GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University)
Coimbatore – 641 013

Curriculum and Syllabi For
M.E. POWER ELECTRONICS AND DRIVES
(Full Time)

2023

Regulations

OFFICE OF THE CONTROLLER OF EXAMINATIONS
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GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai)
Coimbatore-641013

VISION AND MISSION OF THE INSTITUTION

VISION

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

MISSION

To achieve Academic excellence through innovative teaching and learning practices

To enhance employability and entrepreneurship

To improve the research competence to address societal needs

To inculcate a culture that supports and reinforces ethical, professional behaviours for a harmonious and prosperous society

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
GOVERNMENT COLLEGE OF TECHNOLOGY

VISION AND MISSION OF THE DEPARTMENT

VISION:

To be a premier department providing value based and enlightening education committed to excellence in Electrical Engineering and Technology professions.

MISSION:

To facilitate quality learning blended with practical engineering skills

To prepare students to develop all round competitiveness.

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

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
GOVERNMENT COLLEGE OF TECHNOLOGY

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The Programme Educational Objectives (PEOs) of the M.E. Power Electronics and Drives programme

PEO1: To be proficient in the domain of power electronics and competent to solve practical problems.

PEO2: To pursue innovative research in the emerging areas of power conversion system and bequeath optimal solutions.

PEO3: To work synergistically in multidisciplinary tasks exhibiting leadership skills.

PEO4: To Demonstrate Professional ethics and engage in life-long independent reflective learning.

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
GOVERNMENT COLLEGE OF TECHNOLOGY
PROGRAMME OUTCOMES (POs)

Students in the M.E. Power Electronics and Drives Programme should at the time of their graduation be in possession of the following

PO1 : An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

PO4 : Ability to find optimal solutions for power electronics and drives problems in consideration with ethics, safety, societal and environmental factors

PO5: Ability to engage in life-long learning independently, with a high level of passion and proficiency

M.E. POWER ELECTRONICS AND DRIVES

FIRST SEMESTER

S. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23PEFCZ1	Research Methodology and IPR (Common to all Branches)	FC	40	60	100	3	0	0	3
2	23PEFC02	Advanced Mathematics for Electrical Engineering	FC	40	60	100	3	1	0	4
3	23PEPC01	Power Semiconductor Devices and Components	PC	40	60	100	3	0	0	3
4	23PEPC02	Analysis of Power Converters	PC	40	60	100	3	0	0	3
5	23PEPC03	Solid State Drives	PC	40	60	100	3	0	0	3
6	23PEACXX	Audit Course I*	AC	40	60	100	2	0	0	0
THEORY WITH PRACTICAL COMPONENT										
7	23PEPC04	Modelling and Analysis of Electrical Machines	PC	50	50	100	3	0	2	4
PRACTICAL										
8	23PEPC05	Power converters Laboratory	PC	60	40	100	0	0	3	1.5
9	23PEPC06	Renewable Energy Laboratory (Common to PSE & PED)	PC	60	40	100	0	0	3	1.5
TOTAL				**410**	**490**	**900**	**20**	**1**	**8**	**23**

SECOND SEMESTER

S. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23PEPC07	Modelling and Design of SMPC	PC	40	60	100	3	0	0	3
2	23PEPC08	Digital Control for Power Electronic Applications	PC	40	60	100	3	0	0	3
3	23PEPEXX	Professional Elective I	PE	40	60	100	3	0	0	3
4	23PEPEXX	Professional Elective II	PE	40	60	100	3	0	0	3
5	23PEPEXX	Professional Elective III	PE	40	60	100	3	0	0	3
6	23PEACXX	Audit Course II*	AC	40	60	100	2	0	0	0
PRACTICAL										
7	23PEPC09	Electric Drives Laboratory	PC	60	40	100	0	0	4	2
8	23PEEE01	Mini Project	EEC	60	40	100	0	0	4	2
TOTAL				**360**	**440**	**800**	**17**	**0**	**8**	**19**

THIRD SEMESTER

S. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23PEPEXX	Professional Elective IV	PE	40	60	100	3	0	0	3
2	23$$OEXX	Open Elective	OE	40	60	100	3	0	0	3
PRACTICAL										
3	23PEEE02	Internship/Industrial Training	EEC	100	-	100	0	0	**	2
4	23PEEE03	Project-I	EEC	60	40	100	0	0	24	12
TOTAL				**240**	**160**	**400**	**6**	**0**	**24**	**20**

**4 weeks Internship / Industrial Training

FOURTH SEMESTER

S. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23PEEE04	Project Phase II	EEC	60	40	100	0	0	48	24
TOTAL				**60**	**40**	**100**	**0**	**0**	**48**	**24**

TOTAL CREDITS : 86

NOTE : * - NO CREDIT COURSES

LIST OF PROFESSIONAL ELECTIVE SUBJECTS

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
PROFESSIONAL ELECTIVE I										
1	23PEPE01	Linear and Non-Linear Control systems (Common to PSE & PED)	PE	40	60	100	3	0	0	3
2	23PEPE02	Special Machines and Controllers	PE	40	60	100	3	0	0	3
3	23PEPE03	Pulse Width Modulation for Power Converters	PE	40	60	100	3	0	0	3
4	23PEPE04	Computer Aided Design of Electrical Machines	PE	40	60	100	3	0	0	3
PROFESSIONAL ELECTIVE II										
5	23PEPE05	Optimization Techniques	PE	40	60	100	3	0	0	3
6	23PEPE06	Digital Signal Processing and Control	PE	40	60	100	3	0	0	3
7	23PEPE07	HVDC and FACTS (Common to PSE & PED)	PE	40	60	100	3	0	0	3
8	23PEPE08	Smart Grid Technology and Applications (Common to PSE & PED)	PE	40	60	100	3	0	0	3
PROFESSIONAL ELECTIVE III										
9	23PEPE09	Soft Computing Techniques	PE	40	60	100	3	0	0	3
10	23PEPE10	Advanced Electric Drives and Control (Common to PSE & PED)	PE	40	60	100	3	0	0	3
11	23PEPE11	Electric Vehicle	PE	40	60	100	3	0	0	3
12	23PEPE12	Power Electronics in Wind and Solar Power Conversion (Common to PSE & PED)	PE	40	60	100	3	0	0	3
13	23PEPE13	Condition monitoring of Rotating Electric Machines	PE	40	60	100	3	0	0	3
PROFESSIONAL ELECTIVE IV										
14	23PEPE14	Distributed Generations and Microgrid (Common to PSE & PED)	PE	40	60	100	3	0	0	3
15	23PEPE15	Electromagnetic Interference and Compatibility in System Design (Common to PSE & PED)	PE	40	60	100	3	0	0	3
16	23PEPE16	Insulation Materials and Testing for Industrial Applications (Common to PSE & PED)	PE	40	60	100	3	0	0	3
17	23PEPE17	Modern Power Electronics for Traction Applications (Common to PSE & PED)	PE	40	60	100	3	0	0	3
18	23PEPE18	Power Quality Assessment and Mitigation (Common to PSE & PED)	PE	40	60	100	3	0	0	3

LIST OF OPEN ELECTIVES

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23SEOE01	Building Bye-Laws and Codes of Practice	OE	40	60	100	3	0	0	3
2	23SEOE02	Planning of Smart Cities	OE	40	60	100	3	0	0	3
3	23SEOE03	Green Building	OE	40	60	100	3	0	0	3
4	23EEOE04	Environment Health and Safety Management	OE	40	60	100	3	0	0	3
5	23EEOE05	Climate Change and Adaptation	OE	40	60	100	3	0	0	3
6	23EEOE06	Waste to Energy	OE	40	60	100	3	0	0	3
7	23GEOE07	Energy in Built Environment	OE	40	60	100	3	0	0	3
8	23GEOE08	Earth and Its Environment	OE	40	60	100	3	0	0	3
9	23GEOE09	Natural Hazards and Mitigation	OE	40	60	100	3	0	0	3
10	23EDOE10	Business Analytics	OE	40	60	100	3	0	0	3
11	23EDOE11	Introduction to Industrial safety	OE	40	60	100	3	0	0	3
12	23EDOE12	Operations Research	OE	40	60	100	3	0	0	3
13	23MFOE13	Occupational Health and Safety	OE	40	60	100	3	0	0	3
14	23MFOE14	Cost Management of Engineering Projects	OE	40	60	100	3	0	0	3
15	23MFOE15	Composite Materials	OE	40	60	100	3	0	0	3
16	23TEOE16	Global Warming Science	OE	40	60	100	3	0	0	3
17	23TEOE17	Introduction to Nano Electronics	OE	40	60	100	3	0	0	3
18	23TEOE18	Green Supply Chain Management	OE	40	60	100	3	0	0	3
19	23PSOE19	Distribution Automation System	OE	40	60	100	3	0	0	3
20	23PSOE20	Electricity Trading and Electricity Acts	OE	40	60	100	3	0	0	3
21	23PSOE21	Modern Automotive Systems	OE	40	60	100	3	0	0	3
22	23PEOE22	Virtual Instrumentation	OE	40	60	100	3	0	0	3
23	23PEOE23	Energy Management Systems	OE	40	60	100	3	0	0	3
24	23PEOE24	Advanced Energy Storage Technology	OE	40	60	100	3	0	0	3
25	23AEOE25	Design of Digital Systems	OE	40	60	100	3	0	0	3
26	23AEOE26	Basics of Nano Electronics	OE	40	60	100	3	0	0	3
27	23AEOE27	Advanced Processor	OE	40	60	100	3	0	0	3
28	23VLOE28	HDL Programming Languages	OE	40	60	100	3	0	0	3
29	23VLOE29	CMOS VLSI Design	OE	40	60	100	3	0	0	3
30	23VLOE30	High Level Synthesis	OE	40	60	100	3	0	0	3
31	23CSOE31	Artificial Intelligence	OE	40	60	100	3	0	0	3
32	23CSOE32	Computer Network Management	OE	40	60	100	3	0	0	3
33	23CSOE33	BlockChain Technologies	OE	40	60	100	3	0	0	3

LIST OF AUDIT COURSES
(Common to all Branches)

S. No	Course Code	Course Title	Category	Continuous Assessment Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23PEACZ1	English for Research Paper Writing	AC	40	60	100	2	0	0	0
2	23PEACZ2	Disaster Management	AC	40	60	100	2	0	0	0
3	23PEACZ3	Value Education	AC	40	60	100	2	0	0	0
4	23PEACZ4	Constitution of India	AC	40	60	100	2	0	0	0
5	23PEACZ5	Pedagogy Studies	AC	40	60	100	2	0	0	0
6	23PEACZ6	Stress Management by Yoga	AC	40	60	100	2	0	0	0
7	23PEACZ7	Personality Development Through Life Enlightenment Skills	AC	40	60	100	2	0	0	0
8	23PEACZ8	Sanskrit For Technical Knowledge	AC	40	60	100	2	0	0	0

CURRICULUM DESIGN

S. No	Course Work Subject Area	No of Credits					Percentage
		I	II	III	IV	Total	
1.	Foundation Course	7	0	0	0	07	10.29 %
2.	Professional Cores	16	8	0	0	24	35.29 %
3.	Professional Electives	0	9	3	0	12	17.65 %
4.	Open Elective Courses	0	0	3	0	03	4.41 %
5.	Audit Course	0	0	-	-	0	0%
6.	Employability Enhancement Courses	0	2	14	24	40	32.35 %
Total Credits		**23**	**19**	**20**	**24**	**86**	**100%**

23PEFCZ1	RESEARCH METHODOLOGY AND IPR (Common to all Branches)				SEMESTER I	
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		FC	3	0	0	3
Course Objectives	• To impart knowledge on research methodology, Quantitative methods for problem solving, data interpretation and report writing. • To know the importance of IPR and patent rights.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Definition and objectives of Research – Types of research, Various Steps in Research process, Mathematical tools for analysis, Developing a research question-Choice of a problem Literature review, Surveying, synthesizing, critical analysis, reading materials, reviewing, rethinking, critical evaluation, interpretation, Research Purposes, Ethics in research – APA Ethics code						
UNIT – II	**QUANTITATIVE METHODS FOR PROBLEM SOLVING**					**9 Periods**
Statistical Modeling and Analysis, Time Series Analysis Probability Distributions, Fundamentals of Statistical Analysis and Inference, Multivariate methods, Concepts of Correlation and Regression, Fundamentals of Time Series Analysis and Spectral Analysis, Error Analysis, Applications of Spectral Analysis						
UNIT – III	**DATA DESCRIPTION AND REPORT WRITING**					**9 Periods**
Tabular and graphical description of data: Tables and graphs of frequency data of one variable, Tables and graphs that show the relationship between two variables , Relation between frequency distributions and other graphs, preparing data for analysis. Structure and Components of Research Report, Types of Report, Layout of Research Report, Mechanism of writing a research report, referencing in academic writing.						
UNIT – IV	**INTELLECTUAL PROPERTY**					**9 Periods**
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.						
UNIT – V	**PATENT RIGHTS**					**9 Periods**
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES :

1	*Stuart Melville and Wayne Goddard, "**Research methodology: an introduction**", Juta Academic, 2nd edition, 2014*.
2	*Donald H.McBurney and Theresa White, "**Research Methods**", 9th Edition, Cengage Learning, 2013*
3	*RanjitKumar, "**Research Methodology: A Step by Step Guide for Beginners**", 5th Edition, 2019*
4	*Dr. C. R. Kothari and GauravGarg, "**Research Methodology: Methods and Trends**", New age international publishers, 4th Edition, 2018*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate research question for conducting research	K3
CO2	Analyze qualitative and quantitative data	K4
CO3	Interpret research findings and give appropriate conclusions	K4
CO4	Develop a structured content to write technical report	K3
CO5	Summarize the importance of IPR and protect their research work through intellectual property	K2

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	-	2	3	2	1
CO2	2	-	3	1	-
CO3	2	2	3	1	-
CO4	-	3	2	-	-
CO5	-	2	3	2	1
23PEFCZ1	2	2	3	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1/ Case study1/ Seminar 1/Project1	-	50	30	20	-	-	100
Individual Assessment 2/ Case study2/ Seminar 2 /Project2	-	50	30	20	-	-	100
ESE	30	30	20	20	-	-	100

23PEFC02	ADVANCED MATHEMATICS FOR ELECTRICAL ENGINEERING		SEMESTER I			
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		FC	3	1	0	4
Course Objectives	To solve first order ordinary differential equations, nonlinear programming problems and to understand the concepts of Fourier series, matrix theory and standard probability distributions in Electrical Engineering problems.					
UNIT – I	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**		**9+3 Periods**			
Taylor's method – Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order equations - Predictor and corrector methods: Milne's and Adam Bashforth methods.						
UNIT – II	**NON-LINEAR PROGRAMMING**		**9+3 Periods**			
Formulation of Non-Linear Programming Problem-Constrained Optimization with Equality Constraints-Constrained Optimization with inequality Constraints-Saddle Point Problem-Graphical method of Non-linear Programming Problem involving only two variables-Kuhn-Tucker conditions with non-negative constraints.						
UNIT – III	**FOURIER SERIES**		**9+3 Periods**			
Fourier Trigonometric Series: Periodic Function as Power Signals – Convergence Series-Even and Odd function-Cosine and Sine Series-Non–Periodic Function: Extension to other intervals-Power signals: Exponential Fourier Series Parseval's Theorem and Power Spectrum-Eigen Value Problems and Orthogonal Functions-Regular Strum-Loiuville Systems-Generalized Fourier Series.						
UNIT – IV	**MATRIX THEORY**		**9+3 Periods**			
The Cholesky decomposition - Generalized Eigenvectors - Canonical basis - QR factorization - Singular value decomposition - Pseudo inverses - Least square approximation.						
UNIT – V	**RANDOM VARIABLES AND PROBABILITY DISTRIBUTIONS**		**9+3 Periods**			
Random variables–Moments–Moment generating functions and their properties-Standard probability distributions-Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.						
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**						

REFERENCES:

1	*Kandasamy P, Thilagavathy K and Gunavathy K **"Numerical Methods",** S.Chand & Co, Ramnagar, New Delhi, Reprint 2013.*
2	*T.Veerarajan, "**Higher Engineering Mathematics**", Tata McGraw Hill Publishing Company Ltd., New.Delhi 2016.*
3	*Taha,H.A., **"Operations Research-An Introduction"**, Prentice Hall of India, 2003.*
4	*Veerarajan T., **Probability and Random Processes** (with Queueing Theory and Queueing Networks), McGraw Hill Education(India)Pvt Ltd., New Delhi, Fourth Edition 2016.*
5	*Grewal.B.S., **"Higher Engineering Mathematics"**, Khanna Publishers, New Delhi, 44th Edition ,2018.*
6	*Richard Bronson, **"Matrix Operation"**, Schaum's outline series, Second Edition, McGraw Hill, New Delhi, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Solve First order ordinary differential equations with decimal accuracy	K3
CO2	Find optimal solution for nonlinear programming problems	K3
CO3	Form Fourier series using Euler formulae and orthogonal functions	K3
CO4	Apply the concepts of matrix theory in Electrical Engineering problems	K3
CO5	Apply the discrete and continuous probability distributions in engineering problems	K3

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	-	1	1
CO2	3	-	-	1	1
CO3	3	-	-	1	1
CO4	3	-	-	1	1
CO5	3	-	-	1	1
23PEFC02	3	-	-	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	40	35	-	-	-	100
CAT2	25	40	35	-	-	-	100
Individual Assessment1/ Case study1/ Seminar 1/Project1	25	40	35	-	-	-	100
Individual Assessment2/ Case study2/ Seminar 2 /Project2	25	40	35	-	-	-	100
ESE	25	40	35	-	-	-	100

23PEPC04	MODELLING AND ANALYSIS OF ELECTRICAL MACHINES	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
Undergraduate Electrical Machines Course	PC	3	0	2	4

Course Objectives	To understand the importance of conversion of three phase quantity into two phase quantity and to model an electrical machine using reference frame theory to analyze dynamic and steady state performance of electrical machines.

UNIT – I	PRINCIPLES OF ELECTROMAGNETIC ENERGY CONVERSION	9 Periods

Basics of magnetic circuits – General expression of stored magnetic energy – energy and force/Torque Equation – Singly and doubly excited systems – Linear and Non-linear magnetic systems – Analysis of magnetic circuits with air gap and permanent magnets.

UNIT – II	REFERENCE FRAME THEORY	9 Periods

Static and rotating reference frames – Stationary circuit variables transformed to the arbitrary reference frame – Commonly used reference frame -Transformation of variables – Transformation between reference frames – Transformation of a balanced set – Balanced steady state phasor and voltage equations – Variables observed from several frames of reference.

UNIT – III	MODELLING OF DC MACHINE	9 Periods

Voltage and Torque Equations – Dynamic characteristics of permanent magnet and shunt DC motors – Time-domain block diagrams -State equations –Solution of dynamic characteristic by Laplace transformation.

UNIT – IV	MODELLING OF INDUCTION MACHINE	9 Periods

Voltage and Torque Equations – Transformation for rotor circuits – Voltage and torque Equations in reference frame variables – Analysis of steady state operation – Free acceleration characteristics – Dynamic performance for load and torque variations – Dynamic performance for three phase fault – Computer simulation in arbitrary reference frame.

UNIT – V	MODELLING OF SYNCHRONOUS MACHINE	9 Periods

Voltage and Torque Equation – Voltage Equation in arbitrary reference frame and rotor reference frame – Park equations –Rotor angle and angle between rotor – Steady state analysis – Dynamic performances for torque variations–Dynamic performance for three phase fault – Transient stability limit – Critical clearing time – Computer simulation.

LIST OF EXPERIMENTS

1. Transform a balanced abc source to dq0 components. Speed of the rotating reference frame is the same as that of the source.
    a. Rotating reference frame aligned with phase ‘a’ axis.
    b. Rotating reference frame aligned 90 degree lagging with phase ‘a’ axis.
2. Transform an unbalanced abc source to dq0 components. Speed of the rotating reference frame is the same as that of the source.
3. Transform a balanced abc source to dq0 components. Analyze dq variables in synchronous reference frame, arbitrary reference frame and stationary reference frame.
4. Connect load to case 1 and prove that power is variant if a factor of (2/3) is used and power is invariant if a factor of $\sqrt{2/3}$ is used.
5. Simulate induction machine (3 HP, 50 HP, 500 HP and 2250 HP) in arbitrary reference frame and obtain the following characteristic curves
    a. Free acceleration characteristics in machine variables.
    b. Free acceleration characteristics in a stationary reference frame.
    c. Free acceleration characteristics in synchronously rotating reference frames.
    d. Torque-Speed characteristics during free acceleration.
    e. Dynamic performance during step increase and decrease in load torque.

Contact Periods:

Lecture: 45 Periods Tutorial: 0 Periods Practical: 30 Periods Total: 75 Periods

REFERENCES :

1	*Paul C.Krause, Oleg Wasyzczuk, Scott S, Sudhoff, "**Analysis of Electric Machinery and Drive Systems**", JohnWiley & Sons,2013.*
2	*Krishnan.R, "**Electric Motor Drives, Modeling, Analysis and Control**", Prentice Hall of India, 2002.*
3	*Fitzgerald.A.E, Charles Kingsley, Jr, and Stephan D, Umanx, "**Electric Machinery**", Tata McGrawHill, 7th Edition, 2014.*
4	*Chee-Mun-Ong, "**Dynamic Simulations of Electric Machinery: Using MATLAB/SIMULINK",** Prentice Hall, 1991.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Revise the knowledge about principles of electromagnetic energy conversion	K1
CO2	Determine the transformations among various co-ordinate frame	K5
CO3	Formulate machine models based on different reference frames.	K3
CO4	Investigate steady state and dynamic performance of DC machine.	K4
CO5	Examine transient behaviour of AC machine for sudden variation in load and three phase fault.	K4

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	–	–	1	–	1
CO2	1	–	3	–	–
CO3	2	–	3	2	–
CO4	2	–	3	2	–
CO5	2	–	3	2	1
23PEPC04	2	–	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	40	15	15	-	-	100
CAT2	15	10	25	30	20	-	100
Individual Assessment1/ Case study1/ Seminar 1/Project1	10	10	20	30	20	10	100
Individual Assessment2/ Case study2/ Seminar 2 /Project2	25	40	20	15	-	-	100
ESE	30	25	15	20	5	5	100

23PEPC01	POWER SEMICONDUCTOR DEVICES AND COMPONENTS	SEMESTER I

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

Course Objectives	To explore the recent developments of power electronic devices, components, topologies and EMI/EMC techniques

UNIT – I	Power Semiconductor devices	9 Periods

Introduction to switches - Ideal and practical switches - Power Semiconductor devices : Diodes, BJT, Thyristors, JFETs, IGBTs, MoSFETs - Advanced Silicon devices - Silicon HV thyristors, MCT, BRT & EST. - Applications.

UNIT – II	Wide Bandgap devices	9 Periods

Introduction - SiC devices and Gallium nitride devices – SiC JFET - SiC MOSFET - GaN based devices : high-electron-mobility transistor (HEMT) FET and the standard enhancement-mode MOSFET - Comparison – Applications.

UNIT – III	Protection and Driver circuits	9 Periods

Protection schemes for power semiconductor devices – Snubber design – Gate Driver circuits for Power semiconductor devices - Heat transfer - Cooling - Heat sink - types and design - Mounting types

UNIT – IV	Reactive elements	9 Periods

Advances in reactive elements - Advanced magnetic material, technology and design (Powder ferrite, Amorphous, Planar designs) – Advanced capacitive material, technology and designs (Multilayer chip capacitors, double layers for storage, Aluminum electrolytic) – applications

UNIT – V	EMI / EMC	9 Periods

EMI due to switching - EMI sources - EMI Coupling - EMC techniques (Conducted, Radiated emissions & Susceptibility) - System design for EMC

Contact Periods:

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

REFERENCES:

1	*Rashid M.H., "**Power Electronics Circuits, Devices and Applications**", Pearson, Fourth Edition, 2017*
2	*Robert Perret, "**Power Electronics Semiconductor devices**", John Wiley and sons, 2009.*
3	*B. JayantBaliga, **"Silicon Carbide Power Devices"**, World Scientific,2006*
4	*Mohan, Undeland and Robins, **"Power Electronics – Concepts, applications and Design"**, John Wiley and Sons, Singapore, 2007*
5	*Josef Lutz, Heinrich Schlangenotto, UweScheuermann, Rik De Doncker, **"Semiconductor Power Devices Physics", Characteristics, Reliability,** Second Edition,Springer,2018*
6	*Wurth Electronics, **"Trilogy of Magnetics, Design guide for EMI filter design in SMPS & RF circuits"**, 4th extended and revised edition, 2009*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Demonstrate the principles of operation of power semiconductor devices and wide band gap devices	K2
CO2	Select the switching devices for power electronic applications	K3
CO3	Design of snubber and driver circuits for switching devices,	K4
CO4	Recognize recent developments in design aspects of reactive elements	K4
CO5	Examine the EMI/EMC problems and devise solutions for simple power electronic circuits	K3

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	2	2	2
CO2	1	-	1	1	1
CO3	3	-	3	2	1
CO4	1	-	3	1	1
CO5	1	-	1	3	1
23PEPC01	2	-	2	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	30	20	20	-	100
CAT2	-	20	30	30	20	-	100
Individual Assessment1/ Case study1/ Seminar 1/Project1	-	30	30	40	-	-	100
Individual Assessment2/ Case study2/ Seminar 2 /Project2	-	30	30	40	-	-	100
ESE	10	20	30	20	10	10	100

23PEPC02	ANALYSIS OF POWER CONVERTERS	SEMESTER I

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

Course Objectives	To impart knowledge on the working, performance, control techniques and gating circuits of power converters.

UNIT – I	**AC-DC CONVERTERS**	**9 Periods**

Introduction – Single phase and three phase half and fully controlled converters with R,RL and RLE loads- Continuous and discontinuous modes of operation- Inverter operation – performance parameters: harmonics, distortion and power factor –Effect of source impedance-Dual converter: operation and applications

UNIT – II	**DC-DC CONVERTERS**	**9 Periods**

Types of choppers: A, B, C, D and E – Forced commutated choppers- Buck, Boost and Buck-boost and Cuk converters: working, steady state analysis and closed loop control- - battery charging via DC-DC converter.

UNIT – III	**AC VOLTAGE CONTROLLERS AND CYCLO CONVERTERS**	**9 Periods**

Principles of phase and integral cycle control – Single and three phase AC voltage controllers with R and RL loads – AC chopper – Cyclo converter: operation of single and three phase step up and step down converters – Harmonics and power factor control – matrix converters- types.

UNIT – IV	**DC-AC CONVERTERS**	**9 Periods**

Single phase and three phase (120◦ and 180◦ mode)square wave inverters – Fourier analysis of output voltage- Methods of voltage control: PWM (single pulse, multiple pulse and sine PWM techniques)- harmonics elimination: by PWM and stepped wave inverters – Current source inverters: single phase –Multilevel inverter.

UNIT – V	**GATING CIRCUITS FOR CONVERTERS**	**9 Periods**

Introduction – gating circuit for single and three phase fully controlled converter – gating circuits for choppers: gating circuit for AC voltage controllers – Generation of PWM signals for inverter using microcontrollers.

Contact Periods:

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

REFERENCES:

1	*G.K.Dubey, S.R.Doradla., A.Joshi, R.M.K Shinha "**Thyristorised Power Controllers**", New Age International Pvt. Ltd., Delhi, II Edition,2012.*
2	*M.H.Rashid, "**Power Electronics: Circuits, Devices and Application"**, Pearson, Education of India, 2017.*
3	*P.S.Bimbhra, "**Power Electronics"**, Khanna Publishers, Delhi, 14th Edition, 2012.*
4	*M.D.Singh, Kanchandani, "**Power Electronics"**, Tata McGraw Hill., Delhi, II Edition, 2008.*
5	*Mohan, Undeland and Robbins, "**Power Electronics: Converters, Applications and Design"**, John's Wiley and Sons, 2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Demonstrate the mode of operation of power conversion circuits	K3
CO2	Analyze the operation of converters in specific loads	K4
CO3	Identify a suitable converter topology and assess its performance for specific applications	K5
CO4	Design and develop control strategies for efficient operation of converters	K6
CO5	Determine the gating circuit requirements and implement algorithm in digital controllers	K4

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	3	-	2
CO2	3	-	3	2	2
CO3	3	-	3	3	2
CO4	3	1	3	2	-
CO5	3	-	3	3	-
23PEPC02	3	1	3	2	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	30	30	10	-	100
CAT2	-	20	30	30	20	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	-	20	30	30	20	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	-	10	20	40	30	-	100
ESE	10	20	20	30	20	-	100

23PEPC03	SOLID STATE DRIVES		SEMESTER I			
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PC**	**3**	**0**	**0**	**3**
Course Objectives	To provide the concepts, effective control techniques and ability to identify the suitability of electric drives.					
UNIT – I	**CONVENTIONAL AND CONVERTER CONTROL OF DC DRIVES**					**9 Periods**
Review of Conventional Control of DC drives and Characteristics - Methods of braking of dc motors– Models and transfer function of series and separately excited dc motor–Multi quadrant operation. Control of dc drives with single phase and three phase converters- - Closed loop control Dual converter fed dc motor- Implementation of braking schemes – Input side Power factor improvement						
UNIT – II	**CHOPPER CONTROL OF DC MOTORS**					**9 Periods**
Steady state analysis of chopper-controlled dc drives – Continuous and discontinuous current conduction modes–Dynamic state analysis- Control strategies- CLC and TRC strategies – Multi quadrant control - Closed loop control- Micro Computer implementation for drives - Traction motors- Traction supply systems - PV fed DC drives for pumping application						
UNIT – III	**VOLTAGE AND FREQUENCY CONTROLLED INDUCTION MOTOR DRIVES**					**9 Periods**
Introduction - Stator voltage control using AC voltage controller- VSI and CSI driven induction motors: motoring, regenerative braking and closed loop operation – Constant Volts/Hz control: Constant slip speed control and air gap flux weakening control – Four quadrant control and closed loop operation – Effect of non sinusoidal supply on performance of induction motor - Comparison of VSI and CSI fed drives. Soft starting of induction motors						
UNIT – IV	**SCALAR AND VECTOR CONTROL OF INDUCTION MOTOR DRIVES**					**9 Periods**
Vector Control of AC Machines - Direct vector control scheme – Indirect vector control scheme – Direct Torque Control – Comparison between DTC and FOC Schemes. Speed control of slip ring induction motor by injected emf- Torque slip characteristics – static rotor resistance control - Static Kramer and Scherbius drives- sub synchronous and super synchronous operations.						
UNIT – V	**SYNCHRONOUS MOTOR DRIVES**					**9 Periods**
Vector controlled of synchronous motor drives – constant flux and Flux weakening speed control - Power factor control and self-control - closed loop operation- vector control of permanent magnet synchronous motor (Brushless excitation) - EMI and EMC due to electric drives – industrial standards related to electric drives.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES :

1	*Sen, P.C. "**Thyristor DC Drives**", John Wiley and Sons, 1991.*
2	*Krishnan.R. "**Electric Motor Drives- Modelling, Analysis and Control**", Pearson Education, 2010*
3	*Dubey,G.K. "**Power Semiconductor Controlled Drives**", New York:Prentice Hall,1993*
4	*VedamSubramanyam, "**Electric drives concepts and applications**", Tata McGraw Hill publishing company Ltd., II Edition,New Delhi, 2011*
5	*Murphy, J.M.D, Turnbull, F.G. "**Thyristor Control of AC Motors"**, Pergamon press, Oxford, First Edition,1988.*
6	*Bin Wu, Mehdi Narimani , **"High Power Converters and AC Drives",** IEEE Press, A John Wiley & Sons, Inc., Publication, Second Edition ,2017*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Summarize the concepts of conventional DC drive	K2
CO2	Analyze the performance of various semiconductor-controlled DC drives and identify the applications	K4
CO3	Analyze the performance of AC motors with conventional control strategies	K5
CO4	Analyze the performance of AC motors with advanced control strategies	K5
CO5	Identify the suitability of control methods of AC Drives for industrial applications	K6

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	1	1	1
CO2	3	1	2	2	2
CO3	3	-	2	1	2
CO4	3	1	3	2	3
CO5	1	-	2	-	3
23PEPC03	3	1	2	1	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	40	20	-	-	100
CAT2	10	20	40	20	10	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	-	20	30	30	20	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	-	20	30	20	20	10	100
ESE	10	20	20	30	10	10	100

23PEPC05	POWER CONVERTERS LABORATORY	SEMESTER I

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

Course Objectives	To study and analyze the characteristics of the power electronic devices and performance of converter circuits through simulation and hardware setup.

LIST OF EXPERIMENTS

1. Single phase semi and fully controlled rectifier (R & RL Load) -study the effect of nonlinear loads on power quality of input supply
2. Three phase semi converter and full converter (R & RL. Load)- study the effect of balanced non-linear load on neutral current
3. Open loop and closed loop control of buck Converter.
4. Open loop and closed loop control of boost Converter.
5. Three phase square wave inverter (120 and 180 degree modes)- measure output voltage THD and distortion factor.
6. Performance analysis of single phase VSI using unipolar and bipolar sine PWM Techniques- measure output voltage THD and distortion factor.
7. Performance analysis of three phase VSI using unipolar and bipolar sine PWM Techniques- measure output voltage THD and distortion factor.
8. Cascaded multilevel inverter
9. a) Dual converter- Analysis of circulating and non circulating current modes
   b) Single and three phase cyclo-converter-step up and step down modes
10. Single phase ac voltage regulator (R&RL load)- calculate the input power factor and demonstrate the current distortion at the input side (current THD).
11. Study the effect of voltage sag on electrical equipment.
12. Study the voltage sag due to starting of large induction motor in DIGSILENT/MATLAB/PSIM

Contact Periods:

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

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Synthesize various power electronic converter circuits in software platforms.	K3
CO2	Realize the hardware prototype for power converters.	K6
CO3	Design control structure for efficient operation of power converters	K4
CO4	Measure the performance parameters of power converters for various loads	K2
CO5	Test the power converters under various grid conditions	K2

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	3	-	-
CO2	3	-	3	-	-
CO3	3	2	3	2	3
CO4	3	2	3	2	3
CO5	3	2	3	2	3
23PEPC05	3	2	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial					

23PEPC06	RENEWABLE ENERGY LABORATORY (Common to PSE & PED)	SEMESTER I

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

Course Objectives	To explore the operation, study the performance and visualize the renewable based power electronic systems and to interface signal conditioning devices with MATLAB and hardware components.

LIST OF EXPERIMENTS

1. Analyze the given Solar Panel mounted on the roof top using Solar PV analyser.
2. Emulate Solar PV characteristics for a specific location using Solar PV Emulator.
3. Analyze the harmonics of grid connected solar systems using Power Quality Analyser. Extract and study the data logged in the grid connected system.
4. Study of PMSG/DFIG based wind turbine and its associated parameters, characteristics and modes of operation.
5. Emulate Wind Energy characteristics for a specific location using Wind Emulator.
6. Study of energy storage system.

Contact Periods:

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

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Emulate the characteristics of renewable sources.	K6
CO2	Analyze the grid connected renewable system.	K4
CO3	Realize and interface a suitable converter circuit with renewable sources.	K3
CO4	Measure the performance parameters of various renewable systems and work out a suitable solution.	K5
CO5	Explore the operation of circuits with renewable sources.	K2

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	–	3
CO2	3	3	3	1	2
CO3	3	3	2	1	–
CO4	3	3	2	2	1
CO5	3	3	-	–	2
23PEPC06	3	3	2	1	2

1 – Slight, 2 – Moderate, 3 – Substantial

23PEPC07	MODELLING AND DESIGN OF SMPC					SEMESTER II
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PC	3	0	0	3
Course Objectives	To comprehend analysis and design of power converter topologies for real time applications.					
UNIT – I	**DC to DC Converter**					**9 Periods**
Basic concepts of Switched Mode power converters - Primitive DC to DC Power Converter-Operating Principle - Exact and Approximate Analysis.						
UNIT – II	**CONVERTER TOPOLOGIES**					**9 Periods**
Non-isolated DC to DC Power Converter- Buck, Boost, Buck-Boost, Cuk, SEPIC and Quadratic Converters - Isolated DC to DC Power Converter - Forward, Fly back, Half/Full Bridge Converters. - Steady State model, dynamic model, analysis, modeling and performance functions of switching power converters.						
UNIT – III	**RESONANT DC-DC CONVERTERS**					**9 Periods**
Basic of Resonant circuits- Classification : Series resonant circuit, parallel resonant circuit – Resonant switches : Zero voltage switching, Zero current switching – Analysis of M-type and L-type resonant Buck and Boost converters.						
UNIT – IV	**CONVERTER DYNAMICS**					**9 Periods**
AC equivalent circuit analysis – State space averaging – Circuit averaging – Averaged switch modeling – Transfer function model for buck, boost, buck-boost and cuk converters – Input filters.						
UNIT – V	**CONTROLLER DESIGN**					**9 Periods**
Review of P, PI, and PID control concepts – gain margin and phase margin – Bode plot based analysis – Design of closed loop controller for buck, boost, buck-boost and cuk converters.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES:

1	*Ramanarayanan V., "**Course Material on Switched Mode Power Conversion**", Department of Electrical Engineering, Indian Institute of Science, Bangalore, 2007*
2	*L.Umanand, "**Power Electronics Essentials & Applications**", Wiley India Pvt. Ltd., 2009*
3	*Robert W. Erickson & Dragon Maksimovic, **"Fundamentals of Power Electronics"**, Second Edition, 2001 Springer science and Business me*
4	*Issa Batarseh, Ahmad Harb, **"Power Electronics- Circuit Analysis and Design"**, Second edition*
5	*Ned Mohan, **"Power Electronics: A first course",** John Wiley,2012*
6	*Simon Ang and Alejandra Oliva, **"Power-Switching Converters"**, CRC press, 3rd edition, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify existing power converter topologies	K2
CO2	Design new and efficient power converters suitable for specific applications	K4
CO3	Develop transfer function model for converter topologies	K3
CO4	Design and selection of component values based on steady-state dc and ac ripple specifications	K2
CO5	Analyse and Design of Control Loops around switched-mode power converters	K4

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	2	2	2
CO2	3	-	3	2	3
CO3	2	-	3	3	2
CO4	3	-	3	3	2
CO5	2	-	3	2	3
23PEPC07	3	-	3	2	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	-	10	100
CAT2	-	20	30	40	-	10	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	-	30	30	40	-	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	-	30	30	40	-	-	100
ESE	10	20	30	30	-	10	100

23PEPC08	DIGITAL CONTROL FOR POWER ELECTRONIC APPLICATIONS					SEMESTER II
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
CONTROL SYSTEMS		PC	3	0	0	3
Course Objectives	To explore the concepts and applications of digital control systems for power electronic circuits.					
UNIT – I	**DIGITAL CONTROL SYSTEMS**					**9 Periods**
Concepts of digital control -Structure of digital control system -Discrete time systems: Sampling and reconstruction of signals - ZOH circuits - Introduction to z-transforms and inverse z-transforms - Modeling of digital control systems.						
UNIT – II	**STABILITY OF DIGITAL CONTROL SYSTEMS AND DESIGN**					**9 Periods**
Stability conditions - Stability determination - Nyquist criterion - Phase margin and gain margin, Z-domain root locus - State space modeling of power converters - discrete P, PI, PID controller design - Frequency response analysis.						
UNIT – III	**DIGITAL CONTROL APPLICATION IN POWER ELECTRONIC CIRCUITS**					**9 Periods**
Single phase inverter - Digital current mode control - Requirements of digital controller - Basic current control implementations: PI - Predictive controller Three Phase Systems: Space vector modulation - Rotating reference frame current controller - Design of rotating reference frame PI current controller.						
UNIT – IV	**EXTERNAL CONTROL LOOPS**					**9 Periods**
Modeling of internal control loops - Design of voltage controllers - Large band width controllers - Applications of current controlled VSI (Controlled Rectifier, Active power filter)						
UNIT – V	**DESIGN OF FPGA AND DSP BASED SYSTEMS**					**9 Periods**
Introduction to Field Programmable Gate Arrays-types of FPGA-DSP Slices- Design example-Introduction to DSP - Modeling of DSP algorithms in MATLAB - conversion of MATLAB models into fixed point VHDL blocks - Platform implementation issues: FPGA vs DSP						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES:

1	*Simone Buso, paoloMattavelli,* ***"Digital control in power electronics"****, Morgan & Claypool Publishers, 2006.*
2	*M.SamFadali ,* ***"Digital control engineering analysis and design****" Academic Press, 2012.*
3	*Ogata:K,* ***"Modern Control Engineering"****-Prentice Hall -2014*
4	*B K Bose ,* ***"Modern Power Electronics and AC Drives"*** *-Pearson Publications 1edition, 2011*
5	*Prof Miguel Castilla (ed.),* ***"Control Circuits in Power Electronics: Practical issues in design and implementation"*** *IET, 2016.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Demonstrate the concept of digital control systems to design and deal with the Z domain representation of systems.	K4
CO2	Test the real time system stability and design of control loops in the digital domain.	K4
CO3	Analyze the system dynamics with digital controllers.	K5
CO4	Analyze the digital controller-based power electronic systems	K4
CO5	Apply the knowledge acquired about digital controllers for real time applications	K3

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	-	2	1	-
CO2	2	1	1	1	-
CO3	3	-	3	-	3
CO4	2	1	-	2	1
CO5	3	-	2	2	3
23PEPC08	3	1	2	2	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	30	30	10	-	100
CAT2	10	10	20	40	10	10	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	-	20	30	20	10	10	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	-	30	20	20	20	10	100
ESE	10	20	30	20	10	10	100

23PEPC09	ELECTRIC DRIVES LABORATORY	II SEMESTER

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

Course Objectives	To study the performance of power converter fed drives in simulation and hardware platforms and to perform speed control and braking of power converter fed drives

LIST OF EXPERIMENTS:

1. Open and closed loop control of phase controlled converter fed DC drive
2. Open and closed loop control of chopper fed DC drive
3. Speed control of single phase induction motor using AC voltage controller
4. Constant V/f control of PWM inverter fed three phase induction motor (open and closed loop)
5. Speed control of BLDC drive using DSP controller
6. Speed control of SRM drive using DSP controller
7. Stator voltage control of three phase induction motor using Real-Time lab
8. Vector control of three phase induction motor using Real-Time lab
9. Regenerative braking operation of DC motor in PSIM/MATLAB software
10. Regenerative braking operation of induction motor in PSIM/MATLAB software
11. Speed control of five phase Induction Machine

Contact Periods:

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

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Build and test various power electronic converters for drive applications	K3
CO2	Analyze the performance of various drives using simulation software.	K4
CO3	Realize various control techniques for drives using different digital controllers	K6
CO4	Control of speed of drives in various software and hardware platforms	K5
CO5	Realize regenerative operation of drives in simulation	K2

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	3	2
CO2	3	2	3	3	3
CO3	3	2	3	3	3
CO4	3	2	3	3	3
CO5	3	2	3	3	3
23PEPC09	3	2	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

23PEEE01	MINI PROJECT	SEMESTER II

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

Course Objectives	To develop student‘s abilities to transmit technical information clearly and test the same by delivery of Seminar based on the Mini Project

Students can take up problems in the field of Power Electronics and Drives. It can be related to providing solutions to an engineering problem, verification and analysis of experimental data available, conducting experiments on various engineering subjects, material characterization, studying a software tool for the solution of an engineering problem etc.

A project work note should be maintained by the students containing the details of work done, problems faced, solutions evolved etc. and should be duly signed by the Internal Guide on regular intervals.

The students are expected to utilize the laboratory resources before or after their contact hours as per the prescribed module.

Contact Periods:

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

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Articulate the Engineering problems and Analyze the problem statements	K2
CO2	Identify appropriate tools to implement the projects	K4
CO3	Plan and implement the hardware/ software project	K6
CO4	Develop skills to write technical reports, present and defend their work	K6
CO5	Demonstrate the project with effective presentation	K2

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	3	2
CO2	3	-	3	3	1
CO3	3	2	3	3	2
CO4	3	3	2	2	2
CO5	3	3	2	2	-
23PEEE01	3	2	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

23PEEE02	INTERNSHIP/INDUSTRIAL TRAINING					SEMESTER III
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		EEC	-	-	-	-
Course Objectives	To provide students with opportunities for practical, hands-on learning from practitioners in their areas of specialization and enhance their employability skills					

Students have to complete an Internship/ industrial training for a duration of 4 weeks. It should be carried out in industries related to the Power Electronics field.

During the training period students have to keep record of all the useful information in the Log book and maintain the weekly diary.

At the end of the training internal faculty member will assess the work done by the student based on his/her presentation and training report.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Demonstrate the modern tools used in the field of Power electronics for research and product development.	K3
CO2	Apply theoretical learning in practical situations for the tasks assigned in the workplace.	K3
CO3	Demonstrate professional values and ethics in workplace environment	K3
CO4	Develop interpersonal and other critical skills.	K6
CO5	Prepare the technical report and give oral presentations for the training undertaken.	K3

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	3	2	1
CO2	3	-	3	3	1
CO3	-	-	-	2	1
CO4	-	-	2	-	-
CO5	-	3	-	-	-
23PEEE02	3	3	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

** Duration of four weeks

23PEEE03	PROJECT-I	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	24	12

Course Objectives	To undertake detailed technical work in the chosen area of theoretical Engineering studies through simulations for the benefit of Society.

The type of project includes Experimental work, fabrication, prototype, Design projects, feasibility studies, simulations, development of software and applications of emerging technologies.

The progress of the project is evaluated based on three reviews.

The project work is evaluated jointly by external and internal examiners based on oral presentation and the project report.

Contact Periods:

Lecture: 0 Periods Tutorial: 0 Periods Practical: 360 Periods Total: 360 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the engineering problem based on Societal/Industrial demand through detailed Literature Survey	K4
CO2	Design and evaluate the system using software tools	K6
CO3	Gain expertise in the interpretation of simulation / experimental pertaining to the system	K4
CO4	Write technical document in the form of project report and journal publication	K3
CO5	Develop effective Communication through presentation and defend their work	K3

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	3	-
CO2	3	-	3	-	3
CO3	-	-	3	3	-
CO4	-	3	-	-	-
CO5	-	3	-	-	-
23PEEE03	3	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

23PEEE04	PROJECT-II	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	48	24

Course Objectives	To undertake detailed technical work in the chosen area of theoretical Engineering studies through simulations and hardware for the benefit of Society

The type of project includes Experimental work, fabrication, prototype, Design projects, feasibility studies, simulations, development of software and applications of emerging technologies.

The progress of the project is evaluated based on three reviews.

The project work is evaluated jointly by external and internal examiners based on oral presentation and the project report.

Contact Periods:

Lecture: 0 Periods Tutorial: 0 Periods Practical: 720 Periods Total: 720 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify the engineering problem based on Societal/Industrial demand through detailed Literature Survey	K4
CO2	Design and evaluate the system using software/ hardware tools	K6
CO3	Gain expertise in the interpretation of simulation / experimental results.	K4
CO4	Write technical document in the form of project report and journal publication	K3
CO5	Develop effective Communication through presentation and defend their work	K3

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	3	-
CO2	3	-	3	-	3
CO3	-	-	3	3	-
CO4	-	3	-	-	-
CO5	-	3	-	-	-
23PEEE04	3	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

23PEPE01	LINEAR AND NON-LINEAR CONTROL SYSTEMS (Common to PSE and PED)		SEMESTER II			
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
BASIC CONTROL, LINEAR ALGEBRA		PE	3	0	0	3
Course Objectives	To understand the fundamentals of physical systems in terms of its linear and nonlinear models					
UNIT – I	**STATE VARIABLE REPRESENTATION AND STATE EQUATIONS**					**9 Periods**
Concept of state- State space modeling- State equations for dynamic systems- Time invariance and linearity- Non uniqueness of state model- Existence and uniqueness of solutions to continuous time state equations- Solution of linear and non-linear time varying state equations- State transition matrix-Transfer function from state model- Evaluation of matrix exponential- Role of Eigen value and Eigen vector.						
UNIT – II	**STABILITY ANALYSIS AND STATE FEEDBACK CONTROL OF LINEAR SYSTEMS**					**9 Periods**
Controllability and observability- Kalman Rank conditions- Detectability and stabilizability- Kalman decomposition- State feedback controller design using pole placement - observer design using Kalman filter algorithm- LQR/ LQG controller design.						
UNIT – III	**NONLINEAR SYSTEMS**					**9 Periods**
Characteristics of nonlinear systems - Classification of equilibrium points- limit cycles- analysis of systems with piecewise constant inputs using phase plane analysis , perturbation techniques , periodic orbits, stability of periodic solutions , singular perturbation model, slow and fast manifolds.						
UNIT – IV	**LYAPUNOV STABILITY AND DESIGN**					**9 Periods**
Stability of Nonlinear Systems - Lyapunov stability, local stability, local linearization and stability in the small, Direct method of Lyapunov, generation of Lyapunov function for linear and nonlinear systems, variable gradient method, Centre manifold theorem, region of attraction, Invariance theorems - Input output stability, L stability, L stability of state models, L2 stability, Lyapunov based design, Lyapunov redesign, Robust stabilization, Nonlinear Damping, backstepping, sliding mode control, adaptive control, Model controller, model reference adaptive control.						
UNIT – V	**HARMONIC LINEARIZATION AND DESCRIBING FUNCTION METHOD**					**9 Periods**
Harmonic linearization, filter hypothesis, describing function of standard nonlinearities, study of limit cycles (amplitude and frequency) using SIDF, Dual Input Describing function, study of sub- harmonic oscillations, correction on describing functions.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES:

1	*Ogata, K., **"Modern control Engineering"**, Prentice Hall of India, 2010.*
2	*C.T. Chen, "**Linear Systems Theory and Design"**, Oxford University Press, 3rd Edition, 1999.*
3	*M. Vidyasagar, **"Nonlinear Systems Analysis"**, 2nd edition, Prentice Hall, Englewood Cliffs, New Jersey 07632.*
4	*Hassan K. Khalil, **"Nonlinear Systems"**, Pearson Educational International Inc. Upper Saddle River, 3rd Edition.*
5	*S. Wiggins, **"Introduction to Applied Nonlinear Dynamical Systems and chaos"**, Springer, 2010, 2nd Edition.*
6	*H. Nijmeijer & A.J. Vander Schaft **"Nonlinear Dynamic Control Systems"**, Springer, 2016, 1st Edition.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Articulate the physical systems in terms of linear and non linear models and solve linear and non linear state equations.	K2
CO2	Analyze the stability of the linear system and design the state feedback observers and controllers	K4
CO3	Explain the behavioral properties of nonlinear controlled systems	K2
CO4	Analyze stability analysis of nonlinear systems, feedback linearization control method, Lyapunov design and sliding mode control method	K4
CO5	Formulate and solve basic robust and nonlinear controller design problems	K3

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	-	1	2	3
CO2	3	-	2	2	3
CO3	2	-	1	1	3
CO4	3	-	2	2	3
CO5	3	1	2	2	3
23PEPE01	3	1	2	2	3
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	-	20	40	40	-	-	100
CAT2	-	20	40	40	-	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	-	-	40	40	-	20	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	-	-	40	40	-	20	100
ESE	-	20	40	40	-	-	100

23PEPE02	SPECIAL MACHINES AND CONTROLLERS	SEMESTER II

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

Course Objectives	To impart knowledge on the construction, principles of operation, control techniques and performance of special machines.

UNIT – I	**SYNCHRONOUS RELUCTANCE MOTORS**	**9 Periods**

Constructional features -Axial and radial air gap Motors - Operating principle, reluctance torque – Phasor diagram - motor characteristics.

UNIT – II	**STEPPER MOTORS**	**9 Periods**

Classification - Construction - Principle of operation -Modes of excitation- torque production in Variable Reluctance (VR) stepping motor - Dynamic characteristics - Drive systems and circuit for open loop control and Closed loop control -Applications.

UNIT – III	**SWITCHED RELUCTANCE MOTORS**	**9 Periods**

Constructional features-Principle of operation-Torque equation- Types of Power Controllers-Characteristics and current control schemes - Microprocessor based controller.

UNIT – IV	**PERMANENT MAGNET BRUSHLESS DC MOTORS**	**9 Periods**

Commutation in DC motors - Difference between mechanical and electronic commutators - Hall sensors -Optical sensors - Multiphase Brushless motor - Square wave permanent magnet brushless motor drives, Torque and emf equation - Torque-speed characteristics –Controllers for PMBLDC motor –Applications of BLDC in EV

UNIT – V	**PERMANENT MAGNET SYNCHRONOUS MOTORS**	**9 Periods**

Permanent Magnet and Characteristics-Principle of operation, EMF, power input and torque expressions -Phasor diagram - Power controllers - Torque speed characteristics – Self-control - Vector control - Current control schemes- Sensorless control.

Contact Periods:

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

REFERENCES :

1	*Miller, T.J.E. "**Brushless permanent magnet and reluctance motor drives**", Clarendon Press, Oxford University,1989*
2	*Kenjo, T, "**Stepping motors and their microprocessor control**", Clarendon Press, Oxford University, Second Edition, 2003*
3	*Kenjo, T and Naganori, S "**Permanent Magnet and brushless DC motor**", Clarendon Press, Oxford University, 1990*
4	*Kenjo, T. "**Power Electronics for the microprocessor Age"**, Oxford University press, 1995*
5	*B.K. Bose, "**Modern Power Electronics & AC drives**", Prentice Hall Publisher, 2012*
6	*R.Krishnan, "**Electric Motor Drives – Modeling, Analysis and Control**", Prentice-Hall of India Pvt. Ltd., New Delhi, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the working of special machines and its performance	K3
CO2	Relate the characteristics and different types of controllers for the special machines	K4
CO3	Implement the control techniques in the digital controller.	K5
CO4	Analyse the various control techniques for the special machines	K4
CO5	Select the suitability of machine for various applications	K3

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	3	-	2
CO2	3	1	3	3	2
CO3	3	1	2	2	-
CO4	3	-	3	2	-
CO5	3	-	3	3	2
23PEPE02	3	1	3	2	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	40	30	-	-	100
CAT2	10	20	30	40	-	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	-	20	40	40	-	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	-	10	40	40	10	-	100
ESE	10	20	30	40	-	-	100

23PEPE03	PULSE WIDTH MODULATION FOR POWER CONVERTERS					SEMESTER II
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	3	0	0	3
Course Objectives	To introduce the concepts of Pulse Width Modulation and explore the steady-state, dynamic analysis of PWM converters along with the applications					
UNIT – I	**INTRODUCTION TO PWM**					**9 Periods**
Need of PWM : fundamental and harmonic voltages - undesirable effects of harmonic voltages – line current distortion, increased losses, pulsating torque in motor drives; control of fundamental voltage - mitigation of harmonics and their adverse effects – Fundamental concept of Pulse Width Modulation						
UNIT – II	**PWM TECHNIQUES**					**9 Periods**
Single Pulse PWM - Multiple Pulse PWM - Sinusoidal PWM - Hysteresis band PWM - Bus Clamping PWM - Space vector based PWM – Comparison of PWM						
UNIT – III	**ADVANCED PWM TECHNIQUES**					**9 Periods**
Optimized PWM - Third harmonic injection PWM – Selective harmonic elimination - Space Vector PWM for Over modulation - PWM to multilevel inverters						
UNIT – IV	**MODELLING AND ANALYSIS FOR PWM CONVERTERS**					**9 Periods**
Compensation for dead time and DC regulation – Dynamic model of a PWM converter , multilevel converters - Estimation of current ripple and torque ripple in inverter fed drives; line – side converters with power factor compensation						
UNIT – V	**APPLICATIONS OF PWM**					**9 Periods**
constant V/F induction motor drives - Active front end converters - Reactive compensators – Harmonic current compensation - active power filters						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*Mohan, Undeland and Robbins, "**Power Electronics; Converters, Applications and Design"**, John Wiley and Sons, 1989*
2	*Grahame Holmes and Thomas A.Lipo, **"Pulse Width Modulation for Power Converters**: Principle and Practice", IEEE Press, John Wiley and Sons, 2003*
3	*Robert W. Erickson & Dragon Maksimovic "**Fundamentals of Power Electronics**" Second Edition, 2001 Springer science and Business media*
4	*Simon Ang and Alejandra Oliva, "**Power Switching Converter**", Yesdee publishers, New Delhi, 2nd edition (first Indian Reprint), 2010*
5	*Vithyathil J, "**Power Electronics: Principles and Applications"**, McGraw Hill, 1995.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Outline the fundamentals of PWM techniques	K2
CO2	Classify the different techniques of PWM	K2
CO3	Explore the Steady-State, transient modelling and analysis of power converters with various PWM techniques	K4
CO4	Analysis and Design of Control Loops for PWM power converters	K4
CO5	Construct in Environment friendly applications like solid state drives and power quality in societal needs	K3

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	3	2	2
CO2	3	-	2	2	2
CO3	2	-	3	2	3
CO4	3	-	3	3	3
CO5	2	-	2	3	2
23PEPE03	3	-	3	2	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	-	10	100
CAT2	10	40	30	20	-	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	-	20	40	40	-	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	-	20	40	40	-	-	100
ESE	10	30	30	20	-	10	100

23PEPE04	COMPUTER AIDED DESIGN OF ELECTRICAL MACHINES	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
Undergraduate Electrical Machines Course	PE	3	0	0	3

Course Objectives	To study the conventional and computer aided design of electrical machines and to model and analyze the electrical machines with finite element method.

UNIT – I	**DESIGN PROCEDURE**	**9 Periods**
Conventional design procedures-Limitations-Main dimensions and Field system of DC and AC machines-problems.		
UNIT – II	**MATHEMATICAL FORMULATIONS OF FIELD PROBLEMS**	**9 Periods**
Development of torque/force – Electromagnetic Field Equations – Magnetic Vector/ Scalar potential - Electrical Vector/ Scalar potential – Stored energy in field problems – Inductance – Laplace and Poisson's equations – Maxwell equations – Problems		
UNIT – III	**PHILOSOPHY OF FEM**	**9 Periods**
Differential / Integral equations – Numerical methods - Finite Difference method – Finite Element method – Moment method - Energy minimization – Variational method – 2D field problems –Discrimination – Shape functions – Stiffness matrix.		
UNIT – IV	**CAD PACKAGES**	**9 Periods**
Energy functional – Principle of energy conversion - Elements of a CAD System – Preprocessing – Modeling – Simple iterative methods - Newton Raphson and Gauss Seidal Methods - Meshing – Materials properties - Boundary Conditions – Solution techniques – Post processing and Optimization.		
UNIT – V	**APPLICATIONS**	**9 Periods**
Design of Solenoid Actuator – Switched reluctance motor - Induction motor - Stepper motor.		

Contact Periods:

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

REFERENCES :

1	*Silvester and Ferrari, "**Finite Elements for Electrical Engineers**", Cambridge University Press, New York, Third Edition, 1996.*
2	*Trowbridge C.W, "**An Introduction to Computer Aided Electromagnetic Analysis**", Vector Fields Ltd., Oxford, 1990.*
3	*Hoole S.R.H, "**Computer Aided Analysis and Design of Electromagnetic Devices**", Elsevier Science Publishing Co., New York, 1989.*
4	*Sawhney A.K, "**A Course in Electrical Machine Design**", DhanpatRai & Sons, New Delhi, 2016.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Apply the knowledge of machine design and model the system using field concepts	K3
CO2	Analyse the designed system using CAD packages	K4
CO3	Evaluate the performance of each machine using various modern engineering tools.	K5
CO4	Formulate and solve the optimum design problems with computers.	K6
CO5	Explore the energy efficient design techniques of electrical machines.	K3

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	3	-	2
CO2	3	-	3	2	1
CO3	3	-	3	3	1
CO4	3	2	3	2	-
CO5	3	2	3	3	-
23PEPE04	3	2	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	15	15	-	-	100
CAT2	15	10	25	30	20	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	10	10	20	30	20	10	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	25	40	20	15	-	-	100
ESE	30	25	15	20	10	-	100

23PEPE05	OPTIMIZATION TECHNIQUES				SEMESTER II
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	To learn the concepts and techniques of optimization for solving the problems in engineering	
UNIT – I	**INTRODUCTION**	**7 Periods**
Introduction-Basic optimization problem-Classifications of optimization problem - Constraints- Critical points - Conditions for local minima - Contour plots - Derivatives.		
UNIT – II	**LINEAR PROGRAMMING**	**10 Periods**
Principles of single and multi objective problem with and without inequality constraints - Linear programming : Mathematical model, Graphical solution, Simplex method, Revised simplex method- Application of linear programming in power system problems.		
UNIT – III	**ADVANCES IN LINEAR PROGRAMMING**	**9 Periods**
Duality theory- Dual simplex method – Sensitivity analysis–-Transportation problems– Assignment problems- Traveling salesman problem.		
UNIT – IV	**NON LINEAR PROGRAMMING**	**10 Periods**
Steepest descent and conjugate gradient method - Lagrange multiplier - Basic approach of the penalty function method - Interior and exterior penalty function method - Interior point method (Qualitative).		
UNIT – V	**DYNAMIC PROGRAMMING**	**9 Periods**
Formulation of Multi stage decision problem – Characteristics – Concept of sub-optimization and the principle of optimality – Formulation of Dynamic programming – Backward and Forward recursion – Computational procedure – Conversion of final value problem in to Initial value problem-Case studies.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Mykel J. Kochenderfer and Tim A.Wheeler **"Algorithms for Optimization"** MIT press, 2019*
2	*Hillier and Lieberman **"Introduction to Operations Research"**, TMH, 2000.*
3	*R.Panneerselvam, **"Operations Research"**, PHI, 2006*
4	*Hamdy ATaha, **"Operations Research –An Introduction"**, Prentice Hall India, 2003.*
5	*Ronald L.Rardin, **"Optimization in Operation Research"** Pearson Education Pvt. Ltd. New Delhi, 2005.*
6	*Philips, Ravindran and Solberg, **"Operations Research"**, John Wiley, 2002.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the basic concepts of optimization techniques.	K2
CO2	Illustrate the basics and advancements in Linear programming techniques	K3
CO3	Summarize the concept and applications of non-linear programming techniques	K3
CO4	Employ the appropriate methods for solving problems	K3
CO5	Study the formation of dynamic programming problems and its solution	K4

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	3	3	2
CO2	3	1	3	3	2
CO3	3	1	3	3	2
CO4	3	1	3	3	2
CO5	3	1	3	3	2
23PEPE05	3	1	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	-	30	30	20	10	10	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

23PEPE06	DIGITAL SIGNAL PROCESSING AND CONTROL	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
• BASICS OF MICROCONTROLLERS • UNDERSTANDING OF Z - TRANSFORMS	PE	3	0	0	3

Course Objectives	To emphasize intuitive understanding of the concepts of Digital Signal Processing and design theoretically the FIR and IIR Filters. Also to acquire knowledge on DSP processors and their applications in simple control systems.

UNIT – I	DISCRETE SIGNAL LINEAR SYSTEMS	9 Periods

Discrete Linear systems – Time invariance –Causality, Stability, Difference Equations-Transfer functions of linear discrete systems – Impulse, step and frequency response – Linear and circular convolution- Recursive and non-recursive filters – Digital filter realization – Direct, Canonic, Cascade, Parallel and ladder realizations.

UNIT – II	TRANSFORMATIONS IN DSP	9 Periods

Review of Continuous Fourier series- Transform- Discrete Fourier Transform – Properties – IDFT- Introduction to Radix- 2 FFT – Properties – Decimation in time – Decimation in frequency – Computation of IDFT using DFT.

UNIT – III	DIGITAL FILTERS	9 Periods

Approximation of analog filters – Butterworth -Chebyshev – Properties of IIR filter – IIR filter design- Bilinear transformation and Impulse invariance method – Digital transformation – Characteristic of FIR filter - Frequency response of linear phase FIR filter Design of FIR filter – Fourier series method–Window function-Rectangular, Kaiser and Bartlett window methods.

UNIT – IV	dsPIC30f4011	9 Periods

dsPIC30F4011 – Architecture - MCU and DSP features - Hardware DMA - Interrupt Controller - Digital I/O, On-chip Flash, Data EE and RAM - Peripherals - Timers, Communication Modules Motor Control Peripherals - Capture/Compare/PWM, Analog-to-Digital Converters

UNIT – V	DSP CONTROLLER	9 Periods

Introduction to DSP architecture- computational building blocks - Address generation unit, Program control and sequencing- Parallelism, Pipelining - Architecture of TMS320LF2407 - Addressing modes- I/O functionality, Interrupt. ADC, PWM, Event managers, Elementary Assembly Language Programming for control applications.

Contact Periods:

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

REFERENCES :

1	*John.G.Proakis, Dimitrias.G. and Manolakis.* ***"DSP principles Algorithms and applications"****, Prentice Hall of India – Revised Edition, 2014*
2	*Emmanuel C.Ifeachor, University of Plymouth. Barrie.W.Jervis, Sheffield Hallam University,* ***"Digital Signal Processing. A Practical Approach"****, Pearson Education, V Edition, 2019*
3	*SanjitK.Mitra,* ***"Digital Signal Processing A computer Based approach"*** *TataMcGrawHill, Sixth Edition, 2016*
4	*Farzad Nekoogar, Gene moriarty.* ***"Digital Control Using Digital Signal Processing"*** *P.H. International Inc. New Jersey, 2018*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Classify the digital signals and systems and apply various transformation techniques to solve problems	K3
CO2	Solve difference equations using DFT and FFT	K4
CO3	Build digital IIR and FIR filters for the given specifications	K4
CO4	Design and simulate digital filters with signal processing algorithm	K5
CO5	Examine the DSP controllers and understand its functioning for control applications	K4

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	-	1	2	1
CO2	2	-	1	2	1
CO3	2	1	1	2	1
CO4	2	1	1	2	1
CO5	2	-	1	2	1
23PEPE06	2	1	1	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	30	10	10	-	100
CAT2	10	20	20	30	20	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	10	20	30	30	10	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20	10	20	30	20	-	100
ESE	20	20	20	20	20	-	100

23PEPE07	HVDC AND FACTS (Common to PSE and PED)	SEMESTER II

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

Course Objectives	To impart knowledge about HVDC transmission systems and significance of FACTS devices in power systems.	
UNIT – I	**DC POWER TRANSMISSION TECHNOLOGY**	**9 Periods**
Introduction - Comparison of AC and DC transmission – Application of DC transmission –Description of DC transmission system – MTDC systems – Types, Control and protection of MTDC systems-Planning for HVDC transmission – Modern HVDC – State of the art.		
UNIT – II	**ANALYSIS AND CONTROL OF HVDC CONVERTERS**	**9 Periods**
Pulse number – Choice of converter configuration – Simplified analysis of Graetz circuits – Converter bridge characteristics – Characteristics of twelve-pulse converter - General principles of DC Link control – Converter control characteristics – System control hierarchy Firing angle control – Current and extinction angle control-Generation of harmonics – Design of AC filters – DC filters.		
UNIT – III	**STATIC VAR COMPENSATION**	**9 Periods**
FACTS- Basic concepts of static VAR compensator - Resonance damper, Thyristor controlled series capacitor – Static condenser-Phase angle regulator - Thyristor Controlled Reactor - Thyristor Switched Reactor - Thyristor Switched Capacitor -Saturated Reactor - Fixed Capacitor – applications.		
UNIT – IV	**SERIES COMPENSATION**	**9 Periods**
Sub-Synchronous resonance-Torsional interaction, torsional torque – Compensation of conventional, ASC, NGH damping schemes - Modeling and control of thyristor controlled series compensators		
UNIT – V	**UNIFIED POWER FLOW CONTROL**	**9 Periods**
Introduction - Implementation of power flow control using conventional thyristor – Unified Power Flow concept -Implementation of Unified Power Flow controller.		

Contact Periods:

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

REFERENCES:

1	*Padiyar .K .R., "**HVDC Power Transmission Systems**", New age international(P) Ltd, New Delhi, third edition,2015.*
2	*Rakosh Das Begamudre, "**Extra High Voltage AC Transmission Engineering**", Wiley Eastern Ltd, New Delhi, 2007.*
3	*Vijay K. Sood, "**HVDC and FACTS Controllers – Applications of Static Converters in Power Systems**", Kluwer Academic Publishers, 2006.*
4	*Hingorani Narin G., Gyugyi Laszlo, "**Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems**", Wiley-IEEE Press, 2001.*
5	*Narin G.Hingorani, "**Flexible AC Transmission**", IEE Spectrum, April 1993, pp 40-45.*
6	*Narin G.Hingorani, "**High Power Electronics and Flexible AC Transmission Systems**", IEEE High Power Engineering Review, 1998.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Articulate the concept and identify the merits of HVDC transmission.	K4
CO2	Analyze and Design power converters for HVDC transmission systems and develop HVDC controllers in Real time power system environments.	K5
CO3	Assess Harmonics and Disturbances in the HVDC environment.	K6
CO4	Explain the concept of FACTS and Illustrate the concepts of Static VAR compensator.	K6
CO5	Classify the FACTS devices and implementation in the Real Power network.	K6

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	-	-	-	-
CO2	2	1	1	1	-
CO3	3	-	3	-	3
CO4	-	1	-	2	1
CO5	1	-	2	3	2
23PEPE07	2	1	2	2	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	30	10	10	-	100
CAT2	10	20	20	30	10	10	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	10	20	30	30	10	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20	10	20	30	10	10	100
ESE	20	20	20	20	10	10	100

23PEPE08	SMART GRID TECHNOLOGY AND APPLICATIONS (Common to PSE & PED)					SEMESTER II
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**
Course Objectives	To comprehend conventional and modern techniques for the operation of power system, elucidate real & reactive power control techniques for the modern power system and revise communication, information technologies and standards & policies for the implementation of smart power grid					
UNIT – I	**INTRODUCTION**					**9 Periods**
Basic elements of Electrical Power Systems, Overview of Load Flow Analysis, Economic Load Dispatch and Unit Commitment problems, Desirable Traits of a Modern Grid, Principal Characteristics of the Smart Grid, Key Technology Areas, Impact of Smart grid on reliability and carbon emissions.						
UNIT – II	**SENSING AND MEASUREMENT TECHNOLOGIES**					**9 Periods**
Synchro-phasor Technology – Phasor Measurement Unit, Smart metering and demand side integration - Communication infrastructure and protocol for smart metering – Data Concentrator, Meter Data Management System. Demand side Integration – Services, Implementation and Hardware Support of DSI, Distribution Feeder Reconfiguration analysis.						
UNIT – III	**CONTROL AND AUTOMATION TECHNIQUES**					**9 Periods**
Distribution automation equipment – Substation automation equipments: current transformer, potential transformer, Intelligent Electronic Devices, Bay controller, Remote Terminal Unit. Distribution management systems – SCADA: modeling and analysis tools, applications. Renewable sources (Wind, Solar) – Integration to Grid, Controlling Techniques, Challenges and Opportunities, Micro grids						
UNIT – IV	**POWER ELECTRONICS AND ENERGY STORAGE SYSTEMS**					**9 Periods**
Power Electronics in smart grid – Shunt compensation, Series Compensation, Power Electronics for bulk power flow – FACTS, HVDC, Energy Storage Technologies - Batteries, Flow Battery, Fuel Cell and Hydrogen Electrolyser, Flywheel, Superconducting Magnetic Energy Storage System, Supercapacitor.						
UNIT – V	**COMMUNICATION & INFORMATION TECHNOLOGY, ECONOMICS & ENERGY POLICIES**					**9 Periods**
Data Communication, Dedicated and shared communication channels, Layered architecture and protocols, Communication technology and Information security for the smart grid. Smart Grid – Infrastructure Development planning, Reliability Evaluation, Economics, Power/Energy Trading, Energy Policies, Security and Privacy – Cyber security challenges, Load/Demand Profile uncertainties, Privacy Challenges in DSI and Smart homes.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES :

1	*Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, "**Smart Grid Technologies and Applications**", John Wiley Publishers Ltd., 2012.*
2	*Lars T. Berger, Krzysztof Iniewski, "**Smart Applications, Communications and Security**", John Wiley Publishers Ltd., 2012.*
3	*Bernd M. Buchholz, Zbigniew Styczynski,"**Smart Grids – Fundamentals and Technologies in Electricity Networks**"Springer Berlin Heidelberg, 2014*
4	*Caitlin G. Elsworth,"**The Smart Grid and Electric Power Transmission**", Nova Science Publishers, 2010.*
5	*Shady S. Refaat, Omar Ellabban, Sertac Bayhan, Haitham Abu-Rub, Frede Blaabjerg, Miroslav M. Begovic, **"Smart Grid and Enabling Technologies"**, Wiley, 2021.*
6	*Bimal K. Bose, "**Power Electronics in Renewable Energy Systems and Smart Grid Technology and Applications**", Wiley, 2019*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recognize various advanced technologies for improving the performance of the power system operation.	K2
CO2	Compare the control and automation techniques.	K2
CO3	Develop modern techniques for the power grid operation.	K6
CO4	Realize advanced techniques with respect to standards in power system.	K3
CO5	Correlate the electrical power storage technologies for improving the generation and stability	K4

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	3	2	2
CO2	2	-	2	2	-
CO3	3	-	3	3	-
CO4	2	-	2	2	1
CO5	3	-	3	1	1
23PEPE08	3	-	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20	-	-	100
CAT2	20	20	20	20	20	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	30	30	20	20		-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20	20	20	20	20	-	100
ESE	20	20	20	20	20	-	100

23PEPE09	SOFT COMPUTING TECHNIQUES				SEMESTER II
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
• A strong mathematical background • Critical thinking and problem solving skills	PE	3	0	0	3
Course Objectives	To provide knowledge on Neural Networks and Fuzzy Logic Control and to apply soft computing techniques in real life scenario.				
UNIT – I	**INTRODUCTION TO NEURAL NETWORKS**				**9 Periods**
Introduction – Biological and Artificial neural networks - Learning rules – Training - ADALINE - MADALINE – BAM – Discrete Hopfield networks.					
UNIT – II	**ARTIFICIAL NEURAL NETWORKS**				**9 Periods**
Theory, Architecture and Applications of Back propagation network – Counter propagation network – Kohenen's Self Organising Maps.					
UNIT – III	**INTRODUCTION TO FUZZY**				**9 Periods**
Fuzzy sets and membership – Chance Vs ambiguity – Classical sets – Fuzzy sets – Fuzzy relations – Tolerance and Equivalence relations – Value assignments.					
UNIT – IV	**FUZZIFICATION AND DEFUZZIFICATION**				**9 Periods**
Fuzzification – Membership value assignments – Fuzzy to Crisp conversions -Lambda – Cuts for Fuzzy sets and relations – Defuzzification methods. Simple Neuro – Fuzzy Controller.					
UNIT – V	**FUZZY ARITHMETIC, NUMBERS, VECTORS AND EXTENSION PRINCIPLE**				**9 Periods**
Extension principle – Fuzzy numbers – Interval analysis in arithmetic – Approximate methods of extension: Vertex method, DSW algorithm, Restricted DSW algorithm – Fuzzy vectors – Classical predicate logic – Approximate reasoning – Fuzzy tautologies, contradictions, Equivalence and Logical proofs.					
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**					

REFERENCES:

1	*Laurene Fausett, "**Fundamentals of Neural Networks: Architectures, Algorithms and Applications**", Pearson, New Jersey, 2004*
2	*Timothy J.Ross, "**Fuzzy Logic with Engineering Applications**", Wiley India Pvt. Ltd., 3rd Ed., 2010*
3	*Kosko.B, "**Neural Network and Fuzzy Systems**"- Prentice Hall of India Pvt. Ltd., New Delhi, 2007*
4	*S N Sivanandam., S N Deepa, "**Principles of Soft Computing**", Wiley India Pvt. Ltd., 2nd Ed., 2011*
5	*Robert .J.Schalkoff, "**Artificial Neural Networks**", McGraw Hill, Singapore, 2011*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the basic concepts of neural networks.	K2
CO2	Apply ANN to real world problems.	K3
CO3	Describe the functioning of back propagation network and Kohenen's self organizing map.	K3
CO4	Relate the concept of Fuzzy sets and be able to differentiate crisp sets and fuzzy sets.	K2
CO5	Analyze Fuzzification, Defuzzification and Neuro-Fuzzy Modeling	K4

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	2	3	2
CO2	2	1	3	3	1
CO3	2	1	3	2	1
CO4	2	1	3	2	1
CO5	2	1	2	3	1
23PEPE09	2	1	3	3	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	15	15	-	-	100
CAT2	15	10	25	30	20	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	10	10	20	30	20	10	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	25	40	20	15	-	-	100
ESE	30	25	15	20	5	5	100

23PEPE10	ADVANCED ELECTRIC DRIVES AND CONTROL (Common to PSE & PED)		SEMESTER II			
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	3	0	0	3
Course Objectives	To study and analyze the performance of electric drives with modern controllers and techniques.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Need for advanced controls - Principle factor affecting the choice of drive – Parameter identification techniques for electric motors – Electromagnetic compatibility of electric drives – Different options for an adjustable speed electric drive – Simulation of electrical drives – Advanced control strategies for electrical drives						
UNIT – II	**PWM INVERTER CONTROL**					**9 Periods**
Inverter – Operation principle – Inverter switching – Unipolar – Bipolar – Inverter dead time– Inverter modulation – PWM types – Sine Triangle – Analysis of Sine Triangle Modulation – Trapezoidal Modulation – Third harmonic Modulation – Analysis of Third Harmonic Modulation – Output filter requirement for different PWM techniques						
UNIT – III	**SPACE VECTOR MODULATION**					**9 Periods**
Concept of a Space Vector – dq0 Components for Three-phase sine wave source–dq0 Components for Voltage Source Inverter operated in Square Wave Mode –Synchronously rotating reference frame – Space Vector Modulation– Principle –SVM compared to regular sampled PWM - Phase Lag reference for SVM – Naturally sampled SVM – Analytical solution						
UNIT – IV	**DSP CONTROLLERS**					**9 Periods**
DSP controllers – Architecture – Address modes – interrupts – Instruction set: Assembly language instructions - Auxiliary register and data page pointer instructions – TREG, PREG, Multiply instructions – Branch instructions – Control instructions – I/O and memory instructions - DSP based control of electrical drives						
UNIT – V	**ADVANCED CONTROLLER**					**9 Periods**
Current and speed control of Induction Motor – Current control algorithm – Sensorless motion control strategy – Induction Motor Controller using VHDL design - Fuzzy Logic Control of a BLDC motor – VHDL Modelling – FPGA implementation of electrical drives						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES:

1	*Bimal K. Bose, "**Power Electronics and Variable Frequency Drives – Technology and Applications**", IEEE Press, 1997*
2	*Grafame Holmes. D and Thomas A. Lipo, "**Pulse Width Modulation for PowerConverters – Principles and Practice**", IEEE Press, 2003*
3	*Peter Vas, "**Vector Control of AC Machines**", Oxford University Press, 1990*
4	*Hamid A. Toliyat and Steven G.Campbell, "**DSP based Electromechanical MotionControl**", CRC Press 2004*
5	*Ned Mohan, "**Advanced Electric Drives: Analysis, Control and Modelling using SIMULINK**", John Wiley & Sons Ltd., 2001*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the performance parameters and requirements of control strategies	K2
CO2	Examine the performance of inverter for drives with various PWM techniques	K4
CO3	Apply and Analyze the performance of drives by SVM based control	K3
CO4	Apply DSP controller to study the performance of drives	K3
CO5	Expertise to enhance the performance of drives with modern controllers	K3

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	2	2	2
CO2	3	-	3	2	2
CO3	3	-	3	3	3
CO4	3	-	3	2	3
CO5	3	-	2	2	3
23PEPE10	3	-	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	30	20	-	-	100
CAT2	-	20	30	30	10	10	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	-	30	40	30	-	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	-	30	40	30	-	-	100
ESE	10	20	30	20	10	10	100

23PEPE11	ELECTRIC VEHICLE	SEMESTER II

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

Course Objectives	To explain electric, hybrid electric and plug-in hybrid electric vehicle (PHEV), their architecture, technologies and fundamentals and design the component sizing of the power electronics converters and various electric drives suitable for hybrid electric vehicles. Further to to discuss different energy storage technologies used for hybrid electric vehicles, their control charging techniques and energy balancing techniques.

UNIT – I	**INTRODUCTION: ELECTRIC VEHICLE**	**9 Periods**

History - Components of Electric Vehicle - Comparison with Internal combustion Engine: Technology, Benefits and Challenges - EV classification and their electrification levels - EV Terminology - Vehicle Resistance: Rolling Resistance, Aerodynamic Drag, Grading Resistance, Dynamic Equation Tire–Ground Adhesion and Maximum Tractive Effort, Power Train Tractive Effort and Vehicle Speed, EV Powertrain Component Sizing.

UNIT – II	**ELECTRIC VEHICLE ARCHITECTURE DESIGN**	**9 Periods**

Types of Electric Vehicle and components - Electrical protection and system requirement - Photovoltaic solar based EV design - Battery Electric vehicle (BEV) - Hybrid electric vehicle (HEV) - Plug-in hybrid vehicle (PHEV - Fuel cell electric vehicle (FCEV) - Electrification Level of EV - Comparison of fuel vs. Electric and solar power - Solar Power operated Electric vehicles.

UNIT – III	**POWER ELECTRONICS IN EVs**	**9 Periods**

Power electronics circuits used for control and distribution of electric power in DC-DC, AC-DC, DC-AC converters used for HEV. Electric Machines and Drives in HEVs: Fundamental of Drives and Control of EV Using DC motor, Induction Motor, Permanent Magnet Motor, Switched Reluctance Motor, BLDC motor, Design and Sizing of Traction Motors.

UNIT – IV	**ENERGY STORAGE SOLUTION**	**9 Periods**

Batteries, Ultracapacitor, Fuel Cells, and Controls: Introduction, Different batteries for EV, Battery Characterization, Comparison of Different Energy Storage Technologies for HEVs, Battery Charging Control, Charge Management of Storage Devices, Flywheel Energy Storage System, Fuel Cells and Hybrid Fuel Cell Energy Storage System and Battery Management System.

UNIT – V	**EV CHARGING TECHNOLOGIES**	**9 Periods**

Classification of different charging technology for EV charging station, introduction to Grid-to-Vehicle, Vehicle to Grid (V2G) or Vehicle to Buildings (V2B) or Vehicle to Home (V2H) operations, bi-directional EV charging systems, energy management strategies used in hybrid and electric vehicle, Wireless power transfer (WPT) technique for EV charging.

Contact Periods:

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

REFERENCES:

1	*Mehrdad Ehsani, Yimin Gao, Ali Emadi,* ***"Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals"****, CRC Press, 2014.*
2	*Iqbal Hussain,* ***"Electric & Hybrid Vehicles – Design Fundamentals"****, Second Edition, CRC Press, 2012*
3	*James Larminie,* ***"Electric Vehicle Technology Explained"****, John Wiley & Sons, 2013.*
4	*Tariq Muneer, Mohan Lal Kolhe, Aisling Doyle,* ***"Electric Vehicles: Prospects And Challenges"****, 1st edition, Elsevier, 2019.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the various modules of EV and its associated parameters	K4
CO2	Explain the architectural design of different configurations of EV	K4
CO3	Formulate the converter circuits for EV applications	K4
CO4	Summarize the energy storage solutions for EV	K5
CO5	Appraise the charging technologies for the EV	K5

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	-	2	1	1
CO2	2	-	2	1	1
CO3	2	-	2	1	1
CO4	2	1	2	1	1
CO5	2	1	2	1	1
23PEPE11	2	1	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20	-	-	100
CAT2	10	30	20	20	20	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	10	30	30	20	10	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20	20	30	10	20	-	100
ESE	20	40	30	10	-	-	100

23PEPE12	POWER ELECTRONICS IN WIND AND SOLAR POWER CONVERSION (Common to PSE & PED)	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
ANALYSIS OF POWER CONVERTERS	PE	3	0	0	3

Course Objectives	To enrich the knowledge of power electronics to design power converters for improving the performance of wind and solar energy systems.

UNIT – I	**ENERGY SOURCES AND GRID CODES**	**7 Periods**

Trends in energy consumption - World energy scenario – Energy sources and their availability - Conventional and renewable sources - Need to develop new energy technologies and Hybrid Systems – Grid requirements of solar PV and wind turbine (International standards)- Indian grid code for wind energy

UNIT – II	**SOLAR PHOTOVOLTAIC ENERGY CONVERSION**	**9 Periods**

Solar radiation and measurement - Solar atlas of India - Solar cells and their characteristics -Influence of insulation and temperature - PV arrays - Electrical storage with batteries – Converters for Solar PV systems- Maximum power point tracking techniques- Analysis of PhotoVoltaic Systems.

UNIT – III	**WIND ENERGY CONVERSION SYSTEM**	**10 Periods**

Wind survey in India - Basic Principle of wind Energy conversion -Power in the wind - Components of Wind - Energy Conversion System- Classification of WECS - Performance of Induction Generators (SCIG and DFIG) and PMSGs for WECS- Converters for WECS-Maximum Power point tracking algorithms

UNIT – IV	**STAND ALONE SYSTEMS**	**9 Periods**

Self- Excited Induction Generator for isolated Power Generators - Theory of self -excitation – Capacitance requirements –Standalone solar PV system with energy storage- Hybrid system (Wind-Diesel-Solar)-Load sharing and sizing of system components

UNIT – V	**CONVERTERS FOR WIND AND SOLAR POWER SYSTEMS**	**10 Periods**

DC -DC Converters solar PV system- AC Power conditioners - Line commutated and PWM inverters- Synchronized operation with grid supply - Grid connected inverters for WECS - Machine side and grid side converter topologies- (two level and multilevel) - Harmonic filters (LC and LCL). Control of converters for fault operation with LVRT capability.

Contact Periods:

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

REFERENCES:

1	*Mukund R Patel,* ***"Wind and Solar power systems: design, analysis and operation",*** *Second Edition, Taylor & Francis, 2006*
2	*Rai, G.D.,* ***"Non-conventional Energy Sources",*** *Khanna Publications, New Delhi, V Edition, 2013.*
3	*Thomas Markvart and Luis Castaser,* ***"Practical handbook of Photovoltaics",*** *Elsevier Publications, 2nd Edition, 2011*
4	*Teodorescu.R, Liserre.., and Rodr´ıguez. P,* ***"Grid converters for photovoltaic and wind power systems"*** *JohnWiley and sons limited, 2011*
5	*Bin Wu,* ***"High-Power Converters and AC Drives"****, IEEE Press, A John Wiley & Sons, Inc Publication, New York,2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Gain Knowledge of trends in renewable energy and standards for grid interconnection of resources.	K2
CO2	Demonstrate the concept of solar PV energy conversion	K4
CO3	Analyze the concepts of different wind energy conversion systems.	K4
CO4	Extend the concepts of standalone wind and solar energy systems.	K6
CO5	Summarize the concepts of Grid connected wind and solar energy systems.	K5

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	-	-	2	-
CO2	3	-	2	-	-
CO3	3	1	-	3	2
CO4	3	-	1	1	2
CO5	3	1	3	-	3
23PEPE12	3	1	2	2	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	20	20	-	-	100
CAT2	10	30	20	20	10	10	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	10	30	30	20	10	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20	20	30	10	10	10	100
ESE	20	40	30	10	-	-	100

23PEPE13	CONDITION MONITORING OF ROTATING ELECTRIC MACHINES		SEMESTER II			
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	3	0	0	3
Course Objectives	To familiarize with condition monitoring and diagnostic techniques of electrical machines and make the student understand the role of Artificial Intelligence in Condition based monitoring.					
UNIT – I	**INTRODUCTION TO CONDITION MONITORING**		**9 Periods**			
Introduction – Need for monitoring – Overview of Electrical Machines structures and types: Induction and Synchronous Machines – Types of Failures: Electrical and Mechanical – Condition Monitoring Techniques: Invasive and Non-Invasive						
UNIT – II	**FAULT DIAGNOSIS OF ELECTRIC MACHINES USING FREQUENCY DOMAIN TECHNIQUES**		**9 Periods**			
Review of signal processing terminologies – Detection of motor bearing faults – Detection of stator faults – Detection of Rotor Faults						
UNIT – III	**FAULT DIAGNOSIS OF ELECTRIC MACHINES USING MODEL BASED TECHNIQUES**		**9 Periods**			
Model of healthy and faulty motors: Induction and Synchronous – Faults: Broken Rotor Bar, Eccentricity, stator inter-turn faults						
UNIT – IV	**NONINVASIVE METHODS OF MOTOR FAULT DIAGNOSIS**		**9 Periods**			
Introduction to Motor Current Signature Analysis (MCSA), Instant Power Analysis (IPA) and Park Vector Analysis (PVA) – Bearing fault analysis using these techniques – Design, Implementation and analysis of bearing fault: An overview using one of the methods (IPA/PVA/MCSA)						
UNIT – V	**PREDICTIVE MAINTENANCE USING MATLAB**		**9 Periods**			
Study and hand-on of end-to-end workflow of Broken Rotor Bar fault diagnosis and prediction using Matlab. – preprocessing, feature extraction, decision models and prediction models.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES :

1	*Hamid A Toliyat,Subhasis Nandi, Seungdeog Choi and Homayoun Meshgin-Kelk,* ***"Electrical Machines: Modeling, Condition Monitoring and Fault Diagnosis"*** *CRC Press, 2013.*
2	*Nordin Saad, Muhammed Irfanand Rosdiazli Ibrahim,* ***"Condition Monitoring and Fault Diagnosis of Induction Motors : Electrical Signature Analysis"*** *CRC Press, 2019.*
3	https://in.mathworks.com/solutions/predictive-maintenance/resources.html

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the concepts of monitoring for different maintenance principles of rotating electrical machines	K2
CO2	Assess the methods of sensing and monitoring of the condition of electrical machine	K4
CO3	Identify the fault using different techniques	K3
CO4	Analyse the fault diagnosis with different techniques	K4
CO5	Apply Artificial Intelligence techniques for fault diagnosis and prediction.	K3

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	-	2	-	1
CO2	2	-	3	2	1
CO3	2	1	2	2	-
CO4	2	1	3	2	-
CO5	2	-	3	-	-
23PEPE13	2	1	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	30	20	-	-	100
CAT2	20	30	30	20	-	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	-	30	30	30	10	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	-	20	30	30	20	-	100
ESE	20	20	40	20	-	-	100

23PEPE14	DISTRIBUTED GENERATIONS AND MICROGRID (Common to PSE & PED)	SEMESTER III

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

Course Objectives	To introduce the concept of distributed generation, microgrid, grid integration and know the recent developments on microgrid technology.

UNIT – I	DISTRIBUTED GENERATION	9 Periods

Trends in Energy Consumption, Conventional and Nonconventional Energy Sources - Review of Solar Photovoltaic and Wind Energy Conversion Systems – Fuel Cells-Energy storage systems: Batteries – ultra capacitors – fly wheels-Distributed Generation: Concept and topologies, Renewable Energy in Distributed Generation-Siting and sizing of DGs

UNIT – II	INTRODUCTION TO MICROGRID	9 Periods

Introduction – types – Structure and configuration of a Microgrid – AC, DC and hybrid Microgrid – Power Electronic Interfaces for Microgrid – Energy Management Control Strategies of a Microgrid - Case Studies.

UNIT – III	CONTROL AND OPERATION OF AC MICROGRID	9 Periods

Hierarchical Control: Primary, Secondary and Tertiary Control– Primary Control: Droop Control, Virtual Synchronous Generator Control for voltage source converter – Secondary Control – Simulation Studies

UNIT – IV	CONTROL AND OPERATION OF DC MICROGRID	9 Periods

Hierarchical Control: Primary, Secondary and Tertiary Control – Primary Control: Droop Control, Virtual Inertia Control – Secondary Control: Centralized and Decentralized Control – Simulation Studies

UNIT – V	GRID INTEGRATION OF MICROGRIDS	9 Periods

Modes of operation and control of microgrid: Grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes ,stability and power quality issues - IEEE 1547 Standard for Interconnecting Distributed Generation to Electric Power Systems- Concept of multi micro grid.

Contact Periods:

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

REFERENCES

1	*H. Bevrani, Bruno Francois and ToshifumiIse, "**Microgrid Dynamics and Control"**, Wiley, 2017.*
2	*Li Fusheng, Li Ruisheng and Zhou Fengquan, **"Microgrid Technology and Engineering Application",** Elsevier, 2016.*
3	*Fainan Hassan and Math H. J. Bollen, "**Integration of Distributed Generation in the Power System"**, John Wiley and Sons. 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the concept of distributed generation and microgrid	K2
CO2	Summarize classification and control aspects of microgrid	K2
CO3	Analyze the configurations and control aspects of AC microgrid	K4
CO4	Analyze the configurations and control aspects of DC microgrid.	K4
CO5	Evaluate and apply the knowledge to understand the grid integration of microgrid	K5

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	-	3	2
CO2	3	-	3	-	2
CO3	3	-	3	-	2
CO4	3	-	3	-	2
CO5	3	-	3	3	2
23PEPE14	3	-	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	-	30	30	20	10	10	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

23PEPE15	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY IN SYSTEM DESIGN (Common to PSE & PED)		SEMESTER III			
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	**3**	**0**	**0**	**3**
Course Objectives	To Outline the EMI/EMC problems and provide information for solutions to mitigate EMI through system level design as per prescribed standards. To impart comprehensive insight about the current EMC standards and about various measurement techniques.					
UNIT – I	**EMI ENVIRONMENT**					**9 Periods**
EMI/EMC concepts and definitions - Sources of EMI- conducted and radiated EMI- Practical Experiences and Constraints – An Overview of EMI and EMC – Analytical examples – Celestial Electromagnetic Noise – Lightning discharge – ESD - EMP.						
UNIT – II	**OPEN AREA TEST SITES, MEASUREMENT OF RI AND CI**					**9 Periods**
Open area Test site and measurements – Measurement precautions, errors and site imperfections – Terrain roughness imperfections, normalized site attenuation – Antenna factor measurement – RI measurements – Anechoic chamber – TEM cell – Reverberating chamber – GTEM – Comparison. CI measurement - characterization of conduction currents and voltages – conducted EM noise on power supply lines – Conducted EMI from equipment, immunity, detectors and measurement.						
UNIT – III	**EMI MITIGATION**					**9 Periods**
Grounding – Shielding – Electrical Bonding – EMI Filters – characteristics – Power line filter design, installation and evaluation – EMI suppression cables - Connectors – gaskets – isolation transformers – opto isolators – transient and surge suppression devices – EMC accessories.						
UNIT – IV	**SIGNAL INTEGRITY AND EMC STANDARDS**					**9 Periods**
SI problems – analysis – issues in design – modeling and simulation. Standards for EMI / EMC – BS, FCC, CISPR, IEC, EN – IEEE/ANSI standards - Military standards - MIL STD 461E/462 – VDE standards – EMI/EMC standards in Japan. Comparison.						
UNIT – V	**EMC DESIGN OF PCBs**					**9 Periods**
PCB Traces impedance - Routing, Control, Power Distribution Decoupling - Zoning, Motherboard Designs and Propagation Delay Performance Models.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES :

1	*Yang Zhao, Wei Yan, Jun Sun, Mengxia Zhou, Zhaojuan Meng,* ***"Electromagnetic Compatibility Principles and Applications"****, Springer Singapore, 2021.*
2	*Paolo Stefano Crovetti,* ***"Electromagnetic Interference and Compatibility"****, Electronics, 2021.*
3	*C.Saranya,* ***"Electromagnetic Interference and Compatibility",*** *AR Publications, 2018.*
4	*S.Janani, R. Ramesh Kumar,* ***"Electro Magnetic Interference and Compatibility",*** *Sruthi Publishers, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Review the basics of EMI/ EMC	K4
CO2	Demonstrate the EMI measurements, diagnose and solve basic electromagnetic compatibility problems.	K4
CO3	Recognize the EMI mitigation technologies and able to design filters	K2
CO4	Categorize various standards for EMC	K4
CO5	Design the Cable routing & connection and understand the Interconnection Techniques for EMI free system in PCB.	K4

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	-	2	1	1
CO2	2	-	2	1	1
CO3	2	-	2	1	1
CO4	2	-	2	1	1
CO5	2	-	2	1	1
23PEPE15	2	-	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	15	15	-	-	100
CAT2	15	10	25	30	20	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	10	20	20	30	20	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	25	40	20	15	-	-	100
ESE	30	25	15	20	10	-	100

23PEPE16	INSULATION MATERIALS AND TESTING FOR INDUSTRIAL APPLICATIONS (Common to PSE & PED)					SEMESTER III
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	3	0	0	3
Course Objectives	To familiarize with insulation materials, testing and measurement for industrial applications					
UNIT – I	**INSULATION MATERIALS AND MEASUREMENTS**					**9 Periods**
Dielectrics and insulators, resistance of insulation materials, tests and models. Electrical stress - Mechanical stress - Chemical Attack - Thermal stress - Environmental contamination - Predictive Maintenance - Benefit of new technology – Measurement of Insulation Resistance – Operation of insulation Resistance tester - The Guard Terminal - Evaluation and Interpretation of Results.						
UNIT – II	**INSULATION TESTS**					**9 Periods**
Diagnostic High Voltage Insulation Tests - Spot reading test - Time Vs. Resistance test - Polarization index test - Step voltage test - Ramp voltage test - Dielectric discharge test - Different Problems/different tests - Potential sources of error/ensuring Quality test – Results - Test leads - Making Measurements above 100 GΩ - Accuracy statements - Delivery of stated voltage - Interference Rejection - Rules on testing and comparing - CAT Rating - CAT Rating Guidelines – Importance of CAT rating - CAT Rating basic statistics.						
UNIT – III	**TESTING INSULATION RESISTANCE OF ROTATING MACHINERY**					**9 Periods**
Effects of temperature - Effects of Humidity - Ingress Protection - High Potential testing - Current (nA) Readings Vs. Resistance (MΩ) – Burn capability - Drying out electrical equipment - Test item discharge - Charging time for large equipment - Motor driven insulation testers - Test Lead Design - Significant safety enhancements - Things to consider for safe operation - Safety Warnings - Electrical insulation for rotating machines -Insulating liners, separators, sleeving and stator winding insulation.						
UNIT – IV	**EARTH RESISTIVITY AND MEASUREMENT**					**9 Periods**
Factors affecting Minimum Earth Resistance - Basic Definitions - Requirements for a Good Grounding System - National Electrical Code - Maximum Values - Nature of Earth Electrode - Principles Involved in Earth Resistance Testing - Basic Test Methods for Earth Resistance - Effects of Different Reference Probe Locations - Lazy Spikes - Supplementary Tests.						
UNIT – V	**ACCURATE MEASUREMENT OF EARTH RESISTANCE FOR LARGE GROUND**					**9 Periods**
Testing Challenges in Large Ground Systems – Addressing the Testing Challenges in Large Ground Systems – Nomograph Guide to Getting Acceptable Earth Resistance – Clamp-On Method – Attached Rod Techniques – Measurement of the Resistance of Large Earth Electrode Systems: Intersecting – Curves Method1 – Test as a Large Substation – General Comments – Slope Method – Four Potential Method – Star Delta Method – Determining Tough and Step Potential – Ground Testing Methods Chart.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES :

1	*André O. Desjarlais and Robert R. Zarr, **"Insulation Materials: Testing and Applications"**, 4th Volume, ASTM International, March-2002*
2	*Andrew R. Hileman, **"Insulation Coordination for Power Systems"**, CRC Press, June 1999.*
3	*Joseph F. Kimpflen, **"Insulation Materials, Testing, and Applications"**, ASTM International, Jan 1990.*
4	*George L Shew, **"Earth Resistivity Measurement and its Application to Layer Problems"**, University of Southern California Press, 1936.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Articulate different materials for insulation	K2
CO2	Illustrate various measurements and tests of insulators in power system.	K2
CO3	Comprehend the approaches of calculations of insulation specifications.	K4
CO4	Practice the requirements of insulation as applied to large power system.	K3
CO5	Familiarize with the measurement of earth resistance	K2

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	-	2	1	-
CO2	2	-	2	1	1
CO3	2	1	2	1	-
CO4	2	1	2	1	-
CO5	2	1	2	1	1
23PEPE16	2	1	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	15	15	-	-	100
CAT2	15	10	25	30	20	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	10	10	20	30	20	10	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	25	40	20	15	-	-	100
ESE	30	25	15	20	5	5	100

23PEPE17	MODERN POWER ELECTRONICS FOR TRACTION APPLICATIONS (Common to PSE & PED)				SEMESTER III
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
SOLID STATE DRIVES	PE	3	0	0	3

Course Objectives	To annotate the theoretical concepts of dynamics of electric tractions using modern power electronics.

UNIT – I	**INTRODUCTION TO ELECTRIC DRIVES**	**8 Periods**

Basic concepts, Characteristics and operating modes of drive motors, Four quadrant drives, Selection of motors and rating- Desirable characteristics of Traction motors-Motors used for Traction purpose.

UNIT – II	**DC MOTOR DRIVES**	**10 Periods**

Single phase and three phase controlled rectifier fed dc motors - Dual converter with circulating and non-circulating current controlled drives – Closed loop control of dc motor drives, Analysis and performance characteristics of chopper fed dc motors - Analysis of separately excited dc motor with continuous armature current and discontinuous armature current - Analysis of dc series motor drives – Starting - speed control - Motoring and braking operations - Reversible drives - Multiphase chopper - Phase locked loop control of dc drive.

UNIT – III	**INDUCTION MOTOR DRIVES**	**9 Periods**

Stator voltage control of induction motor, Variable voltage variable frequency (VVVF) operation - Voltage source inverter (VSI) fed induction motor drive - Static rotor resistance control - Slip power recovery systems - Operation with unbalanced source voltages and unbalanced rotor impedances - Effect of time harmonics on the motor performance – Braking - closed loop control - Field oriented control - Comparison of ac and dc drive.

UNIT – IV	**ELECTRIC TRACTION**	**9 Periods**

General features of electrical traction, Mechanics of train movement, Nature of traction load, Speed-time curves, Calculations of Traction drive rating and Energy consumption, Train resistance, Adhesive weight and Coefficient of Adhesion, Tractive effort for acceleration and propulsion, Power and Energy output from driving axles, Methods of speed control and braking of motors for traction load, Electric drive systems for electric traction.

UNIT – V	**TRACTION MOTORS AND CONTROL**	**9 Periods**

Methods of starting and speed control of D.C Traction motors-Rheostatic Control- Energy saving with plain Rheostatic control Series-parallel control- Energy saving with series parallel starting - Shunt Transition -Bridge-Transition Drum control- contactor type bridge Transition controller –Metadyne control- Multiple unit control - Regenerative braking.

Contact Periods:

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

REFERENCES:

1	*G.K. Dubey,* ***"Fundamental of Electrical Drives"****, Narosa Publication, Reprint 2015*
2	*B.K. Bose,* ***"Power Electronics & Variable Frequency drive"****, IEEE press,1997*
3	*K. Pillai,* ***"First Course on Electrical Drives"****, New Age International 3rd edition 2017.*
4	*VedamSubramanyam,* ***"Electric Drives– concepts and applications"****, Tata McGraw Hill, 2011.*
5	*C. Garg,* ***"Utilization of Electrical Power and Electrical Traction"****, Khanna Publication. 1990.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the power converters for traction applications.	K4
CO2	Analyze the performance of dc motor drives and induction motor drives for various operating conditions.	K4
CO3	Estimate energy consumption rating of motor for traction application.	K5
CO4	Discriminate various control methods for electrical traction.	K6
CO5	Apply the knowledge to identify the suitability of the motor for traction application.	K3

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	2	-
CO2	-	-	1	2	-
CO3	2	-	-	3	-
CO4	3	-	-	3	1
CO5	2	1	3	2	3
23PEPE17	3	1	2	3	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	20	10	20	-	100
CAT2	-	30	20	30	10	10	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	20	10	10	30	30	-	100
Individual Assessment 2/ Case study2/ Seminar 2 /Project2	-	20	20	30	20	10	100
ESE	10	20	30	20	10	10	100

23PEPE18	POWER QUALITY ASSESSMENT AND MITIGATION (Common to PSE & PED)					SEMESTER III
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	3	0	0	3
Course Objectives	To identify, analyze and create solutions for the power quality problems in power system networks.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Importance of power quality - Terms and definitions as per IEEE std.1159 for transients, short and long duration voltage variations, interruptions, short and long voltage fluctuations, imbalance, flickers - Symptoms of poor power quality- Definitions and terminology of grounding- Purpose of groundings- Good grounding practices - problems due to poor grounding.						
UNIT – II	**ANALYSIS OF CONVENTIONAL MITIGATION METHODS**					**9 Periods**
Classical load balancing problem: Open loop balancing, Closed loop balancing, current balancing, Harmonic reduction, Voltage sag reduction. Analysis of power outages, Analysis of unbalance condition: Symmetrical components in phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers - Analysis of distortion: On–line extraction of fundamental sequence components from measured samples – Harmonic indices – Analysis of voltage sag: Detorit Edison sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI)- Analysis of voltage flicker, Reduced duration and customer impact of outages.						
UNIT – III	**VOLTAGE INTERRUPTIONS**					**9 Periods**
Definitions -Voltage sags versus interruptions - Economic impact, Major causes and consequences - characteristics, assessment, Influence of fault location and fault level on voltage sag - Areas of vulnerability, Assessment of equipment sensitivity, Voltage sag limits for computer equipment- CBEMA, ITIC, SEMI F 42curves, Report of voltage sag analysis, Voltage sag indices, Mitigation measures for voltage sag- DSTATCOM, UPQC,UPS, DVR, SMEs, CVT, utility solutions and end user solutions.						
UNIT – IV	**FLICKERS AND TRANSIENT VOLTAGES**					**9 Periods**
RMS voltage variations in power system, complex power, voltage regulation and per unit system - Basic power flow and voltage drop - Devices for voltage regulation and impact of reactive power management - Causes and effects of voltage flicker - Short term and long term flickers -Methods to reduce flickers- Transient over voltages, impulsive transients, switching transients - Effect of surge impedance and line termination - control of transient voltages.						
UNIT – V	**WAVEFORM DISTORTION**					**9 Periods**
Definition of harmonics, inter-harmonics, sub-harmonics- Causes and effects - Voltage versus current distortion, Fourier analysis, Harmonic indices, A.C. quantities under non-sinusoidal conditions, Triplet harmonics, characteristic and non characteristic harmonics- Series and Parallel resonances- Consequence - Principles for controlling and Reducing harmonic currents in loads, K-rated transformer -Computer tools for harmonic analysis- Locating sources of harmonics, Harmonic filtering- Passive and active filters - Modifying the system frequency response- IEEE Harmonic standard 519-1992						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES:

1	*Arrillaga J. and Watson N**., "Power System Harmonics",** 2nd edition on; John Willey & sons, 2003*
2	*M. H. J. Bollen, **"Understanding Power Quality Problems, Voltage Sag and Interruptions",** IEEE Press, series on Power Engineering, 2000.*
3	*Roger C. Dugan, Mark F. McGranaghan, Surya Santoso and Wayne Beaty H., **"Electrical Power System Quality"**, Second Edition, McGraw Hill Publication Co., 2008.*
4	*G.T.Heydt, **"Electric Power Quality",** Stars in a Circle Publications, 1994(2nd edition).*
5	*Enrique Acha, Manuel Madrigal**, "Power System Harmonics: Computer Modeling and Analysis**", John Wiley and Sons, 2001.*
6	*IEEE Std. 519-1992/ IEEE Std. 1159 IEEE recommended practices and requirements for harmonics control in electrical power system.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire knowledge about the power quality issues and standards like IEEE, IEC on voltage, Frequency and harmonics.	K1
CO2	Recognize the practical issues in the power system	K2
CO3	Articulate the concepts of harmonics	K2
CO4	Analyze the impact of power electronic devices and techniques in power system	K4
CO5	Develop trouble shooting skills and innovative remedies for various power quality problems in power system	K5

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	1	2	2	2
CO2	3	2	3	3	1
CO3	2	-	2	2	1
CO4	3	-	3	2	-
CO5	2	1	3	2	1
23PEPE18	3	1	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	-	10	20	-	100
CAT2	20	20	10	20	30	-	100
Individual Assessment1/ Case study1/ Seminar 1/Project1	30	30	-	20	20	-	100
Individual Assessment2/ Case study2/ Seminar 2 /Project2	20	40	-	20	20	-	100
ESE	30	30	-	10	30	-	100

23SEOE01	BUILDING BYE-LAWS AND CODES OF PRACTICE (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To impart knowledge on the building bye - laws and to emphasize the significance of codes of practice in construction sector.

UNIT – I	**INTRODUCTION TO BUILDING BYE-LAWS**	**9 Periods**

Introduction to Building Bye Laws and regulation, their need and relevance, General definitions such as building height, building line, FAR, Ground Coverage, set back line. Introduction to Master Plan and understanding various land uses like institutional, residential etc. - Terminologies of Building bye-laws.

UNIT – II	**ROLE OF STATUTORY BODIES**	**9 Periods**

Role of various statutory bodies governing building works like development authorities, municipal corporations etc. Local Planning Authority, Town and Country planning organisation, Ministry of urban development.

UNIT – III	**APPLICATION OF BUILDING BYE-LAWS**	**9 Periods**

Interpretation of information given in bye laws including ongoing changes as shown in various annexure and appendices. Application of Bye-laws like structural safety, fire safety, earthquake safety, basement, electricity, water, and communication lines in various building types.

UNIT – IV	**INTRODUCTION TO CODES OF PRACTICE**	**9 Periods**

Introduction to various building codes in professional practice - Codes, regulations to protect public health, safety and welfare - Codes , regulations to ensure compliance with the local authority.

UNIT – V	**APPLICATION OF CODES OF PRACTICE**	**9 Periods**

Applications of various codes as per various building types. Bureau of Indian Standards, Eurocode – Introduction to other international codes.

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

REFERENCES :

1	***"National Building Code of India 2016 – SP 7",*** *NBC 2016, Bureau of Indian Standards.*
2	***"Model Building Bye-Laws (MBBL) – 2016",*** *Town and Country Planning Organization, Ministry of Housing and Urban Affairs, Government of India.*
3	***"Unified Building Bye-laws for Delhi 2016",*** *Nabhi Publications, 2017.*
4	Mukesh *Mittal,* ***"Building Bye Laws",*** *Graphicart publishers, Jaipur, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the building bye-laws in planning, design and construction works.	K3
CO2	Familiarize with the role of various statutory bodies.	K2
CO3	Execute safety related work practices in the construction sector.	K3
CO4	Ensure compliance with the rules and regulations in design and construction practices.	K3
CO5	Perform design and construction practices based on national and international codal provisions.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	3	1	1	2	3
CO2	1	3	1	1	2	3
CO3	1	3	1	1	2	3
CO4	2	3	1	1	2	3
CO5	2	3	1	1	2	3
23SEOE01	2	3	1	1	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

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

23SEOE02	PLANNING OF SMART CITIES (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To have an exposure on planning of smart cities with consideration of the recent challenges and to address the importance of sustainable development of urban area.					
UNIT – I	**SMART CITIES DEVELOPMENT POTENTIALS AND CHALLENGES**					**9 Periods**
Perspectives of Smart Cities: Introduction and Overview - Implementation Challenges - Methodological issues - Spatial distribution of startup cities – Re imagining postindustrial cities - Implementation Challenges for Establishing Smart Urban Information and Knowledge Management System.						
UNIT – II	**SUSTAINABLE URBAN PLANNING**					**9 Periods**
Optimising Green Spaces for Sustainable Urban Planning - 3D City Models for Extracting Urban Environmental Quality Indicators - Assessing the Rainwater Harvesting Potential - The Strategic Role of Green Spaces - Monitoring Urban Expansion.						
UNIT – III	**ENERGY MANAGEMENT AND SUSTAINABLE DEVELOPMENT**					**9 Periods**
Alternatives for Energy Stressed Cities - Social Acceptability of Energy - Efficient Lighting - Energy Management - Urban Dynamics and Resource Consumption - Issues and Challenges of Sustainable Tourism - Green Buildings: Eco-friendly Technique for Modern Cities.						
UNIT – IV	**MULTIFARIOUS MANAGEMENT FOR SMART CITIES**					**9 Periods**
Assessment of Domestic Water Use Practices - Issue of Governance in Urban Water Supply - Assessment of Water Consumption at Urban Household Level - Water Sustainability - Socio-economic Determinants and Reproductive Healthcare System - Problems and Development of Slums.						
UNIT – V	**INTELLIGENT TRANSPORT SYSTEM**					**9 Periods**
Introduction to Intelligent Transport Systems (ITS) - The Range of ITS Applications -Network Optimization - Sensing Traffic using Virtual Detectors - Vehicle Routing and Personal route information - The Smart Car - Commercial Routing and Delivery - Electronic Toll Collection - The Smart Card - Dynamic Assignment - Traffic Enforcement. Urban Mobility and Economic Development.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*Poonam Sharma, Swati Rajput,* ***"Sustainable Smart Cities In India Challenges And Future Perspectives"****, Springer 2017 Co.(P) Ltd. 2013.*
2	*Ivan Nunes Da Silva,* ***"Rogerio Andrade Flauzino-Smart Cities Technologies-Exli4eva"****, 2016.*
3	*Stan McClellan, Jesus A. Jimenez, George Koutitas* ***"Smart Cities_ Applications, Technologies, Standards"****, and Driving Factors-Springer International Publishing, 2018.*
4	*Stan Geertman, Joseph Ferreira, Jr., Robert Goodspeed, John Stillwell,* ***"Planning Support Systems And Smart Cities"****, Springer, 2015.*
5	*Pradip Kumar Sarkar and Amit Kumar Jain* ***"Intelligent Transport Systems"****, PHI Learning, 2018.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Indicate the potential challenges in smart city development.	K2
CO2	Select the different tools for sustainable urban planning.	K3
CO3	Choose appropriate energy conservation system for smart cities.	K3
CO4	Identify the proper method of water management system.	K3
CO5	Apply Intelligent Transport System concepts in planning of smart city.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	2	3	1	1
CO2	1	1	1	3	2	1
CO3	1	1	-	2	2	1
CO4	1	-	1	2	1	1
CO5	1	-	1	3	1	-
23SEOE02	1	1	2	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	45	30	-	-	-	100
CAT2	25	45	30	-	-	-	100
Individual Assessment 1 / Case Study 1/ Seminar 1 / Project1	15	40	45	-	-	-	100
Individual Assessment 2 / Case Study 2/ Seminar 2 / Project 2	10	45	45	-	-	-	100
ESE	20	40	40	-	-	-	100

23SEOE03	GREEN BUILDING (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To introduce the different concepts of energy efficient buildings, indoor environmental quality management, green buildings and its design.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Life cycle impacts of materials and products – sustainable design concepts – strategies of design for the Environment -The sun-earth relationship and the energy balance on the earth's surface, climate, wind – Solar radiation and solar temperature – Sun shading and solar radiation on surfaces – Energy impact on the shape and orientation of buildings – Thermal properties of building materials.						
UNIT – II	**ENERGY EFFICIENT BUILDINGS**					**9 Periods**
Passive cooling and day lighting – Active solar and photovoltaic- Building energy analysis methods- Building energy simulation- Building energy efficiency standards-Lighting system design- Lighting economics and aesthetics- Impacts of lighting efficiency – Energy audit and energy targeting- Technological options for energy management.						
UNIT – III	**INDOOR ENVIRONMENTAL QUALITY MANAGEMENT**					**9 Periods**
Psychrometry- Comfort conditions- Thermal comfort- Ventilation and air quality-Air conditioning requirement- Visual perception- Illumination requirement- Auditory requirement- Energy management options- Air conditioning systems- Energy conservation in pumps- Fans and blowers- Refrigerating machines- Heat rejection equipment- Energy efficient motors- Insulation.						
UNIT – IV	**GREEN BUILDING CONCEPTS**					**9 Periods**
Green building concept- Green building rating tools- Leeds and IGBC codes. – Material selection Embodied energy- Operating energy- Façade systems- Ventilation systems-Transportation- Water treatment systems- Water efficiency- Building economics						
UNIT – V	**GREEN BUILDING DESIGN - CASE STUDY**					**9 Periods**
Case studies - Building form, orientation and site considerations; conservation measures; energy modeling; heating system and fuel choices; renewable energy systems; material choices - construction budget						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES :

1	*Sam Kubba* ***"Handbook of Green Building Design and Construction: LEED, BREEAM, and Green Globes",*** *Elsevier Science, 2012.*
2	*Yudelson, Jerry, McGraw-Hill,* ***"Greening existing buildings",*** *New York, 2010*
3	*Charles J. Kibert, John Wiley & Sons,* ***"Sustainable Construction: Green Building Design and Delivery",*** *3rd Edition, 2012*
4	*R.S. Means, John Wiley & Sons,* ***"Green Building: Project Planning & Cost Estimating",*** *2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the concepts of sustainable design in building construction.	K3
CO2	Execute green building techniques including energy efficiency management in the building design.	K3
CO3	Establish indoor environmental quality in green building.	K3
CO4	Perform the green building rating using various tools.	K3
CO5	Create drawings and models of green buildings.	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	2	3	3	3
CO2	3	3	2	3	3	3
CO3	2	2	2	2	3	3
CO4	2	3	1	3	3	3
CO5	3	3	1	3	3	3
23SEOE03	3	3	2	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

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

23EEOE04	ENVIRONMENT HEALTH AND SAFETY MANAGEMENT (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To impart knowledge on occupational health hazards, safety measures at work place, accident prevention, safety management and safety measures in industries.					
UNIT – I	**OCCUPATIONAL HEALTH HAZARDS**					**9 Periods**
Occupation, Health and Hazards - Safety Health and Management: Occupational Health Hazards - Ergonomics - Importance of Industrial Safety - Radiation and Industrial Hazards: Types and effects - Vibration - Industrial Hygiene - Different air pollutants in industries and their effects - Electrical, fire and Other Hazards.						
UNIT – II	**SAFETY AT WORKPLACE**					**9 Periods**
Safety at Workplace - Safe use of Machines and Tools: Safety in use of different types of unit operations - Ergonomics of Machine guarding - working in different workplaces - Operation, Inspection and maintenance - Housekeeping, Industrial lighting, Vibration and Noise.						
UNIT – III	**ACCIDENT PREVENTION**					**9 Periods**
Accident Prevention Techniques - Principles of accident prevention - Hazard identification and analysis, Event tree analysis, Hazop studies, Job safety analysis - Theories and Principles of Accident causation - First Aid: Body structure and functions - Fracture and Dislocation, Injuries to various body parts.						
UNIT – IV	**SAFETY MANAGEMENT**					**9 Periods**
Safety Management System and Law - Legislative measures in Industrial Safety - Occupational safety, Health and Environment Management, Bureau of Indian Standards on Health and Safety, IS 14489 standards - OSHA, Process safety management (PSM) and its principles - EPA standards						
UNIT – V	**GENERAL SAFETY MEASURES**					**9 Periods**
Plant Layout for Safety - design and location, distance between hazardous units, lighting, colour coding, pilot plant studies, Housekeeping - Accidents Related with Maintenance of Machines - Work Permit System - Significance of Documentation - Case studies involving implementation of health and safety measures in Industries.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES:

1	***"Physical Hazards of the Workplace"****, Barry Spurlock, CRC Press, 2017.*
2	***"Handbook of Occupational Safety and Health",*** *S. Z. Mansdorf, Wiley Publications,2019*
3	***"Safety, Health, and Environment"****, NAPTA, 2nd Edition, Pearson Publications, 2019.*
4	*"**Occupational Health and Hygiene in Industries**", Raja Sekhar Mamillapalli, Visweswara Rao , PharmaMed Press, 1st edition, 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify the occupational health hazards.	K3
CO2	Execute various safety measures at workplace.	K3
CO3	Analyze and execute accident prevention techniques.	K3
CO4	Implement safety management as per various standards.	K3
CO5	Develop awareness on safety measures in Industries.	K3

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	2	2	2	3	2
CO2	2	2	2	1	2	2
CO3	2	3	2	1	2	2
CO4	1	1	1	2	2	2
CO5	1	1	1	1	1	2
23EEOE04	1	2	2	1	2	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	35	20	10	5	5	100
CAT2	25	35	20	10	5	5	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	20	40	30	10	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	20	40	30	10	-	-	100
ESE	25	35	20	10	5	5	100

23EEOE05	CLIMATE CHANGE AND ADAPTATION (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To understand the Earth's climate system, changes and their effects on the earth, identifying the impacts, adaptation, mitigation of climate change and for gaining knowledge on clean technology, carbon trading and alternate energy sources.					
UNIT – I	**EARTH'S CLIMATE SYSTEM**					**9 Periods**
Introduction-Climate in the spotlight - The Earth's Climate Machine – Climate Classification-Global Wind Systems – Trade Winds and the Hadley Cell – The Westerlies – Cloud Formation and Monsoon Rains – Storms and Hurricanes - The Hydrological Cycle – Global Ocean Circulation – El Nino and its Effect - Solar Radiation – The Earth's Natural Green House Effect – Green House Gases and Global Warming – Carbon Cycle.						
UNIT – II	**OBSERVED CHANGES AND ITS CAUSES**					**9 Periods**
Observation of Climate Change – Changes in patterns of temperature, precipitation and sea level rise – Observed effects of Climate Changes – Patterns of Large-Scale Variability –Drivers of Climate Change – Climate Sensitivity and Feedbacks – The Montreal Protocol –UNFCCC – IPCC – Evidences of Changes in Climate and Environment – on a Global Scale and in India – climate change modeling.						
UNIT – III	**IMPACTS OF CLIMATE CHANGE**					**9 Periods**
Impacts of Climate Change on various sectors – Agriculture, Forestry and Ecosystem – Water Resources – Human Health – Industry, Settlement and Society – Methods and Scenarios – Projected Impacts for Different Regions – Uncertainties in the Projected Impacts of Climate Change – Risk of Irreversible Changes.						
UNIT – IV	**CLIMATE CHANGE ADAPTATION AND MITIGATION MEASURES**					**9 Periods**
Adaptation Strategy/Options in various sectors – Water – Agriculture –- Infrastructure and Settlement including coastal zones – Human Health – Tourism – Transport – Energy – Key Mitigation Technologies and Practices – Energy Supply – Transport – Buildings – Industry – Agriculture – Forestry - Carbon sequestration – Carbon capture and storage (CCS) – Waste (MSW & Bio waste, Biomedical, Industrial waste – International and Regional cooperation.						
UNIT – V	**CLEAN TECHNOLOGY AND ENERGY**					**9 Periods**
Clean Development Mechanism – Carbon Trading - examples of future Clean Technology – Biodiesel – Natural Compost – Eco- Friendly Plastic – Alternate Energy – Hydrogen – Biofuels– Solar Energy – Wind – Hydroelectric Power – Mitigation Efforts in India and Adaptation funding.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**						

REFERENCES

1	***"Impacts of Climate Change and Climate Variability on Hydrological Regimes",*** *Jan C. Van Dam, Cambridge University Press, 2003.*
2	*IPCC fourth assessment report - The AR4 synthesis report, 2007*
3	*IPCC fourth assessment report –Working Group I Report****, "The physical sciencebasis",*** *2007*
4	*IPCC fourth assessment report - Working Group II Report,* ***"Impacts, Adaptation and Vulnerability"****, 2007*
5	*IPCC fourth assessment report – Working Group III Report,* ***"Mitigation of Climate Change",*** *2007*
6	***"Climate Change and Water". Technical Paper of the Intergovernmental Panel on Climate Change,*** *Bates, B.C., Z.W. Kundzewicz, S. Wu and J.P. Palutikof, Eds., IPCC Secretariat, Geneva, 2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Classify the Earths climatic system and factors causing climate change and global warming.	K2
CO2	Relate the Changes in patterns of temperature, precipitation and sea level rise and Observed effects of Climate Changes	K2
CO3	Illustrate the uncertainty and impact of climate change and risk of reversible changes.	K3
CO4	Articulate the strategies for adaptation and mitigation of climatic changes.	K3
CO5	Discover clean technologies and alternate energy source for sustainable growth.	K3

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	2	3	1
CO2	3	2	2	2	3	2
CO3	2	2	2	2	3	2
CO4	3	2	2	2	2	2
CO5	3	3	2	3	3	3
23EEOE05	3	3	3	3	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

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

23EEOE06	WASTE TO ENERGY (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To classify waste as fuel, introduce conversion devices, gain knowledge about Biomass Pyrolysis, demonstrate methods, factors for biomass gasification, and acquire knowledge about biogas and its development in India.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, Gasifiers, Digestors.						
UNIT – II	**BIOMASS PYROLYSIS**					**9 Periods**
Biomass Pyrolysis: Pyrolysis -Types, Slow Pyrolysis, Fast Pyrolysis – Manufacture of charcoal – Methods – Yields and Applications – Manufacture of Pyrolytic oils and gases, Yields and Applications.						
UNIT – III	**BIOMASS GASIFICATION**					**9 Periods**
Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, Construction and Operation – Gasifier burner arrangement for thermal heating – Gasifier Engine arrangement and electrical power – Equilibrium and Kinetic Considerations in gasifier operation.						
UNIT – IV	**BIOMASS COMBUSTION**					**9 Periods**
Biomass Combustion – Biomass Stoves – Improved Chullahs, types, some exotic designs, Fixed bed combustors, types – Inclined grate combustors – Fluidized bed combustors, design, construction and operation of all the above biomass combustors.						
UNIT – V	**BIOENERGY SYSTEM**					**9 Periods**
Biogas: Properties of biogas (Calorific value and composition) – Biogas plant technology and status – Bio energy system – Design and constructional features – Biomass resources and their classification - Biomass conversion processes – Thermo chemical conversion – Direct combustion – biomass gasification – pyrolysis and liquefaction – biochemical conversion – anaerobic digestion – Types of biogas plants – Applications – Alcohol production from biomass – Bio diesel production – Urban waste to energy conversion – Biomass energy programme in India.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES:

1	***"Energy Recovery from Municipal Solid Waste by Thermal Conversion Technologies",*** *P Jayaram Reddy, Taylor and Francis Publications, 2016.*
2	***"Waste – to – Energy: Technologies and project Implementations",*** *Marc J Rogoff, Francois Screve, ELSEVIER Publications, Third Edition, 2019.*
3	***"Biogas Technology and Principles"****, Brad Hill, NY RESEARCH PRESS Publications, Illustrated Edition, 2015.*
4	***"Biomass Gasification and Pyrolysis Practical Design and Theory"***,Prabir *ELSEVIE Publications, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Investigate solid waste management techniques.	K2
CO2	Get knowledge about biomass pyrolysis.	K3
CO3	Demonstrate methods and factors considered for biomass gasification.	K3
CO4	Identify the features of different facilities available for biomass combustion.	K4
CO5	Analyze the potential of different Bioenergy systems with respect to Indian condition.	K2

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	3	3	2	3	1
CO2	3	2	2	2	3	1
CO3	3	3	2	3	2	1
CO4	3	2	2	3	3	1
CO5	2	3	3	3	2	1
23EEOE06	3	3	3	3	3	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	20	25	15	10	100
CAT2	10	25	20	10	25	10	100
Individual Assessment 1/ Case Study 1/ Seminar 1 / Project 1	-	15	35	50	-	-	100
Individual Assessment 2/ Case Study 2/ Seminar 2/ Project 2	-	10	40	50	-	-	100
ESE	10	25	25	20	10	10	100

23GEOE07	ENERGY IN BUILT ENVIRONMENT (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objective	To understand constructional energy requirements of buildings, energy audit methods and conservation of energy.					
UNIT–I	**INTRODUCTION**					**9 Periods**
Indoor activities and environmental control - Internal and external factors on energy use – Characteristics of energy use and its management -Macro aspect of energy use in dwellings and its implications –Thermal comfort-Ventilation and air quality-Air-conditioning requirement-Visual perception-Illumination requirement-Auditory requirement.						
UNIT–II	**LIGHTING REQUIREMENTS IN BUILDING**					**9 Periods**
The sun-earth relationship - Climate, wind, solar radiation and temperature - Sun shading and solar radiation on surfaces-Energy impact on the shape and orientation of buildings–Lighting and day lighting :Characteristics and estimation, methods of day-lighting–Architectural considerations for day-lighting.						
UNIT–III	**ENERGY REQUIREMENTS IN BUILDING**					**9 Periods**
Steady and unsteady heat transfer through wall and glazed window-Standards for thermal performance of building envelope- Evaluation of the overall thermal transfer- Thermal gain and net heat gain-End-Use energy requirements-Status of energy use in buildings-Estimation of energy use in a building.						
UNIT–IV	**ENERGY AUDIT**					**9 Periods**
Energy audit and energy targeting-Technological options for energy management-Natural and forced ventilation–Indoor environment and air quality-Air flow and air pressure on buildings-Flow due to Stack effect.						
UNIT–V	**COOLING IN BUILT ENVIRONMENT**					**9 Periods**
Passive building architecture–Radiative cooling-Solar cooling techniques-Solar desiccant dehumidification for ventilation-Natural and active cooling with adaptive comfort–Evaporative cooling –Zero energy building concept.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*J.Krieder and A.Rabl**, "Heating and Cooling of Buildings: Design for Efficiency"**, McGraw-Hill, 2000.*
2	*S.M.Guinnes and Reynolds, "**Mechanical and Electrical Equipment for Buildings"**,Wiley, 1989.*
3	*A.Shaw, "**Energy Design for Architects"**, AEE Energy Books, 1991.*
4	*ASHRAE,"**Hand book of Fundamentals"**,ASHRAE,Atlanta,GA.,2001.*
5	*Reference Manuals of DOE-2 (1990), Orlando Lawrence-Berkeley Laboratory, University of California, and Blast, University of Illinois , USA.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand energy and its usage	K2
CO2	Know lighting to be given to a building	K1
CO3	Analyse the energy requirements in a building	K3
CO4	Apply the energy audit concepts.	K3
CO5	Study architectural specifications of a building	K1

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	1	2	1
CO2	2	-	3	1	2	1
CO3	2	-	3	1	2	1
CO4	2	-	3	1	2	1
CO5	2	-	3	1	2	1
23GEOE07	2	-	3	1	2	1
1–Slight, 2–Moderate, 3–Substantial						

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

23GEOE08	EARTH AND ITS ENVIRONMENT (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**
Course Objective	To know about the planet earth, the geosystems and the resources like ground water and air and to learn about the Environmental Assessment and sustainability.				
UNIT–I	**EVOLUTION OF EARTH**				**9 Periods**
Evolution of earth as habitable planet-Evolution of continents-oceans and landforms-evolution of life through geological times - Exploring the earth's interior - thermal and chemical structure - origin of gravitational and magnetic fields.					
UNIT–II	**GEOSYSTEMS**				**9 Periods**
Plate tectonics - working and shaping the earth - Internal geosystems – earthquakes – volcanoes - climatic excursions through time - Basic Geological processes - igneous, sedimentation – metamorphic processes.					
UNIT–III	**GROUND WATER GEOLOGY**				**9 Periods**
Geology of ground water occurrence –recharge process-Ground water movement-Ground water discharge and catchment hydrology – Ground water as a resource - Natural ground water quality and contamination-Modelling and managing ground water systems.					
UNIT–IV	**ENVIRONMENTAL ASSESMENT AND SUSTAINABILITY**				**9 Periods**
Engineering and sustainable development - population and urbanization - toxic chemicals and finite resources - water scarcity and conflict - Environmental risk - risk assessment and characterization – hazard assessment-exposure assessment.					
UNIT–V	**AIR AND SOLIDWASTE**				**9 Periods**
Air resources engineering-introduction to atmospheric composition–behaviour-atmospheric photo chemistry-Solid waste management–characterization-management concepts.					
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**					

REFERENCES

1	*John Grotzinger and Thomas H.Jordan, "**Understanding Earth",** Sixth Edition,W.H.Freeman, 2010.*
2	*Younger,P.L., "**Ground water in the Environment: An introduction"**, Blackwell Publishing,2007.*
3	*Mihelcic, J. R., Zimmerman,J. B., "**Environmental Engineering:Fundamentals, Sustainability and Design"**,Wiley,NJ, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	To know about evolution of earth and the structure of the earth.	K2
CO2	To understand the internal geosystems like earthquakes and volcanoes and the Various geological processes.	K2
CO3	To able to find the geological process of occurrence and movement of Ground water and the modeling systems.	K3
CO4	To assess the Environmental risks and the sustainability developments.	K3
CO5	To learn about the photochemistry of atmosphere and the solid waste Management concepts.	K1

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	-	2	2	-
CO2	3	-	3	3	-	3
CO3	2	-	-	-	-	-
CO4	-	2	-	-	1	-
CO5	2	2	-	1	-	-
23GEOE08	2	2	3	3	2	3
1–Slight, 2–Moderate, 3–Substantial						

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

23GEOE09	NATURAL HAZARDS AND MITIGATION (Common to all Branches)					
PREREQUISITES:		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objective	To get idea on the causes, effects and mitigation measures of different types of hazards with case studies.					
UNIT–I	**EARTH QUAKES**					**9 Periods**
Definitions and basic concepts-different kinds of hazards–causes-Geologic Hazards–Earthquakes-causes of earthquakes–effects-plate tectonics-seismic waves-measures of size of earthquakes-earthquake resistant design concepts.						
UNIT–II	**SLOPE STABILITY**					**9 Periods**
Slope stability and landslides-causes of landslides–principles of stability analysis-remedial and corrective measures for slope stabilization.						
UNIT–III	**FLOODS**					**9 Periods**
Climatic Hazards–Floods-causes of flooding-regional flood frequency analysis–flood control measures-flood routing-flood forecasting-warning systems.						
UNIT–IV	**DROUGHTS**					**9 Periods**
Droughts –causes - types of droughts –effects of drought -hazard assessment – decision making-Use of GIS in natural hazard assessment–mitigation-management.						
UNIT–V	**TSUNAMI**					**9 Periods**
Tsunami–causes–effects–under sea earthquakes–landslides–volcanic eruptions–impact of sea meteorite–remedial measures–precautions–case studies.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*Donald Hyndman and David Hyndman, **"Natural Hazards and Disasters",** Brooks/Cole Cengage Learning, 2008.*
2	*Edward Bryant, **"Natural Hazards"**, Cambridge University Press,2005.*
3	*J Michael Duncan and Stephan G Wright, **"Soil Strength and Slope Stability"**, John Wiley & Sons, Inc,2005.*
4	*AmrS.Elnashai and Luigi Di Sarno, **"Fundamentals of Earthquake Engineering"**, John Wiley & Sons,Inc,2008*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Learn the basic concepts of earthquakes and the design concepts of earthquake Resistant buildings.	K2
CO2	Acquire knowledge on the causes and remedial measures of slope stabilization.	K3
CO3	As certain the causes and control measures of flood.	K3
CO4	Know the types, causes and mitigation of droughts.	K2
CO5	Study the causes, effects and precautionary measures of Tsunami.	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	-	3	2	3
CO2	3	1	2	3	3	3
CO3	3	2	3	-	-	3
CO4	3	-	-	3	2	3
CO5	3	-	2	2	-	3
23GEOE09	3	1	2	3	2	3
1–Slight, 2–Moderate, 3–Substantial						

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

23EDOE10	BUSINESS ANALYTICS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	• To apprehend the fundamentals of business analytics and its life cycle. • To gain knowledge about fundamental business analytics. • To study modeling for uncertainty and statistical inference. • To apprehend analytics the usage of Hadoop and Map Reduce frameworks. • To acquire insight on other analytical frameworks.					
UNIT – I	**BUSINESS ANALYTICS AND PROCESS**					**9 Periods**
Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling andestimation methods overview.						
UNIT – II	**REGRESSION ANALYSIS**					**9 Periods**
Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.						
UNIT – III	**STRUCTURE OF BUSINESS ANALYTICS**					**9 Periods**
Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.						
UNIT – IV	**FORECASTING TECHNIQUES**					**9 Periods**
Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.						
UNIT – V	**DECISION ANALYSIS AND RECENT TRENDS IN BUSINESS ANALYTICS**					**9 Periods**
Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.Recent Trends: Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**						

REFERENCES

1	*VigneshPrajapati, **"Big Data Analytics with R and Hadoop",**Packt Publishing, 2013.*
2	*Umesh R Hodeghatta, UmeshaNayak**, "Business Analytics Using R – A Practical Approach",**Apress, 2017.*
3	*AnandRajaraman, Jeffrey David Ullman, **"Mining of Massive Datasets",** Cambridge University Press, 2012.*
4	*Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, **"Essentials of Business Analytics",** Cengage Learning, second Edition, 2016.*
5	*U. Dinesh Kumar, **"Business Analytics: TheScience of Data-Driven Decision Making",** Wiley, 2017.*
6	*Rui Miguel Forte, **"Mastering Predictive Analytics with R",** Packt Publication, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the real world business problems and model with analytical solutions.	K4
CO2	Solve analytical problem with relevant mathematics background knowledge.	K4
CO3	Convert any real world decision making problem to hypothesis and apply suitable statistical testing.	K4
CO4	Write and Demonstrate simple applications involving analytics using Hadoop and Map Reduce	K4
CO5	Use open source frameworks for modeling and storing data.	K4

Course Articulation Matrix

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	1	2	1
CO2	1	1	1	2	1
CO3	2	2	1	1	-
CO4	2	2	1	-	-
CO5	1	2	-	-	-
23EDOE10	1	2	1	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	25	25	-	-	100
CAT2	20	25	25	30	-	-	100
Assignment 1	25	30	25	20	-	-	100
Assignment 2	30	20	30	20	-	-	100
ESE	20	30	20	30	-	-	100

23EDOE11	INTRODUCTION TO INDUSTRIAL SAFETY (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	• Summarize basics of industrial safety. • Describe fundamentals of maintenance engineering. • Explain wear and corrosion. • Illustrate fault tracing. • Identify preventive and periodic maintenance.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc., Safety color codes. Fire prevention and firefighting, equipment and methods.						
UNIT – II	**FUNDAMENTALS OF MAINTENANCE ENGINEERING**					**9 Periods**
Definition and aim of maintenance engineering, Primary and secondary functions andresponsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.						
UNIT – III	**WEAR AND CORROSION AND THEIR PREVENTION**					**9 Periods**
Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.						
UNIT – IV	**FAULT TRACING**					**9 Periods**
Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault-finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.						
UNIT – V	**PERIODIC AND PREVENTIVE MAINTENANCE**					**9 Periods**
Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0 Periods Total:45 Periods**						

REFERENCES

1	*Hans F. Winterkorn,* ***"Foundation Engineering Handbook",*** *Chapman & Hall London,2013.*
2	***"Maintenance Engineering"*** *by Dr. Siddhartha Ray, New Age International (P) Ltd., Publishers, 2017*
3	***"Industrial Safety Management",****McGraw Hill Education; New edition (1 July 2017)*
4	***"Industrial Engineering And Production Management",*** *S. Chand Publishing; Third edition, 2018*
5	***"Industrial Safety and Maintenance Engineering",*** *Parth B. Shah, 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Ability to summarize basics of industrial safety	K4
CO2	Ability to describe fundamentals of maintenance engineering	K4
CO3	Ability to explain wear and corrosion	K4
CO4	Ability to illustrate fault tracing	K4
CO5	Ability to identify preventive and periodic maintenance	K4

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	2	1	1	-	-
CO2	2	2	1	-	1
CO3	1	2	1	1	1
CO4	2	1	1	1	1
CO5	2	1	2	1	1
23EDOE11	2	1	1	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	25	25	25	25	-	-	100
CAT2	20	25	25	30	-	-	100
Assignment 1	25	30	25	20	-	-	100
Assignment 2	30	20	30	20	-	-	100
ESE	20	30	20	30	-	-	100

23EDOE12	OPERATIONS RESEARCH (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	• Solve linear programming problem and solve using graphical method. • Solve LPP using simplex method. • Solve transportation, assignment problems. • Solve project management problems. • Solve scheduling problems.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models		
UNIT – II	**LINEAR PROGRAMMING PROBLEM**	**9 Periods**
Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming		
UNIT – III	**NON-LINEAR PROGRAMMING PROBLEM**	**9 Periods**
Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT		
UNIT – IV	**SEQUENCING AND INVENTORY MODEL**	**9 Periods**
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.		
UNIT – V	**GAME THEORY**	**9 Periods**
Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*H.A. Taha, **"Operations Research, An Introduction",** PHI, 2017.*
2	***"Industrial Engineering and Management",** O. P. Khanna, 2017.*
3	***"Operations Research",** S.K. Patel, 2017.*
4	***"Operation Research",** Anup Goel, Ruchi Agarwal, Technical Publications, Jan 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Formulate linear programming problem and solve using graphical method.	K4
CO2	Solve LPP using simplex method.	K4
CO3	Formulate and solve transportation, assignment problems.	K4
CO4	Solve project management problems.	K4
CO5	Solve scheduling problems	K4

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	-	-
CO2	2	2	1	-	-
CO3	1	1	2	1	1
CO4	1	1	-	-	-
CO5	2	1	-	-	-
23EDOE12	2	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

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

23MFOE13	OCCUPATIONAL HEALTH AND SAFETY (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	• To gain knowledge about occupational health hazard and safety measures at work place. • To learn about accident prevention and safety management. • To learn about general safety measures in industries.					
UNIT – I	**OCCUPATIONAL HEALTH AND HAZARDS**					**9 Periods**
Safety- History and development, National Safety Policy- Occupational Health Hazards - Ergonomics - Importance of Industrial Safety Radiation and Industrial Hazards- Machine Guards and its types, Automation.						
UNIT – II	**SAFETY AT WORKPLACE**					**9 Periods**
Safety at Workplace - Safe use of Machines and Tools: Safety in use of different types of unit operations - Ergonomics of Machine guarding - working in different workplaces - Operation, Inspection and maintenance, Plant Design and Housekeeping, Industrial lighting, Vibration and Noise Case studies.						
UNIT – III	**ACCIDENT PREVENTION**					**9 Periods**
Accident Prevention Techniques - Principles of accident prevention - Definitions, Theories, Principles – Hazard identification and analysis, Event tree analysis, Hazop studies, Job safety analysis - Theories and Principles of Accident causation - First Aid : Body structure and functions - Fracture and Dislocation, Injuries to various body parts.						
UNIT – IV	**SAFETY MANAGEMENT**					**9 Periods**
Safety Management System and Law - Legislative measures in Industrial Safety: Various acts involved in Detail- Occupational safety, Health and Environment Management: Bureau of Indian Standards on Health and Safety, 14489, 15001 - OSHA, Process safety management (PSM) and its principles - EPA standards- Safety Management: Organisational & Safety Committee - its structure and functions.						
UNIT – V	**GENERAL SAFETY MEASURES**					**9 Periods**
Plant Layout for Safety -design and location, distance between hazardous units, lighting, colour coding, pilot plant studies, Housekeeping - Accidents Related with Maintenance of Machines - Work Permit System: Significance of Documentation Directing Safety, Leadership -Case studies involving implementation of health and safety measures in Industries.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES:

1	*Benjamin O.Alli, **Fundamental Principles of Occupational Health and Safety** ILO 2008.*
2	*Danuta Koradecka, **Handbook of Occupational Health and Safety**, CRC, 2010.*
3	*Dr. Siddhartha Ray, **Maintenance Engineering,** New Age International (P) Ltd., Publishers, 2017*
4	*Deshmukh. L.M., **Industrial Safety Management**, 3rd Edition, Tata McGraw Hill, New Delhi, 2008.*
5	*https://nptel.ac.in/courses/110105094*
6	*https://archive.nptel.ac.in/courses/110/105/110105094/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Gain the knowledge about occupational health hazard and safety measures at work place.	K3
CO2	Learn about accident prevention and safety management.	K2
CO3	Understand occupational health hazards and general safety measures in industries.	K3
CO4	Know various laws, standards and legislations.	K2
CO5	Implement safety and proper management of industries.	K4

Course Articulation Matrix:					
Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	1	1
CO2	2	2	1	1	1
CO3	1	2	1	1	1
CO4	2	1	1	1	1
CO5	2	1	2	1	1
23MFOE13	2	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

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

23MFOE14	COST MANAGEMENT OF ENGINEERING PROJECTS (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	• To understand the costing concepts and their role in decision making. • To acquire the project management concepts and their various aspects in selection. • To gain the knowledge in costing concepts with project execution. • To develop knowledge of costing techniques in service sector and various budgetary control techniques. • To familiarize with quantitative techniques in cost management.

UNIT – I	**INTRODUCTION TO COSTING CONCEPTS**	**9 Periods**

Introduction and Overview of the Strategic Cost Management Process, Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision - Making.

UNIT – II	**PROJECT PLANNING ACTIVITIES**	**9 Periods**

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process.

UNIT – III	**COST ANALYSIS**	**9 Periods**

Cost Behaviour and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.

UNIT – IV	**PRICING STRATEGIES AND BUDGETORY CONTROL**	**9 Periods**

Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing, Costing of service sector, Just-in -time approach, Material Requirement Planning, Enterprise Resource Planning. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT – V	**TQM AND OPERATIONS REASEARCH TOOLS**	**9 Periods**

Total Quality Management and Theory of constraints, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Contact Periods:

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

REFERENCES:

1	*Charles T. Horngren and George Foster, "**Advanced Management Accounting"**, 2018.*
2	*John M. Nicholas, "**Project Management for Engineering, Business and Technology"**, Taylor & Francis, 2016*
3	*Nigel J, "**Engineering Project Management"**, John Wiley and Sons Ltd, Smith 2015.*
4	*Charles T. Horngren and George Foster, "**Cost Accounting a Managerial Emphasis"**, Prentice Hall of India, New Delhi, 2011.*
5	*https://archive.nptel.ac.in/courses/110/104/110104073/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the costing concepts and their role in decision making.	K3
CO2	Apply the project management concepts and analyze their various aspects in selection.	K4
CO3	Interpret costing concepts with project execution.	K4
CO4	Gain knowledge of costing techniques in service sector and various budgetary control techniques.	K2
CO5	Become familiar with quantitative techniques in cost management.	K3

Course Articulation Matrix:

COs/Pos	PO1	PO2	PO3	PO4	PO5
CO1	1	1	2	1	1
CO2	2	1	1	1	-
CO3	2	2	2	-	-
CO4	1	1	1	1	1
CO5	1	2	1	1	-
23MFOE14	1	1	1	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	-	40	60	-	-	100
CAT2	-	30	30	40	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	40	60	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	30	30	40	-	-	100
ESE	-	20	40	40	-	-	100

23MFOE15	COMPOSITE MATERIALS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	• To summarize the characteristics of composite materials and effect of reinforcement in composite materials. • To identify the various reinforcements used in composite materials. • To compare the manufacturing process of metal matrix composites. • To understand the manufacturing processes of polymer matrix composites. • To analyze the strength of composite materials.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Definition – Classification and characteristics of Composite materials. Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement on overall composite performance.						
UNIT – II	**REINFORCEMENT**					**9 Periods**
Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures. Isostrain and Isosteres conditions.						
UNIT – III	**MANUFACTURING OF METAL MATRIX COMPOSITES**					**9 Periods**
Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing- Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering–Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving- Properties and applications.						
UNIT – IV	**MANUFACTURING OF POLYMER MATRIX COMPOSITE**					**9 Periods**
Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.						
UNIT – V	**STRENGTH ANALYSIS OF COMPOSITES**					**9 Periods**
Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES:

1	*Chawla K.K.,* ***Composite Materials****, Springer, 2013.*
2	*Lubin.G,* ***Hand Book of Composite Materials****, Springer New York, 2013.*
3	*Deborah D.L. Chung,* ***Composite Materials Science and Applications****, Springer, 2011.*
4	*uLektz,* ***Composite Materials and Mechanics****, uLektz Learning Solutions Private Limited, Lektz, 2013.*
5	*https://nptel.ac.in/courses/112104168*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know the characteristics of composite materials and effect of reinforcement in composite materials.	K2
CO2	Know the various reinforcements used in composite materials.	K2
CO3	Understand and apply the manufacturing processes of metal matrix composites	K3
CO4	Understand and apply the manufacturing processes of polymer matrix composites.	K3
CO5	Analyze the strength of composite materials.	K4

Course Articulation Matrix:					
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	1	2	1	1	1
CO2	2	2	1	1	2
CO3	2	1	2	1	1
CO4	1	2	2	2	1
CO5	1	2	1	1	1
23MFOE15	1	2	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

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

23TEOE16	GLOBAL WARMING SCIENCE (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To make the students learn about the material consequences of climate change, sea level change due to increase in the emission of greenhouse gases and to examine the science behind mitigation and adaptation proposals.

UNIT – I	**INTRODUCTION**	**9 Periods**

Terminology relating to atmospheric particles – Aerosols - Types, characteristics, measurements – Particle mass spectrometry - Anthropogenic-sources, effects on humans.

UNIT – II	**CLIMATE MODELS**	**9 Periods**

General climate modeling- Atmospheric general circulation model - Oceanic general circulation model, sea ice model, land model concept, paleo-climate - Weather prediction by numerical process. Impacts of climate change - Climate Sensitivity - Forcing and feedback.

UNIT – III	**EARTH CARBON CYCLE AND FORECAST**	**9 Periods**

Carbon cycle-process, importance, advantages - Carbon on earth - Global carbon reservoirs - Interactions between human activities and carbon cycle - Geologic time scales - Fossil fuels and energy - Perturbed carbon cycle.

UNIT – IV	**GREENHOUSE GASES**	**9 Periods**

Blackbody radiation - Layer model - Earth's atmospheric composition and Green house gases effects on weather and climate - Radioactive equilibrium - Earth's energy balance.

UNIT – V	**GEO ENGINEERING**	**9 Periods**

Solar mitigation - Strategies – Carbon dioxide removal - Solar radiation management - Recent observed trends in global warming for sea level rise, drought, glacier extent.

Contact Periods:

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

REFERENCES:

1	*Eli Tziperman, **"Global Warming Science: A Quantitative Introduction to Climate Change and Its Consequences"**, Princeton University Press, 1st Edition, 2022.*
2	*John Houghton, **"Global warming: The Complete Briefing"**, Cambridge University Press, 5th Edition, 2015.*
3	*David Archer, **"Global warming: Understanding the Forecast"**, Wiley, 2nd Edition, 2011.*
4	*David S.K. Ting, Jacqueline A Stagner, **"Climate Change Science: Causes, Effects and Solutions for Global Warming"**, Elsevier, 1st Edition, 2021.*
5	*Frances Drake, **"Global Warming: The Science of Climate Change"**, Routledge, 1st edition, 2000.*
6	*Dickinson, **"Climate Engineering-A review of aerosol approaches to changing the global energy balance"**, Springer, 1996.*
7	*Andreas Schmittner, **"Introduction to Climate Science"**, Oregon State University, 2018.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the global warming in relation to climate changes throughout the earth.	K2
CO2	Assess the best predictions of current climate models.	K4
CO3	Understand the importance of carbon cycle and its implication on fossil fuels.	K2
CO4	Know about current issues, including impact from society, environment, economy as well as ecology related to greenhouse gases.	K4
CO5	Know the safety measures and precautions regarding global warming.	K5

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	2	1	1	2
CO2	1	1	2	1	1	1
CO3	1	2	1	1	1	2
CO4	1	1	1	1	1	2
CO5	2	1	2	1	1	2
23TEOE16	1	1	1	1	1	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	35	35	10	-	-	100
CAT2	15	25	25	20	15	-	100
Individual Assessment 1 / Case Study 1 / Seminar 1 / Project 1	25	20	20	35	-	-	100
Individual Assessment 2 / Case Study 2 / Seminar 2 / Project 2	20	20	35	15	10	-	100
ESE	25	20	25	20	10	-	100

23TEOE17	INTRODUCTION TO NANO ELECTRONICS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
ENGINEERING PHYSICS		**OE**	**3**	**0**	**0**	**3**
Course Objectives	To make the students provide strong, essential, important methods and foundations of quantum mechanics and apply quantum mechanics on engineering fields.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Particles and Waves - Operators in quantum mechanics - The Postulates of quantum mechanics - The Schrodinger equation values and wave packet Solutions - Ehrenfest's Theorem.						
UNIT – II	**ELECTRONIC STRUCTURE AND MOTION**					**9 Periods**
Atoms- The Hydrogen Atom - Many-Electron Atoms – Pseudopotentials, Nuclear Structure, Molecules, Crystals - Translational motion – Penetration through barriers – Particle in a box - Two terminal quantum dot devices - Two terminal quantum wire devices.						
UNIT – III	**SCATTERING THEORY**					**9 Periods**
The formulation of scattering events - Scattering cross section - Stationary scattering state - Partial wave stationary scattering events - multi-channel scattering - Solution for Schrodinger equation- Radial and wave equation - Greens' function.						
UNIT – IV	**CLASSICAL STATISTICS**					**9 Periods**
Probabilities and microscopic behaviours - Kinetic theory and transport processes in gases - Magnetic properties of materials - The partition function.						
UNIT – V	**QUANTUM STATISTICS**					**9 Periods**
Statistical mechanics - Basic Concepts - Statistical models applied to metals and semiconductors - The thermal properties of solids- The electrical properties of materials - Black body radiation - Low temperatures and degenerate systems.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES:

1	*Vladimi V.Mitin, Viatcheslav A. Kochelap and Michael A.Stroscio,* ***"Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications"****, Cambridge University Press, 1st Edition, 2007.*
2	*Vinod Kumar Khanna,* ***"Introductory Nanoelectronics: Physical Theory and Device Analysis"****, Routledge, 1st Edition, 2020.*
3	*George W. Hanson,* ***"Fundamentals of Nanoelectronics"****, Pearson Publishers, United States Edition, 2007.*
4	*Marc Baldo,* ***"Introduction to Nanoelectronics"****, MIT Open Courseware Publication, 2011.*
5	*Vladimi V.Mitin,* ***"Introduction to Nanoelectronics"****, Cambridge University Press, South Asian Edition, 2009.*
6	*Peter L. Hagelstein, Stephen D. Senturia and Terry P. Orlando, "****Introductory Applied Quantum Statistical Mechanics"****, Wiley, 2004.*
7	*A. F. J. Levi,* ***"Applied Quantum Mechanics"****, 2nd Edition, Cambridge, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the postulates of quantum mechanics.	K2
CO2	Know about nano electronic systems and building blocks.	K2
CO3	Solve the Schrodinger equation in 1D, 2D and 3Ddifferent applications.	K4
CO4	Learn the concepts involved in kinetic theory of gases.	K2
CO5	Know about statistical models applies to metals and semiconductor.	K3

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	1	1	1	1
CO2	2	2	1	1	1	1
CO3	2	2	2	1	1	1
CO4	1	1	1	1	1	1
CO5	1	1	1	1	1	1
23TEOE17	1	1	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial						

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

22TEOE18	GREEN SUPPLY CHAIN MANAGEMENT (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To make the students learn and focus on the fundamental strategies, tools and techniques required to analyze and design environmentally sustainable supply chain systems.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Intro to SCM – complexity in SCM, Facility location - Logistics – Aim, activities, importance, progress, current trends - Integrating logistics with an organization.		
UNIT – II	**ESSENTIALS OF SUPPLY CHAIN MANAGEMENT**	**9 Periods**
Basic concepts of supply chain management - Supply chain operations – Planning and sourcing - Making and delivering - Supply chain coordination and use of technology - Developing supply chain systems.		
UNIT – III	**PLANNING THE SUPPLY CHAIN**	**9 Periods**
Types of decisions – strategic, tactical, operational - Logistics strategies, implementing the strategy - Planning resources – types, capacity, schedule, controlling material flow, measuring and improving performance.		
UNIT – IV	**ACTIVITIES IN THE SUPPLY CHAIN**	**9 Periods**
Procurement – cycle, types of purchase – Framework of e-procurement - Inventory management – EOQ, uncertain demand and safety stock, stock control - Material handling – Purpose of warehouse and ownership, layout, packaging - Transport – mode, ownership, vehicle routing and scheduling models- Travelling salesman problems - Exact and heuristic methods.		
UNIT – V	**SUPPLY CHAIN MANAGEMENT STRATEGIES**	**9 Periods**
Five key configuration components - Four criteria of good supply chain strategies - Next generation strategies- New roles for end-to-end supply chain management - Evolution of supply chain organization – International issues in SCM – Regional differences in logistics.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES:

1	*Charisios Achillas, Dionysis D. Bochtis, Dimitrios Aidonis and Dimitris Folinas,* ***"Green Supply Chain Management"****, Routledge, 1st Edition, 2019.*
2	*Hsiao-Fan Wang and Surendra M.Gupta,* ***"Green Supply Chain Management: Product Life Cycle Approach"****,McGraw-Hill Education, 1st Edition, 2011.*
3	*Joseph Sarkis and Yijie Dou,* ***"Green Supply Chain Management"****, Routledge, 1st Edition, 2017.*
4	*Arunachalam Rajagopal,* ***"Green Supply Chain Management: A Practical Approach"****, Replica, 2021.*
5	*Mehmood Khan, Matloub Hussain and Mian M. Ajmal,* ***"Green Supply Chain Management for Sustainable Business Practice"****, IGI Global, 1st Edition, 2016.*
6	*S Emmett,* ***"Green Supply Chains: An Action Manifesto"****, John Wiley & Sons Inc, 2010.*
7	*Joseph Sarkis and Yijie Dou,* ***"Green Supply Chain Management: A Concise Introduction"****, Routledge, 1st Edition, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Integrate logistics with an organization.	K2
CO2	Evaluate complex qualitative and quantitative data to support strategic and operational decisions.	K5
CO3	Develop self-leadership strategies to enhance personal and professional effectiveness.	K3
CO4	Analyze inventory management models and dynamics of supply chain.	K4
CO5	Identify issues in international supply chain management and outsources strategies.	K3

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	1	1	1	1	3
CO2	2	2	1	1	1	1
CO3	2	1	2	1	1	1
CO4	2	2	1	1	2	2
CO5	1	1	2	1	1	3
23TEOE18	2	1	1	1	1	2
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	25	25	30	10	10	-	100
CAT2	30	40	20	10	-	-	100
Individual Assessment 1 / Case Study 1 / Seminar 1 / Project 1	30	20	25	15	10	-	100
Individual Assessment 2 / Case Study 2 / Seminar 2 / Project 2	35	30	25	10	-	-	100
ESE	30	30	20	10	10	-	100

23PSOE19	DISTRIBUTION AUTOMATION SYSTEM (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		OE	3	0	0	3
Course Objectives	To study about the distributed automation and economic evaluation schemes of power network.					
UNIT – I	**INTRODUCTION**					**9 Periods**
Introduction to Distribution Automation (DA) - Control system interfaces- Control and data requirements- Centralized (vs) decentralized control- DA system-DA hardware-DAS software.						
UNIT – II	**DISTRIBUTION AUTOMATION FUNCTIONS**					**9 Periods**
DA capabilities - Automation system computer facilities- Management processes- Information management- System reliability management- System efficiency management- Voltage management- Load management.						
UNIT – III	**COMMUNICATION SYSTEMS**					**9 Periods**
Communication requirements - reliability- Cost effectiveness- Data requirements- Two way capability- Communication during outages and faults - Ease of operation and maintenance- Conforming to the architecture of flow. Distribution line carrier- Ripple control-Zero crossing technique- Telephone, cableTV, radio, AM broadcast, FM SCA,VHF radio, microwave satellite, fiber optics-Hybrid communication systems used in field tests.						
UNIT – IV	**ECONOMIC EVALUATION METHODS**					**9 Periods**
Development and evaluation of alternate plans- select study area – Select study period- Project load growth-Develop alternatives- Calculate operating and maintenance costs-Evaluate alternatives.						
UNIT – V	**ECONOMIC COMPARISON**					**9 Periods**
Economic comparison of alternate plans-Classification of expenses - capital expenditures-Comparison of revenue requirements of alternative plans-Book life and continuing plant analysis-Year by year revenue requirement analysis, Short term analysis- End of study adjustment-Break even analysis, sensitivity analysis - Computational aids.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*M.K. Khedkar, G.M. Dhole, **"A Textbook of Electric Power Distribution Automation"**, Laxmi Publications, Ltd., 2010.*
2	*Maurizio Di Paolo Emilio, **"Data Acquisition Systems: From Fundamentals to Applied Design"**, Springer Science & Business Media, 21-Mar-2013*
3	*IEEE Tutorial course **"Distribution Automation"**, IEEE Working Group on Distribution Automation, IEEE Power Engineering Society. Power Engineering Education Committee, IEEE Power Engineering Society. Transmission and Distribution Committee, Institute of Electrical and Electronics Engineers, 1988*
4	*Taub, **"Principles Of Communication Systems",** Tata McGraw-Hill Education, 07-Sep-2008*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyse the requirements of distributed automation	K1
CO2	Know the functions of distributed automation	K2
CO3	Perform detailed analysis of communication systems for distributed automation.	K3
CO4	Study the economic evaluation method	K4
CO5	Understand the comparison of alternate plans	K5

Course Articulation Matrix				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	2	-	1	3
CO2	3	-	3	2
CO3	3	-	3	2
CO4	3	-	3	1
CO5	2	-	1	2
23PSOE19	3	-	3	2
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	20	10	20	-	100
CAT2	20	20	20	20	20	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	20	10	30	20	20	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20	30	10	20	20	-	100
ESE	30	20	20	20	10	-	100

23PSOE20	ELECTRICITY TRADING AND ELECTRICITY ACTS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		OE	3	0	0	3
Course Objectives	To acquire expertise on Electric supply and demand of Indian Grid, gain exposure on energy trading in the Indian market and infer the electricity acts and regulatory authorities.					
UNIT – I	**ENERGY DEMAND**					**9 Periods**
Basic concepts in Economics - Descriptive Analysis of Energy Demand - Decomposition Analysis and Parametric Approach - Demand Side Management - Load Management - Demand Side Management - Energy Efficiency - Rebound Effect						
UNIT – II	**ENERGY SUPPLY**					**9 Periods**
Supply Behavior of a Producer - Energy Investment - Economics of Non-renewable Resources - Economics of Renewable Energy Supply Setting the context - Economics of Renewable Energy Supply - Economics of Electricity Supply						
UNIT – III	**ENERGY MARKET**					**9 Periods**
Perfect Competition as a Market Form - Why is the Energy Market not Perfectly Competitive? - Market Failure and Monopoly - Oil Market: Pre OPEC Era I - Oil Market: Pre OPEC Era II - Oil Market: OPEC						
UNIT – IV	**LAW ON ELECTRICITY**					**9 Periods**
Introduction of the Electricity Law; Constitutional Design - Evolution of Laws on Electricity Salient Features of Electricity Act, 2003 - Evolution of Laws on Electricity - Salient Features of the Electricity Act 2003						
UNIT – V	**REGULATORY COMMISSIONS FOR ELECTRICITY ACT**					**9 Periods**
Regulatory Commissions - Appellate Tribunal - Other Institutions under the Act - Electricity (Amendment) Bill 2020/2021. A Critical Comment - Renewable Energy - Role of Civil Society; Comments on Draft Renewable Energy Act, 2015						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*Bhattacharyya, Subhes. C. (2011).* ***"Energy Economics: Concepts, Issues, Markets and Governance****". Springer.London, UK*
2	*Stevens, P. (2000).* ***"An Introduction to Energy Economics. In Stevens, P.(ed.) The Economics of Energy"****, Vol.1, Edward Elgar, Cheltenham, UK.*
3	*Nausir Bharucha,* ***"Guide to the Electricity Laws"****, LexisNexis, 2018*
4	*Mohammad Naseem,* ***"Energy Laws in India"****, Kluwer Law International, 3rd Edn, The Netherlands, 2017.*
5	*Alok Kumar & Sushanta K Chaterjee,* ***"Electricity Sector in India: Policy and Regulation"****, OUP, 2012.*
6	*Benjamin K Sovacool & Michael H Dowrkin,* ***"Global Energy Justice: Problems, Principles and Practices"****, Cambridge Univesity Press, 2014.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe electric supply and demand of power grid	K1
CO2	Summarize various energy trading strategies	K2
CO3	Relate the electricity acts practically	K3
CO4	Cite the electricity regulatory authorities	K2
CO5	Analyze/check the existing power grid for its technical and economical sustainability	K4

Course Articulation Matrix				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	3	3
CO2	3	-	1	1
CO3	3	-	2	2
CO4	3	-	1	2
CO5	3	-	3	3
23PSOE20	3	-	2	2
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	20	30	-	-	100
CAT2	20	20	20	20	20	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	20	30	30	20	-	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20	30	-	20	-	40	100
ESE	30	30	-	20	20	-	100

23PSOE21	MODERN AUTOMOTIVE SYSTEMS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		OE	3	0	0	3
Course Objectives	To expose the students with theory and applications of Automotive Electrical and Electronic Systems.					
UNIT – I	**INTRODUCTION TO MODERN AUTOMOTIVE ELECTRONICS**					**9 Periods**
Introduction to modern automotive systems and need for electronics in automobiles- Role of electronics and microcontrollers- Sensors and actuators- Possibilities and challenges in automotive industry- Enabling technologies and industry trends.						
UNIT – II	**SENSORS AND ACTUATORS**					**9 Periods**
Introduction- basic sensor arrangement- Types of sensors- Oxygen sensor, engine crankshaft angular position sensor – Engine cooling water temperature sensor- Engine oil pressure sensor- Fuel metering- vehicle speed sensor and detonation sensor- Pressure Sensor- Linear and angle sensors- Flow sensor- Temperature and humidity sensors- Gas sensor- Speed and Acceleration sensors- Knock sensor- Torque sensor- Yaw rate sensor- Tyre Pressure sensor- Actuators - Stepper motors – Relays.						
UNIT – III	**POWERTRAIN CONTROL SYSTEMS IN AUTOMOBILE**					**9 Periods**
Electronic Transmission Control - Digital engine control system: Open loop and close loop control systems- Engine cooling and warm up control- Acceleration- Detonation and idle speed control - Exhaust emission control engineering- Onboard diagnostics- Future automotive powertrain systems.						
UNIT – IV	**SAFETY, COMFORT AND CONVENIENCE SYSTEMS**					**9 Periods**
Cruise Control- Anti-lock Braking Control- Traction and Stability control- Airbag control system- Suspension control- Steering control- HVAC Control.						
UNIT – V	**ELECTRONIC CONTROL UNITS (ECU)**					**9 Periods**
Introduction to Energy Sources for ECU, Need for ECUs- Advances in ECUs for automotives - Design complexities of ECUs- V-Model for Automotive ECU's- Architecture of an advanced microcontroller (XC166 Family, 32-bit Tricore) used in the design of automobile ECUs- On chip peripherals, protocol interfaces, analog and digital interfaces.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*Enrique Acha, Manuel Madrigal**, "Power System Harmonics: Computer Modeling and Analysis**", John Wiley and Sons, 2001.*
2	*M. H. J. Bollen, **"Understanding Power Quality Problems, Voltage Sag and Interruptions",** IEEE Press, series on Power Engineering, 2000.*
3	*Roger C. Dugan, Mark F. McGranaghan, Surya Santoso and Wayne Beaty H., **"Electrical Power SystemQuality"**, Second Edition, McGraw Hill Publication Co., 2008.*
4	*G.T.Heydt, **"Electric Power Quality",** Stars in a Circle Publications, 1994(2nd edition).*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire knowledge about conventional automotive control units and devices.	K1
CO2	Recognize the practical issues in the automotive control systems	K2
CO3	Analyze the impact of modern automotive techniques in various Engineering applications	K4
CO4	Develop modern automotive control system for electrical and electronics systems	K6
CO5	Understand the function of sensors and actuators	K2

Course Articulation Matrix				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	1	3
CO2	3	-	3	2
CO3	3	-	3	2
CO4	2	-	3	1
CO5	2	-	1	2
23PSOE21	3	-	2	2
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	20	30	-	-	100
CAT2	20	20	20	20	20	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	20	30	-	20	-	30	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20	30	-	20	-	40	100
ESE	30	30	20	20	-	-	100

23PEOE22	VIRTUAL INSTRUMENTATION (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		OE	3	0	0	3
Course Objectives	To comprehend the Virtual instrumentation programming concepts towards measurements and control and to instill knowledge on DAQ, signal conditioning and its associated software tools					
UNIT – I	**INTRODUCTION**					**7 Periods**
Introduction - advantages - Block diagram and architecture of a virtual instrument - Conventional Instruments versus Traditional Instruments - Data-flow techniques, graphical programming in data flow, comparison with conventional programming.						
UNIT – II	**GRAPHICAL PROGRAMMING AND LabVIEW**					**9 Periods**
Concepts of graphical programming - LabVIEW software - Concept of VIs and sub VI - Display types - Digital - Analog - Chart and Graphs. Loops - structures - Arrays – Clusters- Local and global variables – String - Timers and dialog controls.						
UNIT – III	**MANAGING FILES & DESIGN PATTERNS**					**11 Periods**
High-level and low-level file I/O functions available in LabVIEW – Implementing File I/O functions to read and write data to files – Binary Files – TDMS – sequential programming – State machine programming – Communication between parallel loops –Race conditions – Notifiers & Queues – Producer Consumer design patterns						
UNIT – IV	**PC BASED DATA ACQUISITION**					**9 Periods**
Introduction to data acquisition on PC, Sampling fundamentals, ADCs, DACs, Calibration, Resolution, - analog inputs and outputs - Single-ended and differential inputs - Digital I/O, counters and timers, DMA, Data acquisition interface requirements - Issues involved in selection of Data acquisition cards - Use of timer-counter and analog outputs on the universal DAQ card.						
UNIT – V	**DATA ACQUISITION AND SIGNAL CONDITIONING**					**9 Periods**
Components of a DAQ system, Bus, Signal and accuracy consideration when choosing DAQ hardware – Measurement of analog signal with Finite and continuous buffered acquisition- analog output generation – Signal conditioning systems – Synchronizing measurements in single & multiple devices – Power quality analysis using Electrical Power Measurement tool kit.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES :

1	*Jeffrey Travis, Jim Kring,* ***"LabVIEW for Everyone: Graphical Programming Made Easy and Fun" (3rd Edition),*** *Prentice Hall, 2006.*
2	*Jovitha Jerome,* ***"Virtual Instrumentation using LabVIEW",*** *PHI, 2010*
3	*Gary W. Johnson, Richard Jennings,* ***"LabVIEW Graphical Programming"****, McGraw Hill Professional Publishing, 2019*
4	*Robert H. Bishop,* ***"Learning with LabVIEW"****, Prentice Hall, 2013.*
5	*Kevin James, "****PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control"****, Newness, 2000*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the graphical programming techniques using LabVIEW software.	K2
CO2	Explore the basics of programming and interfacing using related hardware.	K4
CO3	Analyse the aspects and utilization of PC based data acquisition and Instrument interfaces.	K4
CO4	Create programs and Select proper instrument interface for a specific application.	K6
CO5	Familiarize and experiment with DAQ and Signal Conditioning	K3

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	-	3	2	1
CO2	3	-	3	2	1
CO3	3	-	2	2	2
CO4	3	1	3	3	1
CO5	3	1	3	3	2
23PEOE22	3	1	3	2	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	40	15	15	-	-	100
CAT2	15	10	25	30	20	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	10	10	20	30	20	10	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	25	40	20	15	-	-	100
ESE	30	25	15	20	5	5	100

23PEOE23	ENERGY MANAGEMENT SYSTEMS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		OE	3	0	0	3
Course Objectives	To Comprehend energy management schemes, perform energy audit and execute economic analysis and load management in electrical systems.					
UNIT – I	**GENERAL ASPECTS OF ENERGY AUDIT AND MANAGEMENT**					**9 Periods**
Energy Conservation Act 2001 and policies – Eight National Missions - Basics of Energy and its forms (Thermal and Electrical) - Energy Management and Audit - Energy Managers and Auditors - Types and Methodology Audit Report - Material and energy balance diagrams - .Energy Monitoring and Targeting.						
UNIT – II	**STUDY OF BOILERS, FURNACES AND COGENERATION**					**9 Periods**
Boiler Systems - Types - Performance Evaluation of boilers - Energy Conservation Opportunity - Steam Distribution - Efficient Steam Utilisation - Furnaces:types and classification - Performance evaluation of a typical fuel fired furnace. Cogeneration: Need - Principle - Technical options - classification - Technical parameters and factors influencing cogeneration choice - Prime Movers - Trigeneration.						
UNIT – III	**ENERGY STUDY OF ELECTRICAL SYSTEMS**					**9 Periods**
Electricity Billing – Electricity load management - Maximum Demand Control - Power Factor improvement and its benefits - pf controllers - capacitors - Energy efficient transformers and Induction motors - rewinding and other factors influencing energy efficiency - Standards and labeling programme of distribution transformers and IM - Analysis of distribution losses - demand side management - harmonics - filters - VFD and its selection.						
UNIT – IV	**STUDY OF ELECTRICAL UTILITIES**					**9 Periods**
Compressor types - Performance - Air system components - Efficient operation of compressed air systems- Compressor capacity assessment - HVAC: psychrometrics and air-conditioning processes - Types of refrigeration system - Compressor types and applications - Performance assessment of refrigeration plants - Lighting Systems: Energy efficient lighting controls - design of interior lighting - Case study.						
UNIT – V	**PERFORMANCE ASSESSMENT FOR EQUIPMENT**					**9 Periods**
Performing Financial analysis: Fixed and variable costs – Payback period – ROI - methods – factors affecting analysis. Energy Performance Assessment: Heat exchangers - Fans and Blowers - Pumps. Energy Conservation in buildings and ECBC.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES:

1	*Murphy W.R. and G.Mckay Butter worth , "**Energy Management**", Heinemann Publications, 2007*
2	*Albert Thumann, Terry Niehus, William J. Younger, "**Handbook of Energy Audits"**, Ninth Edition, River Publishers, 2012.*
3	*Dr. Subhash Gadhave Anup Goel Siddu S. Laxmikant D. Jathar, **"Energy Audit & Management"**, Second edition, Technical Publications, 2019.*
4	*S. M. Chaudhari, S. A. Asarkar, M. A. Chaudhari, **"Energy Conservation and Audit"**, Second Edition, Nirali Prakashan Publications, 2021.*
5	www.em-ea.org/gbook1.asp

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the feature of energy audit methodology and documentation of report.	K3
CO2	Perform action plan and financial analysis	K4
CO3	Familiarize with thermal utilities.	K4
CO4	Familiarize with electrical utilities.	K4
CO5	Perform assessment of different systems.	K5

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	3	2	2	1	1
CO2	3	2	2	1	1
CO3	3	2	2	1	1
CO4	3	2	2	1	1
CO5	3	2	2	1	1
23PEOE23	3	2	2	1	1
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment1/ Case study1/ Seminar 1/Project1	-	30	30	20	20	-	100
Individual Assessment2/ Case study2/ Seminar 2 /Project2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

23PEOE24	ADVANCED ENERGY STORAGE TECHNOLOGY (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		OE	3	0	0	3
Course Objectives	To explore the fundamentals, technologies and applications of energy storage					
UNIT – I	**ENERGY STORAGE: HISTORICAL PERSPECTIVE, INTRODUCTION AND CHANGES**					**9 Periods**
Storage Needs - Variations in Energy Demand- Variations in Energy Supply- Interruptions in Energy Supply- Transmission Congestion - Demand for Portable Energy-Demand and scale requirements - Environmental and sustainability issues-conventional energy storage methods: battery-types.						
UNIT – II	**TECHNICAL METHODS OF STORAGE**					**9 Periods**
Introduction: Energy and Energy Transformations, Potential energy (pumped hydro, compressed air, springs)- Kinetic energy (mechanical flywheels)- Thermal energy without phase change passive (adobe) and active (water)-Thermal energy with phase change (ice, molten salts, steam)- Chemical energy (hydrogen, methane, gasoline, coal, oil)- Electrochemical energy (batteries, fuel cells)- Electrostatic energy (capacitors), Electromagnetic energy (superconducting magnets)- Different Types of Energy Storage Systems.						
UNIT – III	**PERFORMANCE FACTORS OF ENERGY STORAGE SYSTEMS**					**9 Periods**
Energy capture rate and efficiency- Discharge rate and efficiency- Dispatch ability and load flowing characteristics, scale flexibility, durability – Cycle lifetime, mass and safety – Risks of fire, explosion, toxicity- Ease of materials, recycling and recovery- Environmental consideration and recycling , Merits and demerits of different types of Storage.						
UNIT – IV	**APPLICATION CONSIDERATION**					**9 Periods**
Comparing Storage Technologies- Technology options- Performance factors and metrics- Efficiency of Energy Systems- Energy Recovery - Battery Storage System: Introduction with focus on Lead Acid and Lithium- Chemistry of Battery Operation, Power storage calculations, Reversible reactions, Charging patterns, Battery Management systems, System Performance, Areas of Application of Energy Storage: Waste heat recovery, Solar energy storage, Green house heating, Power plant applications, Drying and heating for process industries, energy storage in automotive applications in hybrid and electric vehicles.						
UNIT – V	**HYDROGEN FUEL CELLS AND FLOW BATTERIES**					**9 Periods**
Hydrogen Economy and Generation Techniques, Storage of Hydrogen, Energy generation - Super capacitors: properties, power calculations – Operation and Design methods - Hybrid Energy Storage: Managing peak and Continuous power needs, options - Level 1: (Hybrid Power generation) Bacitor "Battery + Capacitor" Combinations: need, operation and Merits; Level 2: (Hybrid Power Generation) Bacitor + Fuel Cell or Flow Battery operation-Applications: Storage for Hybrid Electric Vehicles, Regenerative Power, capturing methods.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES :

1	*DetlefStolten,"**Hydrogen and Fuel Cells: Fundamentals, Technologies and Applications**",Wiley, 2010.*
2	*Jiujun Zhang, Lei Zhang, Hansan Liu, Andy Sun, Ru-Shi Liu, "**Electrochemical Technologies for Energy Storage and Conversion**", John Wiley and Sons, 2012.*
3	*Francois Beguin and ElzbietaFrackowiak, "**Super capacitors**", Wiley, 2013.*
4	*Doughty Liaw, Narayan and Srinivasan, "**Batteries for Renewable Energy Storage**", The Electrochemical Society, New Jersy, 2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recollect the historical perspective and technical methods of energy storage.	K1
CO2	Explain the basics of different storage methods.	K2
CO3	Determine the performance factors of energy storage systems.	K2
CO4	Identify applications for renewable energy systems.	K4
CO5	Outline the basics of Hydrogen cell and flow batteries.	K2

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5
CO1	3	1	3	3	3
CO2	3	1	3	3	3
CO3	3	1	3	3	3
CO4	3	1	3	3	3
CO5	3	1	3	3	3
23PEOE24	3	1	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	30	20	10	-	100
CAT2	10	30	30	20	10	-	100
Individual Assessment1/ Case study1/ Seminar 1/ Project1	-	30	30	20	10	10	100
Individual Assessment2/ Case study2/ Seminar 2 / Project2	-	30	30	20	20	-	100
ESE	10	30	30	20	10	-	100

23AEOE25	DESIGN OF DIGITAL SYSTEMS (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	• To gain knowledge in the design and VHDL programming of synchronous and asynchronous sequential circuits, PLD's and the basic concepts of testing in VLSI circuits

UNIT–I	**SYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN**	**9 Periods**
Analysis of Clocked Synchronous Sequential Circuits - Modeling, state table reduction, state assignment, Design of Synchronous Sequential circuits, Design of iterative circuits- ASM chart –ASM realization.		
UNIT–II	**ASYNCHRONOUS SEQUENTIAL CIRCUIT DESIGN**	**9 Periods**
Analysis of Asynchronous Sequential Circuits - Races in ASC – Primitive Flow Table - Flow Table Reduction Techniques, State Assignment Problem and the Transition Table – Design of ASC – Static and Dynamic Hazards – Essential Hazards– Data Synchronizers.		
UNIT–III	**SYSTEM DESIGN USING PLDS**	**9 Periods**
Basic concepts – Programming Technologies - Programmable Logic Element (PLE) – Programmable Array Logic (PLA)-Programmable Array Logic (PAL) –Design of combinational and sequential circuits using PLDs– Complex PLDs (CPLDs).		
UNIT– IV	**INTRODUCTION TO VHDL**	**9 Periods**
Design flow -Software tools – VHDL: Data Objects-Data types – Operators –Entities and Architectures – Components and Configurations – Signal Assignment – Concurrent and Sequential statements — Behavioral, Dataflow and Structural modeling– Transport and Inertial delays –Delta delays-Attributes - Generics–Packages and Libraries.		
UNIT–V	**LOGIC CIRCUIT TESTING AND TESTABLE DESIGN**	**9 Periods**
Digital logic circuit testing - Fault models - Combinational logic circuit testing - Sequential logic circuit testing-Design for Testability - Built-in Self-test, Board and System Level Boundary Scan - Case Study: Traffic Light Controller.		

Contact Periods:

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

REFERENCES:

1	*Donald G.Givone, "**Digital principles and Design**", Tata Mc Graw Hill, 2002.*
2	*Nelson, V.P., Nagale, H.T., Carroll, B.D., and Irwin, J.D., "**Digital Logic Circuit Analysis and Design"**, Prentice Hall International, Inc., NewJersey, 1995.*
3	*VolneiA.Pedroni, "**Circuit Design with VHDL**",PHI Learning, 2011.*
4	*ParagK Lala, "**Digital Circuit Testing and Testability**", AcademicPress, 1997.*
5	*CharlesHRoth, "**Digital Systems Design Using VHDL",** Cencage 2nd Edition 2012.*
6	*NripendraN.Biswas, "**Logic Design Theory**"Prentice Hall of India, 2001.*

COURSEOUTCOMES: Upon completion of the course, students will be able to/have:		**Bloom's Taxonomy Mapped**
CO1	To design synchronous sequential circuits based on specifications.	K3
CO2	To design asynchronous sequential circuits based on specifications	K3
CO3	Ability to illustrate digital design implementation using PLDs.	K2
CO4	To develop algorithm and VHDL code for design of digital circuits.	K3
CO5	Understand the different testing methods for combinational and sequential circuits.	K2

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	-	1
CO2	3	-	2	-	-	1
CO3	3	-	2	-	-	1
CO4	3	-	2	-	-	1
CO5	3	-	2	-	-	1
23AEOE25	3	-	2	-	-	1
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	50	50	-	-	-	100
ESE	20	45	35	-	-	-	100

23AEOE26	BASICS OF NANO ELECTRONICS (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objective	• The students will be able to acquire knowledge about nano device fabrication technology, nano structures, nano technology for memory devices and applications of nano electronics in data transmission.

UNIT – I	**TECHNOLOGY AND ANALYSIS**	**9 Periods**

Fundamentals : Dielectric, Ferroelectric and Optical properties - Film Deposition Methods – Lithography Material removing techniques - Etching and Chemical Mechanical Polishing - Scanning Probe Techniques.

UNIT – II	**CARBON NANO STRUCTURES**	**9 Periods**

Principles and concepts of Carbon Nano tubes - Fabrication - Electrical, Mechanical and Vibration Properties - Applications of Carbon Nano tubes.

UNIT – III	**LOGIC DEVICES**	**9 Periods**

Silicon MOSFET's: Novel materials and alternative concepts - Single electron devices for logic applications - Super conductor digital electronics - Carbon Nano tubes for data processing.

UNIT – IV	**MEMORY DEVICES AND MASS STORAGE DEVICES**	**9 Periods**

Flash memories - Capacitor based Random Access Memories - Magnetic Random Access Memories - Information storage based on phase change materials - Resistive Random Access Memories - Holographic Data storage.

UNIT – V	**DATA TRANSMISSION AND INTERFACING DISPLAYS**	**9 Periods**

Photonic Networks - RF and Microwave Communication System - Liquid Crystal Displays - Organic Light emitting diodes.

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

REFERENCES:

1	*Rainer Waser, "**Nano Electronics and Information Technology, Advanced Electronic materials and novel devices**", 3rd Edition, Wiley VCH, 2012.*
2	*T. Pradeep, "**Nano: The essentials**", Tata McGraw Hill, 2007.*
3	*Charles Poole, "**Introduction to Nano Technology**", Wiley Interscience, 2003*
4	*Vladimir V.Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio, "**Introduction to Nano Electronics Science, Nanotechnology, Engineering and Applications**", Cambridge University Press, 2011.*
5	*C.Wasshuber Simon, "**Simulation of Nano Structures Computational Single-Electronics**", Springer, 2001.*
6	*Mark Reed and Takhee Lee, "**Molecular Nano Electronics, American Scientific Publisher, California**", 2003.*

COURSE OUTCOMES: Upon completion of the course, students will be able to/have:		**Bloom's Taxonomy Mapped**
CO1	Explain principles of nano device fabrication technology.	K2
CO2	Describe the concept of Nano tube and Nano structure.	K2
CO3	Explain the function and application of various nano devices	K3
CO4	Reproduce the concepts of advanced memory technologies.	K2
CO5	Emphasize the need for data transmission and display systems.	K2

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	-	1
CO2	3	-	2	-	-	1
CO3	3	-	2	-	-	1
CO4	3	-	2	-	-	1
CO5	3	-	2	-	-	1
22AEOE26	3	-	2	-	-	1

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

23AEOE27	ADVANCED PROCESSOR (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objective	• The students will be able to acquire knowledge about the high performance RISC, CISC and special purpose processors.					
UNIT – I	**MICROPROCESSOR ARCHITECTURE**					**9 Periods**
Instruction set – Data formats – Instruction formats – Addressing modes – Memory hierarchy – register file – Cache – Virtual memory and paging – Segmentation – Pipelining – The instruction pipeline – pipeline hazards – Instruction level parallelism – reduced instruction set – Computer principles – RISCversus CISC – RISC properties – RISC evaluation.						
UNIT – II	**HIGH PERFORMANCE CISC ARCHITECTURE –PENTIUM**					**9 Periods**
The software model – functional description – CPU pin descriptions – Addressing modes – Processor flags – Instruction set – Bus operations – Super scalar architecture – Pipe lining – Branch prediction – Theinstruction and caches – Floating point unit– Programming the Pentium processor.						
UNIT – III	**HIGH PERFORMANCE CISC ARCHITECTURE – PENTIUM INTERFACE**					**9 Periods**
Protected mode operation – Segmentation – paging – Protection – multitasking – Exception and interrupts - Input /Output – Virtual 8086 model – Interrupt processing.						
UNIT – IV	**HIGH PERFORMANCE RISC ARCHITECTURE: ARM**					**9 Periods**
ARM architecture – ARM assembly language program – ARM organization and implementation – ARMinstruction set - Thumb instruction set.						
UNIT – V	**SPECIAL PURPOSE PROCESSORS**					**9 Periods**
Altera Cyclone Processor – Audio codec – Video codec design – Platforms – General purpose processor – Digital signal processor – Embedded processor – Media Processor – Video signal Processor – Custom Hardware – Co-Processor.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES:

1	*Daniel Tabak, "**Advanced Microprocessors**", McGraw Hill Inc., 2011.*
2	*James L. Antonakos, "**The Pentium Microprocessor**", Pearson Education, 1997.*
3	*Steve Furber, "**ARM System –On –Chip architecture**", Addison Wesley, 2009.*
4	*Gene. H. Miller, "**Micro Computer Engineering**", Pearson Education, 2003.*
5	*Barry. B. Brey, "**The Intel Microprocessors Architecture, Programming and Interfacing**", PHI, 2008.*
6	*Valvano, "**Embedded Microcomputer Systems**" Cencage Learing India Pvt Ltd, 2011.*
7	*Iain E.G. Richardson, "**Video codec design**", John Wiley & sons Ltd, U.K, 2002.*

COURSE OUTCOMES: Upon completion of the course, students will be able to		**Bloom's Taxonomy Mapped**
CO1	Describe the fundamentals of various processor architecture.	K2
CO2	Interpret and understand the high performance features in CISC architecture.	K2
CO3	Describe the concepts of Exception and interrupt processing.	K2
CO4	Develop programming skill for ARM processor.	K3
CO5	Explain various special purpose processor	K2

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	-	1
CO2	3	-	2	-	-	1
CO3	3	-	2	-	-	1
CO4	3	-	2	-	-	1
CO5	3	-	2	-	-	1
22AEOE27	3	-	2	-	-	1
1 – Slight, 2 – Moderate, 3 – Substantial						

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

23VLOE28	HDL PROGRAMMING LANGUAGES (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		OE	**3**	**0**	**0**	**3**
Course Objective	• To code and simulate any digital function in Verilog HDL and understand the difference between synthesizable and non-synthesizable codes.					
UNIT – I	**VERILOG INTRODUCTION AND MODELING**					**9 Periods**
Introduction to Verilog HDL, Language Constructs and Conventions, Gate Level Modeling, Modeling at Dataflow Level, Behavioral Modeling, Switch Level Modeling, System Tasks, Functions and Compiler Directives.						
UNIT – II	**SEQUENTIAL MODELING AND TESTING**					**9 Periods**
Sequential Models - Feedback Model, Capacitive Model, Implicit Model, Basic Memory Components, Functional Register, Static Machine Coding, Sequential Synthesis. Test Bench - Combinational Circuits Testing, Sequential Circuit Testing, Test Bench Techniques, Design Verification, Assertion Verification.						
UNIT – III	**SYSTEM VERILOG**					**9 Periods**
Introduction, System Verilog declaration spaces, System Verilog Literal Values and Built-in Data Types, System Verilog User-Defined and Enumerated Types, system Verilog Arrays, Structures and Unions, system verilog Procedural Blocks, Tasks and Functions.						
UNIT – IV	**SYSTEM VERILOG MODELING**					**9 Periods**
System Verilog Procedural Statements, Modeling Finite State Machines with System Verilog, System Verilog Design Hierarchy.						
UNIT – V	**INTERFACES AND DESIGN MODEL**					**9 Periods**
System Verilog Interfaces, A Complete Design Modeled with System Verilog, Behavioral and Transaction Level Modeling.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES:

1	*T.R.Padmanabhan, B Bala Tripura Sundari, "**Design through Verilog HDL"**, Wiley 2009.*
2	*Stuart Sutherland, Simon Davidmann, Peter Flake, Foreword by Phil Moorby, "**System Verilog For Design Second Edition A Guide to Using System Verilog for Hardware Design and Modelling"**, Springer 2006.*
3	*Samir Palnitkar, "**Verilog HDL**", 2nd Edition, Pearson Education, 2009.*
4	*ZainalabdienNavabi, "**Verilog Digital System Design"**,TMH, 2nd Edition,2005.*
5	*System Verilog 3.1a, Language Reference Manual, Accellera, 2004*
6	*Dr.SRamachandran, "**Digital VLSI Systems Design: A Design Manual for Implementation of Projects on FPGAs and ASICs Using Verilog"**, Springer, 2007.*
7	*Chris Spear, "**System verilog for verification a guide to learning the test bench Language Features**", Springer 2006.*
6	*Stuart Sutherland, Simon Davidmann, Peter Flake, "**System Verilog For Design: A Guide to Using System Verilog for Hardware Design and Modeling**" 1st Edition, 2003*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the verilog coding and simulate any digital function using Verilog HDL	K2
CO2	Develop sequential modeling based Verilog HDL code and develop the test bench for the modeling	K3
CO3	Explain the system verilog modeling	K2
CO4	Differentiate the synthesizable and non-synthesizable code	K3
CO5	Apply good coding techniques on system verilog interfaces and complete design model	K3

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	-	2	-	2
CO2	3	3	-	2	-	2
CO3	3	3	-	2	-	2
CO4	3	3	-	2	-	2
CO5	3	3	-	2	-	2
23VLOE28	3	3		2	-	2
1 – Slight, 2 – Moderate, 3 – Substantial						

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

23VLOE29	CMOS VLSI DESIGN (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		OE	**3**	**0**	**0**	**3**
Course Objective	• To gain knowledge on CMOS Circuits with its characterization and to design CMOS logic and sub-system with low power					
UNIT – I	**INTRODUCTION TO MOS CIRCUITS**					**9 Periods**
MOS Transistor Theory -Introduction MOS Device Design Equations -MOS Transistor as a Switches - Pass Transistor - CMOS Transmission Gate -Complementary CMOS Inverter - Static Load MOS Inverters - Inverters with NMOS loads - Differential Inverter - Tri State Inverter - BiCMOS Inverter.						
UNIT – II	**CIRCUIT CHARACTERIZATION AND PERFORMANCE ESTIMATION**					**9 Periods**
Delay Estimation, Logical Effort and Transistor Sizing, Power Dissipation, Sizing Routing Conductors, Charge Sharing, Design Margin and Reliability.						
UNIT – III	**CMOS CIRCUIT AND LOGIC DESIGN**					**9 Periods**
CMOS Logic Gate Design, Physical Design of CMOS Gate, Designing with Transmission Gates, CMOS Logic Structures, Clocking Strategies, I/O Structures.						
UNIT – IV	**CMOS SUBSYSTEM DESIGN**					**9 Periods**
DataPath Operations-Addition/Subtraction, Parity Generators, Comparators, Zero/One Detectors, Binary Counters, ALUs, Multipliers, Shifters, Memory Elements, Control-FSM, Control Logic Implementation.						
UNIT – V	**LOWPOWERCMOS VLSIDESIGN**					**9 Periods**
Introduction to Low Power Design, Power Dissipation in FET Devices, Power Dissipation in CMOS, Low-Power Design through Voltage Scaling – VTCMOS Circuits, MTCMOS Circuits, Architectural Level Approach – Pipelining and Parallel Processing Approaches, Low Power Basics CMOS Gate and Adder Design.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES:

1	*Sung Mo Kang, Yusuf Lablebici,* ***"CMOS Digital Integrated Circuits:Analysis & Design"****, Tata Mc-Graw Hill, 2011.*
2	*N.Weste and K.Eshranghian,* ***"Principles of CMOS VLSI Design"****, AddisonWesley,1998.*
3	*Neil H. E. Weste, David Harris, Ayan Banerjee,* ***"CMOS VLSI Design: A Circuits and Systems Perspective"****, Pearson Education 2013.*
4	*Kiat-Seng Yeo, Kaushik Roy,* ***"Low-Voltage, Low-Power VLSI Subsystems",*** *McGraw-Hill Professional, 2004.*
5	*Gary K.Yeap,* ***"Practical Low Power Digital VLSI Design"****, Kluwer Academic Press, 2002.*
6	*Jan M .Rabaey,* ***"Digital Integrated Circuits: A Design Perspective"****, Pearson Education, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the MOS circuits and Transmission gates	K2
CO2	Illustrate the CMOS Circuits with its characterization	K2
CO3	Design CMOS logic circuits	K3
CO4	Design CMOS sub-system	K3
CO5	Discuss low power CMOS VLSI Design	K2

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	1	-	2	-	3
CO2	2	1	-	2	-	3
CO3	2	1	-	2	-	3
CO4	3	1	-	2	-	3
CO5	3	1	-	2	-	3
23VLOE29	3	1	-	2	-	3
1 – Slight, 2 – Moderate, 3 – Substantial						

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

23VLOE30	HIGH LEVEL SYNTHESIS (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		OE	**3**	**0**	**0**	**3**
Course Objective	• To provide students with foundations in High level synthesis, verification and CAD Tools					
UNIT – I	**HIGH-LEVEL SYNTHESIS (HLS) FUNDAMENTALS**					**9 Periods**
Overview HLS flow, Scheduling Techniques, Resource sharing and Binding Techniques, Data-path and Controller Generation Techniques.						
UNIT – II	**HIGH LEVEL SYNTHESIS**					**9 Periods**
Introduction to HDL, HDL to DFG, operation scheduling: constrained and unconstrained scheduling, ASAP, ALAP, List scheduling, Force directed Scheduling, operator binding, Static Timing Analysis: Delay models, setup time, hold time, cycle time, critical paths, Topological mvs. Logical timing analysis, False paths, Arrival time (AT), Required arrival Time (RAT), Slacks.						
UNIT – III	**HIGH-LEVEL SYNTHESIS VERIFICATION**					**9 Periods**
Simulation based verification - Formal Verification of digital systems- BDD based approaches, functional equivalence, finite state automata, ω-automata, FSM verification.						
UNIT – IV	**CAD TOOLS FOR SYNTHESIS**					**9 Periods**
CAD tools for synthesis, optimization, simulation and verification of design at various levels as well as for special realizations and structures such as microprogrammes, PLAs, gate arrays etc. Technology mapping for FPGAs. Low power issues in high level synthesis and logic synthesis.						
UNIT – V	**ADVANCED TOPICS**					**9 Periods**
Relative Scheduling, IO scheduling modes - cycle fixed scheduling modes, super-fixed scheduling modes, free-floating scheduling mode, Pipelining, Handshaking, System Design, High-Level Synthesis for FPGA.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES :

1	*Philippe Coussy and Adam Morawiec, "**High-level Synthesis from Algorithm to Digital Circuit**",S pringer, 2008.*
2	*Sherwani, N., "**Algorithms for VLSI Physical Design Automation**", Springer, 3rd ed., 2005.*
3	*D. Micheli,"**Synthesis and optimization of digital systems**", Mc Graw Hill, 2005.*
4	*Dutt, N. D. and Gajski, D. D., "**High level synthesis**", Kluwer, 2000.*
5	*Gerez S.H., "**Algorithms for VLSI Design Automation**", John Wiley (1998)*
6	*David. C. Ku and G. De Micheli, "**High-level Synthesis of ASICs Under Timing and Synchronization Constraints**", Kluwer Academic Publishers, 1992.*
7	*K. Parhi, "**VLSI Digital Signal Processing Systems: Design and Implementation**", Jan 1999, Wiley.*
8	*Egon Boerger and Robert Staerk "**Abstract State Machines: A Method for High-Level System Design and Analysis**", Springer, 2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the fundamentals of High level synthesis	K2
CO2	Synthesis the HDL for operation scheduling	K2
CO3	Simulate and verify any digital systems	K2
CO4	Apply CAD tools for synthesis	K2
CO5	Have knowledge on various scheduling modes	K2

COURSE ARTICULATION MATRIX :

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	2	-	2	2	-
CO2	2	2	-	2	2	-
CO3	2	2	-	2	2	-
CO4	2	2	-	2	2	-
CO5	2	2	-	2	2	-
23VLOE30	2	2	-	2	2	-

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

23CSOE31	ARTIFICIAL INTELLIGENCE (Common to all Branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	Identify and apply AI techniques in the design of systems that act intelligently, making automatic decisions and learn from experience.	
UNIT – I	**SEARCH STRATEGIES**	**9 Periods**
Uninformed Strategies – BFS, DFS, Djisktra, Informed Strategies – A* search, Heuristic functions, Hill Climbing, Adversarial Search – Min-max algorithm, Alpha-beta Pruning		
UNIT – II	**PLANNING AND REASONING**	**9 Periods**
State Space search, Planning Graphs, Partial order planning, Uncertain Reasoning – Probabilistic Reasoning, Bayesian Networks, Dempster Shafer Theory, Fuzzy logic		
UNIT – III	**PROBABILISTIC REASONING**	**9 Periods**
Probabilistic Reasoning over Time - Hidden Markov Models, Kalman Filters, Dynamic Bayesian Networks. Knowledge Representations – Ontological Engineering, Semantic Networks and description logics.		
UNIT – IV	**DECISION MAKING**	**9 Periods**
Utility Theory, Utility Functions, Decision Networks – Sequential Decision Problems – Partially Observable MDPs – Game Theory.		
UNIT – V	**REINFORCEMENT LEARNING**	**9 Periods**
Reinforcement Learning - Passive and active reinforcement learning - Generations in Reinforcement Learning - Policy Search – Deep Reinforcement Learning.		

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

REFERENCES :

1	*Deepak Khemani, **"A First Course in Artificial Intelligence",** Tata Mc Graw Hill Education 2013*
2	*Yang Q, **"Intelligent Planning: A decomposition and Abstraction based Approach",** Springer, 2006.*
3	*Russell and Norvig, **"Artificial Intelligence, A Modern Approach**", 3rd edition, Pearson Prentice Hall,2010.*
4	*Elaine Rich,Kevin Knight,Shivashankar B. Nair, **"Artificial Intelligence",** 3rd edition, Tata Mc Graw Hill, 2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Use search techniques to solve AI problems	K2
CO2	Reason facts by constructing plans and understand uncertainty efficiently.	K3
CO3	Examine data using statistical codes and solve complex AI problems	K6
CO4	Apply techniques to make apt decisions.	K4
CO5	Use deep reinforcement learning to solve complex AI problems	K6

COURSE ARTICULATION MATRIX						
COs/ POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	2	-	3	3
CO2	3	-	2	-	3	3
CO3	3	-	3	-	3	3
CO4	3	-	3	-	3	3
CO5	3	-	3	-	3	3
23CSOE31	3	-	3	-	3	3
1 – Slight, 2 – Moderate, 3 – Substantial						

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

23CSOE32	COMPUTER NETWORK MANAGEMENT (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	After the completion of the course, the students will be able to understand the concept of layering in networks, functions of protocols of each layer of TCP/IP protocol suite, concepts related to network addressing and routing and build simple LANs, perform basic configurations for routers and switches, and implement IPv4 and IPv6 addressing schemes using Cisco Packet Tracer.					
UNIT – I	**INTRODUCTION AND APPLICATION LAYER**					**9 Periods**
Building network – Network Edge and Core – Layered Architecture – OSI Model – Internet Architecture (TCP/IP) Networking Devices: Hubs, Bridges, Switches, Routers, and Gateways – Performance Metrics - Ethernet Networking – Introduction to Sockets – Application Layer protocols – HTTP – FTP Email Protocols – DNS.						
UNIT – II	**TRANSPORT LAYER AND ROUTING**					**9 Periods**
Transport Layer functions –User Datagram Protocol – Transmission Control Protocol – Flow Control – Retransmission Strategies – Congestion Control - Routing Principles – Distance Vector Routing – Link State Routing – RIP – OSPF – BGP – Introduction to Quality of Service (QoS).Case Study: Configuring RIP, OSPF BGP using Packet tracer						
UNIT – III	**NETWORK LAYER**					**9 Periods**
Network Layer: Switching concepts – Internet Protocol – IPV4 Packet Format – IP Addressing – Subnetting – Classless Inter Domain Routing (CIDR) – Variable Length Subnet Mask (VLSM) – DHCP – ARP – Network Address Translation (NAT) – ICMP – Concept of SDN.Case Study: Configuring VLAN, DHCP, NAT using Packet tracer						
UNIT – IV	**INTERNETWORK MANAGEMENT**					**9 Periods**
Introduction to the Cisco IOS - Router User Interface – CLI - Router and Switch Administrative Functions - Router Interfaces - Viewing, Saving, and Erasing Configurations - Switching Services - Configuring Switches - Managing Configuration Registers - Backing Up and Restoring IOS - Backing Up and Restoring the Configuration - Using Discovery Protocol (CDP) - Checking Network Connectivity						
UNIT – V	**TRAFFIC MANAGEMENT AND WAN PROTOCOLS**					**9 Periods**
Managing Traffic with Access Lists: Introduction to Access Lists - Standard Access Lists - Extended Access Lists - Named Access Lists - Monitoring Access Lists - Wide Area Networking Protocols: Introduction to Wide Area Networks - Cabling the Wide Area Network - High-Level Data-Link Control (HDLC) Protocol - Point-to-Point Protocol (PPP) - Frame Relay: Frame Relay Implementation and Monitoring - Integrated Services Digital Network (ISDN) - Dial-on-Demand Routing (DDR): Configuring DDR.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES :

1	*James F. Kurose, Keith W. Ross,* ***"Computer Networking: A Top-Down Approach",*** *Seventh Edition, Pearson Education, 2017.*
2	*William Stallings,* ***"Data and Computer Communications",*** *Tenth Edition, Pearson Education, 2014*
3	*Larry L. Peterson, Bruce S. Davie,* ***"Computer Networks: A Systems Approach",*** *Fifth Edition, Morgan Kaufmann Publishers Inc., 2011.*
4	*Todd Lammle,* ***"CCNA™: Cisco® Certified Network Associate Study Guide",*** *5th Edition, Sybex, 2003*
5	*Ying-Dar Lin, Ren-Hung Hwang, Fred Baker,* ***"Computer Networks: An Open Source Approach",*** *McGraw Hill, 2012.*
6	*Ron Gilster, Jeff Bienvenu, and Kevin Ulstad,* ***"CCNA for Dummies",*** *IDG Books Worldwide, 2000*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Highlight the significance of the functions of each layer in the network.	K1
CO2	Identify the devices and protocols to design a network and implement it.	K4
CO3	Apply addressing principles such as subnetting and VLSM for efficient routing.	K3
CO4	Build simple LANs, perform basic configurations for routers and switches	K6
CO5	Illustrate various WAN protocols	K2

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	-	3	-	2	1
CO2	3	-	3	-	2	2
CO3	3	-	3	-	3	2
CO4	3	-	3	-	3	3
CO5	3	-	3	-	3	3
23CSOE32	3	-	3	-	3	2
1 – Slight, 2 – Moderate, 3 – Substantial						

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

23CSOE33	BLOCKCHAIN TECHNOLOGIES (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**
Course Objectives	The objective of the course is to explore basics of block chain technology and its application in various domaiin					
UNIT – I	**INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN**		**9 Periods**			
History of Blockchain - Types of blockchain- CAP theorem and blockchain – benefits and Limitations of Blockchain – Decentalization using blockchain – Blockchain implementations- Block chain in practical use - Legal and Governance Use Cases						
UNIT – II	**BITCOIN AND CRYPTOCURRENCY**		**9 Periods**			
Introduction to Bitcoin, The Bitcoin Network, The Bitcoin Mining Process, Mining Developments, Bitcoin Wallets, Decentralization and Hard Forks, Ethereum Virtual Machine (EVM), Merkle Tree, Double-Spend Problem, Blockchain and Digital Currency, Transactional Blocks, Impact of Blockchain Technology on Cryptocurrency						
UNIT – III	**ETHEREUM**		**9 Periods**			
Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, Transactions, Receiving Ethers, Smart Contracts						
UNIT – IV	**HYPERLEDGER AND SOLIDITY PROGRAMMING**		**9 Periods**			
Introduction to Hyperledger, Distributed Ledger Technology & its Challenges, Hyperledger & Distributed Ledger Technology, Hyperledger Fabric, Hyperledger Composer. Solidity – Programming with solidity						
UNIT – V	**BLOCKCHAIN APPLICATIONS**		**9 Periods**			
Ten Steps to build your Blockchain application – Application: Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES:

1	*Imran Bashir, **"Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained"**, Second Edition, Packt Publishing, 2018.*
2	*Joseph J. Bambara Paul R. Allen, **"Blockchain A Practical Guide to Developing Business, Law, and Technology Solutions"**, McGraw Hill Education ,2018.*
3	*Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, **"Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction"** Princeton University Press, 2016.*
4	*Manav Gupta **"Blockchain for Dummies",** IBM Limited Edition 2017.*
5	*Antonopoulos and G. Wood, **"Mastering Ethereum: Building Smart Contracts and Dapps",** O'Reilly Publishing, 2018*
6	***NPTEL Course : Blockchain and its applications*** *https://archive.nptel.ac.in/courses/106/105/106105235/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Comprehend the working of Blockchain technology	K2
CO2	Narrate working principle of smart contracts and create them using solidity for given scenario.	K3
CO3	Comprehend the working of Hyperledger in an real time application	K2
CO4	Apply the learning of solidity to build de-centralized apps on Ethereum	K3
CO5	Develop applications on Blockchain	K3

COURSE ARTICULATION MATRIX						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	2	-	3	2	-	3
CO2	2	3	3	3	2	3
CO3	3	-	3	2	-	3
CO4	3	3	3	3	2	3
CO5	3	3	3	3	2	3
23CSOE33	3	3	3	3	2	3
1 – Slight, 2 – Moderate, 3 – Substantial						

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40	-	-	-	100
CAT2	20	30	50	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	70	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	40	60	-	-	-	100
ESE	10	60	30	-	-	-	100

23PEACZ1	ENGLISH FOR RESEARCH PAPER WRITING (Common to all Branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**AC**	**2**	**0**	**0**	**0**
Course Objectives	• The objective of the course is to make the learners understand the format and intricacies involved in writing a research paper.					
UNIT – I	**PLANNING AND PREPARATION**					**6 Periods**
Need for publishing articles, Choosing the journal, Identifying a model journal paper, Creation of files for each section, Expectations of Referees, Online Resources.						
UNIT – II	**SENTENCES AND PARAGRAPHS**					**6 Periods**
Basic word in English, Word order in English and Vernacular, placing nouns, Verbs, Adjectives, and Adverb suitably in a sentence, Using Short Sentences, Discourse Markers and Punctuations- Structure of a Paragraph, Breaking up lengthy Paragraphs.						
UNIT – III	**ACCURACY, BREVITY AND CLARITY (ABC) OF WRITING**					**6 Periods**
Accuracy, Brevity and Clarity in Writing, Reducing the linking words, Avoiding redundancy, Appropriate use of Relative and Reflexive Pronouns, Monologophobia, verifying the journal style, Logical Connections between others author's findings and yours.						
UNIT – IV	**HIGHLIGHTING FINDINGS, HEDGING AND PARAPHRASING**					**6 Periods**
Making your findings stand out, Using bullet points headings, Tables and Graphs- Availing non-experts opinions, Hedging, Toning Down Verbs, Adjectives, Not over hedging, Limitations of your research.						
UNIT – V	**SECTIONS OF A PAPER**					**6 Periods**
Titles, Abstracts, Introduction, Review of Literature, Methods, Results, Discussion, Conclusions, References.						
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**						

REFERENCES :

1	Goldbort R , ***"Writing for Science"***, Yale University Press (available on GoogleBooks),2006
2	*Day R ,* ***How to Write and Publish a Scientific Paper****, Cambridge University Press, 2006.*
3	*Highman N,* ***"Handbook of Writing for the Mathematical Sciences"****, SIAM. Highman's book, 1998.*
4	*Adrian Wallwork,"* ***English for Writing Research Papers"****, Springer New York Dordrecht Heidelberg London, 2011.*

COURSE OUTCOMES : Upon completion of this course the learners will be able to		**Bloom's Taxonomy Mapped**
CO1	**U**nderstand the need for writing good research paper.	K2
CO2	Practice the appropriate word order, sentence structure and paragraph writing.	K4
CO3	Practice unambiguous writing.	K3
CO4	Avoid wordiness in writing.	K2
CO5	Exercise the elements involved in writing journal paper.	K3

COURSE ARTICULATION MATRIX :						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	1	1	1	1
CO2	3	3	1	1	1	1
CO3	3	3	1	1	1	1
CO4	3	3	1	1	1	1
CO5	3	3	1	1	1	1
23PEACZ1	3	3	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial						

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

23PEACZ2	DISASTER MANAGEMENT (Common to all branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**AC**	**2**	**0**	**0**	**0**
Course Objectives	• To become familiar in key concepts and consequences about hazards, disaster and area of occurrence. • To know the various steps in disaster planning. • To create awareness on disaster preparedness and management.					
UNIT – I	**INTRODUCTION**					**6 Periods**
Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude. Areas proneto, Earthquakes Floods, Droughts, Landslides, Avalanches, Cyclone and Coastal Hazards with special reference to Tsunami.						
UNIT – II	**REPERCUSSIONS OF DISASTERS AND HAZARDS**					**6 Periods**
Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War and Conflicts.						
UNIT – III	**DISASTER PLANNING**					**6 Periods**
Disaster Planning-Disaster Response Personnel roles and duties, Community MitigationGoals, Pre-Disaster Mitigation Plan, Personnel Training, Comprehensive Emergency Management, Early Warning Systems.						
UNIT – IV	**DISASTER PREPAREDNESS AND MANAGEMENT**					**6 Periods**
Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and other Agencies, Media Reports: Governmental and Community Preparedness.						
UNIT – V	**RISK ASSESSMENT**					**6 Periods**
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment, Strategies for Survival.						
Contact Periods: **Lecture:30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**						

REFERENCES:

1	*R. Nishith, Singh AK, **"Disaster Management In India: Perspectives, Issues And Strategies"**, New Royal book Company, 2007.*
2	*Sahni, PardeepEt.Al. (Eds.), **"Disaster Mitigation Experiences And Reflections"**, Prentice Hall Of India, New Delhi, 2010*
3	*Goel S. L, **"Disaster Administration And Management Text And Case Studies"**, Deep &Deep Publication Pvt. Ltd., New Delhi, 2008.*
4	*Jagbir Singh, **"Disaster Management: Future Challenges And Opportunities"**, I.K. International Publishing House Pvt. Ltd., New Delhi, 2007.*
5	*Damon Coppola **"Introduction To International Disaster Management"**, Butterworth-Heinemann, 2015*
6	*Ryan Lanclos **"Dealing With Disasters: Gis For Emergency Management"**,ESRI Press 2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Differentiate hazard and disaster with their significance.	K4
CO2	Analyse the causes and impact of natural and manmade disaster.	K4
CO3	Execute the steps involved in disaster planning.	K4
CO4	Predict vulnerability of disaster and to prevent, mitigate their impact.	K4
CO5	Prepare risk assessment strategy for national and global disaster.	K4

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	2	1	1	2	2
CO2	1	2	1	1	1
CO3	1	1	1	2	2
CO4	1	1	1	2	2
CO5	2	1	1	2	2
23PEACZ2	1	1	1	2	2
1 – Slight, 2 – Moderate, 3 – Substantial					

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

23PEACZ3	VALUE EDUCATION (Common to all branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**AC**	**2**	**0**	**0**	**0**

Course Objectives	• Value of education and self- development • Requirements of good values in students • Importance of character	
UNIT – I	**ETHICS AND SELF-DEVELOPMENT**	**6 Periods**
Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moralvaluation. Standards and principles. Value judgements.		
UNIT – II	**PERSONALITY AND BEHAVIOR DEVELOPMENT**	**6 Periods**
Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness.Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance.		
UNIT – III	**VALUES IN HUMAN LIFE**	**6 Periods**
Importance of cultivation of values, Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature,Discipline.		
UNIT – IV	**VALUES IN SOCIETY**	**6 Periods**
True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association andCooperation. Doing best for saving nature.		
UNIT – V	**POSITIVE VALUES**	**6 Periods**
Character and Competence –Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES :

1	*Chakroborty, S.K. **"Values and Ethics for organizations Theory and practice"**, Oxford University Press,New Delhi,1998*
2	*Dr. Yogesh Kumar Singh, **"Value Education"**, A.P.H Publishing Corporation,New Delhi,2010*
3	*R.P Shukla, **"Value Education and Human Rights"**, Sarup and Sons, NewDelhi,2004*
4	*https://nptel.ac.in/courses/109104068/36*

COURSE OUTCOMES : Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know the values and work ethics.	K3
CO2	Enhance personality and 143ehavior development.	K3
CO3	Apply the values in human life.	K3
CO4	Gain Knowledge of values in society.	K3
CO5	Learn the importance of positive values in human life.	K3

Course Articulation Matrix						
Cos/Pos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	3	-	-	1
CO2	-	-	3	-	-	1
CO3	-	-	3	-	-	1
CO4	-	-	3	-	-	1
CO5	-	-	3	-	-	1
23PEACZ3	-	-	3	-	-	1
1 – Slight, 2 – Moderate, 3 – Substantial						

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

23PEACZ4	CONSTITUTION OF INDIA (Common to all branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	AC	**2**	**0**	**0**	**0**

Course Objectives	• To address the importance of constitutional rights and duties • To familiarize about Indian governance and local administration. • To know about the functions of election commission.

UNIT – I	**INDIAN CONSTITUTION**	**6 Periods**

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working) - Philosophy of the Indian Constitution: Preamble Salient Features.

UNIT – II	**CONSTITUTIONAL RIGHTS & DUTIES**	**6 Periods**

Contours of Constitutional Rights & Duties: Fundamental Rights , Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT – III	**ORGANS OF GOVERNANCE**	**6 Periods**

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT – IV	**LOCAL ADMINISTRATION**	**6 Periods**

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT – V	**ELECTION COMMISSION**	**6 Periods**

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

Contact Periods:

Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods

REFERENCES:

1	***"The Constitution of India"**, 1950 (Bare Act), Government Publication.*
2	*Dr. S. N. Busi, Dr. B. R. Ambedkar **"Framing of Indian Constitution"**, 1st Edition, 2015.*
3	*M. P. Jain,"**Indian Constitution Law"**, 7th Edn., Lexis Nexis, 2014.*
4	*D.D. Basu,"**Introduction to the Constitution of India"**, Lexis Nexis, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Discuss the growth of the demand for civil rights in India.	K2
CO2	Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.	K2
CO3	Understand the various organs of Indian governance.	K2
CO4	Familiarize with the various levels of local administration.	K2
CO5	Gain knowledge on election commission of india.	K2

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	1	1	1
CO2	-	-	1	1	1	2
CO3	-	-	1	1	2	1
CO4	-	-	1	1	1	1
CO5	-	-	1	1	1	1
23PEACZ4	-	-	1	1	1	1
1 – Slight, 2 – Moderate, 3 – Substantial						

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

23PEACZ5	PEDAGOGY STUDIES (Common to all branches)				
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**AC**	**2**	**0**	**0**	**0**

Course Objectives	• To understand of various theories of learning, prevailing pedagogical practices and design of curriculum in engineering studies. • Application of knowledge in modification of curriculum, its assessment and introduction of innovation in teaching methodology.	
UNIT – I	**INTRODUCTION**	**6 Periods**
Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions. Overview of methodology and Searching.		
UNIT – II	**PEDAGOGICAL PRACTICES**	**6 Periods**
Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education. Evidence on the effectiveness of pedagogical practices Methodology for the in depth stage: quality assessment of		
UNIT – III	**PEDAGOGICAL APPROACHES**	**6 Periods**
How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? Theory of change. Strength and nature of the body of evidence for effective pedagogical practices. Pedagogic theory and pedagogical approaches. Teacher's attitudes and beliefs and Pedagogic strategies.		
UNIT – IV	**PROFESSIONAL DEVELOPMENT**	**6 Periods**
Professional development: alignment with classroom practices and follow-up support. Peer support Support from the head teacher and the community. Curriculum and assessment Barriers to learning: limited resources and large class sizes.		
UNIT – V	**CURRICULUM AND ASSESSMENT**	**6 Periods**
Research gaps and future directions Research design Contexts Pedagogy Teacher education Curriculum and assessment Dissemination and research impact.		
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**		

REFERENCES:

1	*Ackers J, Hardman F, "**Classroom interaction in Kenyan primary schools",** Compare, 31 (2): 245-261, 2001.*
2	*Alexander RJ, "**Culture and pedagogy: International comparisons in primary education**", Oxford and Boston: Blackwell, 2001*
3	*Akyeampong K, Lussier K, Pryor J, Westbrook J, "**Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count?"** International Journal Educational Development, 33 (3): 272–282, 2013.*
4	*Agrawal M, "**Curricular reform in schools: The importance of evaluation"**, Journal of Curriculum Studies, 36 (3): 361-379, 2004*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the concept of curriculum, formal and informal education systems and teacher education.	K3
CO2	Explain the present pedagogical practices and the changes occurring in pedagogical approaches	K3
CO3	Understand the relation between teacher and community, support from various levels of teachers to students and limitation in resources and size of the class.	K3
CO4	Perform research in design a problem in pedagogy and curriculum development.	K3

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	1	2	1
CO2	-	-	1	1	1	2
CO3	-	-	1	1	2	1
CO4	-	-	1	1	2	1
23PEACZ5	-	-	1	1	2	1
1 – Slight, 2 – Moderate, 3 – Substantial						

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

23PEACZ6	STRESS MANAGEMENT BY YOGA (Common to all branches)					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		AC	2	0	0	0
Course Objectives	• To create awareness on the benefits of yoga and meditation. • To understand the significance of Asana and Pranayama.					
UNIT – I	**PHYSICAL STRUCTURE AND ITS FUNCTIONS**					**6 Periods**
Yoga - Physical structure, Importance of physical exercise, Rules and regulation of simplified physical exercises, hand exercise, leg exercise, breathing exercise, eye exercise, kapalapathy, maharasana, body massage, acupressure, body relaxation.						
UNIT – II	**YOGA TERMINOLOGIES**					**6 Periods**
Yamas - Ahimsa, satya, astheya, bramhacharya, aparigraha Niyamas- Saucha, santosha, tapas, svadhyaya, Ishvara pranidhana.						
UNIT – III	**ASANA**					**6 Periods**
Asana - Rules & Regulations – Types & Benefits						
UNIT – IV	**PRANAYAMA**					**6 Periods**
Regularization of breathing techniques and its effects-Types of pranayama						
UNIT – V	**MIND**					**6 Periods**
Bio magnetism& mind - imprinting & magnifying – eight essential factors of living beings, Mental frequency and ten stages of mind, benefits of meditation, such as perspicacity, magnanimity, receptivity, adaptability, creativity.						
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**						

REFERENCES :

1	*Janardan Swami Yogabhyasi Mandal, **"Yogic Asanas for Group Training-Part-I"**, Nagpur.*
2	*Swami Vivekananda, **"Rajayoga or conquering the Internal Nature"**, Advaita Ashrama (Publication Department), Kolkata.*
3	*Pandit Shambu Nath, **"Speaking of Stress Management Through Yoga and Meditation"**, New Dawn Press, New Delhi, 2016.*
4	*K. N. Udupa, **"Stress and its management by Yoga",** Motilal Banarsidass Publishers, New Delhi, 2007.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Practice physical exercises and maintain good health.	K3
CO2	Attain knowledge on the various concepts of Yoga.	K2
CO3	Perform various asanas with an understanding on their benefits.	K3
CO4	Practice breathing techniques in a precise manner.	K3
CO5	Attain emotional stability and higher level of consciousness.	K2

Course Articulation Matrix					
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**
CO1	-	-	-	-	2
CO2	-	-	-	-	3
CO3	-	-	-	-	2
CO4	-	-	-	-	1
CO5	-	-	-	-	1
23PEACZ6	-	-	-	-	2
1 – Slight, 2 – Moderate, 3 – Substantial					

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	30	30	-	-	-	100
CAT2	30	40	30	-	-	-	100
Individual Assessment1 / Case study1/ Seminar 1/Project1	40	40	20	-	-	-	100
Individual Assessment2 / Case study2/ Seminar 2 /Project2	30	30	40	-	-	-	100
ESE	30	30	40	-	-	-	100

23PEACZ7	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS (Common to all branches)				
PREREQUISITES :	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	AC	**2**	**0**	**0**	**0**

Course Objectives	• To familiar with Techniques to achieve the highest goal in life. • To become a person with stable mind, pleasing personality and determination.

UNIT – I		**6 Periods**
Neetisatakam-Holistic development of personality-Verses- 19,20,21,22 (wisdom)-Verses29,31,32 (pride & heroism)-Verses- 26,28,6.		
UNIT – II		**6 Periods**
Verses- 52,53,59 (dont's)-Verses- 71,73,75,78 (do's). - Approach to day to day work and duties.- Shrimad BhagwadGeeta - Chapter 2-Verses 41, 47,48,		
UNIT – III		**6 Periods**
Shrimad BhagwadGeeta -Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,- Chapter 18-Verses 45, 46, 48.		
UNIT – IV		**6 Periods**
Statements of basic knowledge.-Shrimad BhagwadGeeta: -Chapter2-Verses 56, 62, 68 -Chapter 12 - Verses 13, 14, 15, 16,17, 18-Personality of Role model.		
UNIT – V		**6 Periods**
Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42, Chapter 4-Verses 18, 38,39-Chapter18 – Verses 37,38,63.		

Contact Periods:
Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods

REFERENCES :

1	*Swami SwarupanandaAdvaita Ashram "**Srimad Bhagavad Gita**",AdvaitaAshrama, Kolkata,2016*
2	*P.Gopinath, Rashtriya Sanskrit Sansthanam "**Bhartrihari's Three Satakam**" (Niti-sringar-vairagya), New Delhi, 1986.*
3	*Swami Mukundananda, JagadguruKripalujiYog "**Bhagavad Gita: The Song Of God**", USA,2019*
4	*A.C. Bhaktivedanta Swami Prabhupada "**Bhagavad-Gita As It Is**",Bhaktivedanta Book Trust Publications,2001*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the Holistic development in life	K4
CO2	Effective Planning of day to day work and duties	K4
CO3	Identify mankind to peace and prosperity	K4
CO4	Develop versatile personality.	K4
CO5	Awakening wisdom in life	K4

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	1	-	-	-
CO2	-	-	1	-	-	-
CO3	-	-	1	-	-	-
CO4	-	-	1	-	-	-
CO5	-	-	1	-	-	-
23PEACZ7	-	-	1	-	-	-
1 – Slight, 2 – Moderate, 3 – Substantial						

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

23PEACZ8	SANSKRIT FOR TECHNICAL KNOWLEDGE (Common to all Branches)					
PREREQUISITES:		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		AC	2	0	0	0
Course Objectives	• To get a working knowledge in illustrious Sanskrit, the scientific language in the world. • Learning of Sanskrit to improve brain functioning. • Enhancing the memory power. • Learning of Sanskrit to develop the logic in mathematics, science & other subjects.					
UNIT – I	**BASICS OF SANSKRIT**					**6 Periods**
Alphabets in Sanskrit, Past/Present/Future Tense.						
UNIT – II	**SENTENCES AND ROOTS**					**6 Periods**
Simple Sentences - Order, Introduction of roots						
UNIT – III	**SANSKRIT LITERATURE**					**6 Periods**
Technical information about Sanskrit Literature						
UNIT – IV	**TECHNICAL CONCEPTS -1**					**6 Periods**
Technical concepts of Engineering-Electrical, Mechanical						
UNIT – V	**TECHNICAL CONCEPTS -2**					**6 Periods**
Technical concepts of Engineering-Architecture, Mathematics						
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 30 Periods**						

REFERENCES:

1	*Dr.Vishwas, "**Abhyaspustakam", Samskrita -Bharti Publication, New Delhi, 2020.*
2	*Prathama Deeksha Vempati Kutumbshastri, "**Teach Yourself Sanskrit**", Rashtriya Sanskrit Sansthanam, New Delhi, Publication, 2009.*
3	*Suresh Soni, **"India's Glorious Scientific Tradition**", Ocean books (P) Ltd., New Delhi,2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recognize ancient literature and their basics	K3
CO2	Formulate the sentences with order and understand the roots of Sanskrit	K2
CO3	Acquire familiarity of the major traditions of literatures written in Sanskrit	K3
CO4	Distinguish the Technical concepts of Electrical & Mechanical Engineering	K2
CO5	Categorize the Technical concepts of Architecture & Mathematics	K2

Course Articulation Matrix						
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	-	-	1	2	1
CO2	-	-	-	1	2	-
CO3	-	-	-	1	1	1
CO4	-	-	-	2	1	1
CO5	-	-	-	1	2	1
23PEACZ8	**-**	**-**	**-**	1	2	1
1 – Slight, 2 – Moderate, 3 – Substantial						

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