, selection, Training and Development, Performance Management, Career planning and management	
UNIT IV - DIRECTING	**(9)**
Foundations of individual and group behaviour - motivation -motivation theories - motivational techniques - job satisfaction - job enrichment - leadership - types and theories of leadership -communication - process of communication - barrier in communication - effective communication -communication and IT.	
UNIT V - CONTROLLING	**(9)**
System and process of controlling - budgetary and non-budgetary control techniques - use of computers and IT in Management control - Productivity problems and management - control and performance -direct and preventive control -reporting.	
TOTAL (L:45) : 45 PERIODS	

TEXT BOOKS:

1. Harold Koontz, Heinz Weihrich and Mark V. Cannice "Essentials of Management: An International, Innovation, and Leadership Perspective", 11th Edition, Tata McGraw-Hill Education, 2021.
2. J.A.F. Stoner, R.E. Freeman, and Daniel R. Gilbert "Management", 6th Edition, Pearson Education, 2018.

REFERENCES:

1. JAF Stoner, Freeman R.E and Daniel R Gilbert "Management", 6th Edition, Pearson Education, 2004.
2. Robert Kreitner & Mamata Mohapatra, "Management", Biztantra, 2008.
3. Stephen A. Robbins & David A. Decenzo & Mary Coulter, "Fundamentals of Management", 7th Edition, Pearson Education, 2011.
4. Tripathy PC & Reddy PN, "Principles of Management", Tata Mcgraw Hill, 1999.

Mapping of COs with POs / PSOs														
	POs												PSOs	
COs	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3										3			
2		3									3			
3										3				
4			3							3				
5											3	3		
CO (W.A)	3	3	3							3	3	3		

22GEA03- TOTAL QUALITY MANAGEMENT				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : NIL				
Course Objective:	• To Recognize the importance of quality councils and strategic planning in TQM. • To Explore the elements and historical development of TQM. • To Foster employee involvement through motivation, empowerment, teamwork, and recognition. • To Implement continuous process improvement methods like Juran's Trilogy, PDSA Cycle, 5S, and Kaizen. • To Conduct quality audits and understand the introduction to other ISO standards like ISO 14000, IATF 16949, TL 9000, IEC 17025, ISO 18000, ISO 20000, ISO 22000, and ISO 21001.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Describe the elements and principles of Total Quality Management (TQM).	Ap	30%
CO2	Apply continuous process improvement methodologies such as Juran's Trilogy, PDSA Cycle, 5S, and Kaizen.	Ap	20%
CO3	Apply various quality tools and techniques in both manufacturing and service industry.	Ap	20%
CO4	Develop strong supplier partnerships and understand supplier selection, rating and relationship development.	An	20%
CO5	choose appropriate quality standards and implement them in the respective industry App.	E	10%

UNIT – I QUALITY CONCEPTS AND PRINCIPLES	**(9)**
Definition of Quality - Dimensions of Quality - Quality Planning - Quality Assurance and Control - Quality Costs with Case Studies - Elements / Principles of TQM - Historical Review – Leadership – Qualities / Habits - Quality Council - Quality Statements, Strategic Planning – Importance - Case Studies - Deming Philosophy - Barriers to TQM Implementation – Cases with TQM Success and Failures.	
UNIT – II TQM-PRINCIPLES AND STRATEGIES	**(9)**
Customer Satisfaction - Customer Perception of Quality - Customer Complaints - Customer Retention, Employee Involvement – Motivation - Empowerment - Teams - Recognition and Reward - Performance Appraisal, Continuous Process Improvement - Juran's Trilogy - PDSA Cycle - 5S - Kaizen, Supplier Partnership - Partnering - Sourcing - Supplier Selection - Supplier Rating - Relationship Development, Performance Measures – Purpose – Methods - Cases.	
UNIT – III CONTROL CHARTS FOR PROCESS CONTROL	**(9)**
Basic Seven Tools of Quality and its Role in Quality Control, Statistical Fundamentals - Measures of Central Tendency and Dispersion, Population and Sample - Normal Curve - Control Charts for Variables and Attributes - Process Capability - Case Study- Introduction to Six Sigma.	

UNIT – IV TQM-MODERN TOOLS	(9)
New Seven Tools of Quality, Benchmarking - Need - Types and Process, Quality Function Deployment - House of Quality (HOQ) Construction - Case Studies, Introduction to Taguchi's Robust Design - Quality Loss Function - Design of Experiments (DOE), Total Productive Maintenance (TPM) - Uptime Enhancement, Failure Mode and Effect Analysis (FMEA) - Risk Priority Number (RPN) – Process - Case Studies.	
UNIT – V QUALITY SYSTEMS	**(9)**
Need for ISO 9000 and Other Quality Systems - ISO 9000: 2015 Quality System – Elements - Implementation of Quality System - Documentation - Quality Auditing, Introduction to ISO 14000 - IATF 16949 - TL 9000-IEC 17025 - ISO 18000 - ISO20000 - ISO 22000 - ISO21001. Process of Implementing ISO - Barriers in ISO Implementation.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOK:

1. Besterfield Dale H., Besterfield Carol, Besterfield Glen H., Besterfield Mary, Urdhwareshe Hemant, UrdhwareshеRashmi "Total Quality Management", 5th Edition, Pearson Education, Noida, 2018.

REFERENCES:

1. Subburaj Ramasamy, "Total Quality Management", McGraw Hill Education, New Delhi, 2017.
2. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, Cengage Learning, 2012.
3. David Goetsch & Stanley Davis, "Quality Management for Organizational Excellence: Introduction to Total Quality", 8th Edition, Pearson, 2017.

Mapping of COs with POs / PSOs

	POs												PSOs	
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3													
2	3													
3	3													
4		3												
5	3				2									
CO (W.A)	**3**	**3**			**2**									

22GEA04- PROFESSIONAL ETHICS				
	L	T	P	C
	3	0	0	3
PRE-REQUISITE : NIL				
Course Objective:	• To develop students' ability to identify, analyse, and resolve ethical dilemmas in engineering contexts, fostering a commitment to professional responsibility, integrity, and ethical decision-making. • To provide engineering students with a comprehensive understanding of ethical principles and practices in the engineering profession. • To Familiarize students with key ethical theories, principles, and frameworks that guide ethical decision-making in professional practice. • To Foster the ability to communicate ethical concerns and collaborate effectively with diverse stakeholders, including colleagues, clients, and the public. • To Encourage students to uphold integrity, honesty, and accountability in their professional activities, fostering a culture of trust and reliability.			

Course Outcomes The Student will be able to		**Cognitive Level**	**Weightage of COs in End Semester Examination**
CO1	Apply ethical reasoning to evaluate and resolve these issues.	Ap	30%
CO2	Apply ethical principles and reasoning to analyze real-world case studies in engineering.	Ap	30%
CO3	Analyze the importance of ethics in professional practice.	An	20%
CO4	Develop the ability to make informed and ethical decisions in engineering practice.	An	10%
CO5	Recognize the importance of continuous learning and professional development in maintaining ethical standards.	E	10%

UNIT I: INTRODUCTION TO PROFESSIONAL ETHICS	**(9)**
Definition and Importance of Ethics, Ethical Theories and Principles, Ethics vs. Morals vs. Values, Role of Ethics in Engineering.	
UNIT II: PROFESSIONAL RESPONSIBILITY AND CODES OF CONDUCT	**(9)**
Professional Responsibility and Accountability, Codes of Conduct in Engineering (e.g., IEEE, NSPE), Conflicts of Interest and Whistleblowing, Case Studies.	
UNIT III: ETHICAL DECISION-MAKING AND PROBLEM-SOLVING	**(9)**
Ethical Decision-Making Models, Tools and Frameworks for Ethical Analysis, Resolving Ethical Dilemmas, Case Studies	
UNIT IV: LEGAL AND REGULATORY ASPECTS	**(9)**

Legal Frameworks Governing Engineering Practice, Intellectual Property Rights, Health, Safety, and Environmental Regulations, Case Studies.	
UNIT V: SOCIAL AND ENVIRONMENTAL RESPONSIBILITY	**(9)**
Social Responsibility of Engineers, Sustainable Engineering Practices, Impact of Engineering on Society and Environment, Case Studies.	
TOTAL (L:45) = 45 PERIODS	

TEXT BOOKS:

1. Charles E. Harris Jr., Michael S. Pritchard, and Michael J. Rabins, "Engineering Ethics: Concepts and Cases" 6th edition, 2018.
2. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering" 5th Edition 2010.
3. by M. Govindarajan, S. Natarajan, and V. S. Senthil Kumar,"Professional Ethics and Human Values",Ist Edition 2006.

REFERENCES:

1. Stephen H. Unger, "Engineering Ethics: Real-World Case Studies"
2. Online Ethics Center for Engineering and Science - www.onlineethics.org
3. National Society of Professional Engineers (NSPE) - www.nspe.org

Mapping of COs with POs / PSOs

	POs												PSOs	
COs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3													
2	3													
3		3												
4		3												
5								3						
CO (W.A)	**3**	**3**						**3**						