GOVERNMENT COLLEGE OF TECHNOLOGY

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

Curriculum and Syllabi For
M.E. POWER SYSTEMS ENGINEERING
(Full Time)

2023

Regulations

OFFICE OF THE CONTROLLER OF EXAMINATIONS
GOVERNMENT COLLEGE OF TECHNOLOGY
THADAGAM ROAD, COIMBATORE – 641 013

PHONE 0422 – 2433355
Email: gctcoe@gct.ac.in

GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution Affiliated to Anna University, Chennai)

Coimbatore – 641 013.

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 and 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 M.E. - POWER SYSTEMS ENGINEERING in tune with the Vision and Mission of the department will:

PEO1:

Enable the graduates to apply the principles of power system operation, control and automation to solve electrical power utility problems

PEO2:

Undertake innovative research in the emerging areas of electric power systems

PEO3:

Exhibit leadership skills, effective communication and ability to work in collaborative, multidisciplinary tasks in their profession

PEO4:

Become socially, ethically responsible and demonstrate life-long independent reflective learning skills in their career

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

GOVERNMENT COLLEGE OF TECHNOLOGY

PROGRAMME OUTCOMES (POs)

Students in the Power systems Engineering Programme at the time of their graduation should be in possession of the following:

PO1:

Ability to independently carry out research /investigation and development work to solve practical problems of power system networks.

PO2:

Ability to write and present a substantial technical report/document

PO3:

Students should be able to demonstrate a degree of mastery over the area of power system engineering. The mastery should be at a level higher than the requirements in the appropriate bachelor program

PO4:

Ability to practice professional ethics and intellectual integrity to contribute to the community for sustainable development of society through life-long learning.

CURRICULUM FOR CANDIDATES ADMITTED DURING 2023-2024 AND ONWARDS

TWO YEAR M.E PROGRAMME

POWER SYSTEMS ENGINEERING

CHOICE BASED CREDIT SYSTEM-CURRICULUM

FIRST SEMESTER

Sl. No	Course Code	Course Title	Category	Continuous Assessment Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23PSFCZ1	Research Methodology and IPR (Common to all Branches)	FC	40	60	100	3	0	0	3
2	23PSFCZ2	Optimization Techniques for Electrical Engineering	FC	40	60	100	3	0	0	3
3	23PSPC01	Electric Distribution Systems	PC	40	60	100	3	0	0	3
4	23PSPC03	Advanced Power System Operation and Control	PC	40	60	100	3	0	0	3
5	23PSPC04	Graph Theory Application to Power System	PC	40	60	100	3	0	0	3
6	23PSACZX	Audit Course I*	AC	40	60	100	2	0	0	0
THEORY WITH PRACTICAL COMPONENT										
7	23PSPC02	Computer Aided Power System Analysis	PC	40	60	100	2	0	2	3
PRACTICALS										
8	23PSPC05	Power System Simulation Laboratory	PC	60	40	100	0	0	3	1.5
9	23PSPC06	Renewable Energy Laboratory (Common to PSE & PED)	PC	60	40	100	0	0	3	1.5
TOTAL				**400**	**500**	**900**	**19**	**0**	**8**	**21**

SECOND SEMESTER

Sl. No	Course Code	Course Title	Category	Continuous Assessment Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23PSPC08	Restructured Power System and Deregulation	PC	40	60	100	3	0	0	3
2	23PSPC09	Digital Power System Protection	PC	40	60	100	3	0	0	3
3	23PSPEXX	Professional Elective I	PE	40	60	100	3	0	0	3
4	23PSPEXX	Professional Elective II	PE	40	60	100	3	0	0	3
5	23PSPEXX	Professional Elective III	PE	40	60	100	3	0	0	3
6	23PSACZX	Audit Course II*	AC	40	60	100	2	0	0	0
THEORY WITH PRACTICAL COMPONENT										
7	23PSPC07	Power System Dynamics and Control	PC	40	60	100	2	0	2	3
PRACTICALS										
8	23PSPC10	Advanced Power System Simulation Laboratory	PC	60	40	100	0	0	4	2
9	23PSEE01	Mini Project	EEC	40	60	100	0	0	4	2
TOTAL				**380**	**520**	**900**	**19**	**0**	**10**	**22**

THIRD SEMESTER

Sl. No	Course Code	Course Title	Category	Continuous Assessment Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	23PSPEXX	Professional Elective IV	PE	40	60	100	3	0	0	3
2	23$$OEXX	Open Elective	OE	40	60	100	3	0	0	3
PRACTICALS										
3	23PSEE02	Internship/Industrial Training	EEC	100	-	100	0	0	**	2
4	23PSEE03	Project Phase I	EEC	100	100	200	0	0	12	6
TOTAL				**280**	**2200**	**500**	**6**	**0**	**12**	**14**

**4 weeks Internship / Industrial Training

FOURTH SEMESTER

Sl. No	Course Code	Course Title	Category	Continuous Assessment Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23PSEE04	Project Phase II	EEC	200	200	400	0	0	24	12
TOTAL				**200**	**200**	**400**	**0**	**0**	**24**	**12**

TOTAL CREDITS: 69

NOTE : * - NO CREDIT COURSES

LIST OF PROFESSIONAL ELECTIVE SUBJECTS

Sl. No	Course Code	Course Title	Category	Continuous Assessment Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
PROFESSIONAL ELECTIVE I										
1	23PSPE01	Linear and Non-Linear Control system (Common to PSE & PED)	PE	40	60	100	3	0	0	3
2	23PSPE02	Power System Transients and Surge Protection	PE	40	60	100	3	0	0	3
3	23PSPE03	Hybrid Power System Economics	PE	40	60	100	3	0	0	3
4	23PSPE04	Power System Planning and Reliability	PE	40	60	100	3	0	0	3
5	23PSPE05	Power System Security	PE	40	60	100	3	0	0	3
6	23PSPE06	Smart Grid Technology and Applications (Common to PSE & PED)	PE	40	60	100	3	0	0	3
PROFESSIONAL ELECTIVE II										
7	23PSPE07	Power Electronics in wind and solar power conversion (Common to PSE & PED)	PE	40	60	100	3	0	0	3
8	23PSPE08	HVDC and FACTS (Common to PSE & PED)	PE	40	60	100	3	0	0	3
9	23PSPE09	FEM Modeling of High Voltage Apparatus and Systems	PE	40	60	100	3	0	0	3
10	23PSPE10	High Voltage and Insulation Systems	PE	40	60	100	3	0	0	3
11	23PSPE11	Big Data Analytics for Power Systems	PE	40	60	100	3	0	0	3
PROFESSIONAL ELECTIVE III										
12	23PSPE12	Advanced Electric Drives and Controls (Common to PSE & PED)	PE	40	60	100	3	0	0	3
13	23PSPE13	Computer Relaying and Wide Area Measurement System	PE	40	60	100	3	0	0	3
14	23PSPE14	Intelligent Techniques in Power Systems	PE	40	60	100	3	0	0	3
15	23PSPE15	Modern Communication Techniques for Power Systems	PE	40	60	100	3	0	0	3
PROFESSIONAL ELECTIVE IV										
16	23PSPE16	Electromagnetic Interference and Compatibility in System Design (Common to PSE & PED)	PE	40	60	100	3	0	0	3
17	23PSPE17	Distributed Generations and Microgrid (Common to PSE & PED)	PE	40	60	100	3	0	0	3
18	23PSPE18	Insulation Materials and Testing for Industrial Applications (Common to PSE & PED)	PE	40	60	100	3	0	0	3
19	23PSPE19	Modern Power Electronics for Traction Applications (Common to PSE & PED)	PE	40	60	100	3	0	0	3
20	23PSPE20	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)

Sl. No	Course Code	Course Title	Category	Continuous Assessment Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	23PSACZ1	English for Research Paper Writing	AC	40	60	100	2	0	0	0
2	23PSACZ2	Disaster Management	AC	40	60	100	2	0	0	0
3	23PSACZ3	Value Education	AC	40	60	100	2	0	0	0
4	23PSACZ4	Constitution of India	AC	40	60	100	2	0	0	0
5	23PSACZ5	Pedagogy Studies	AC	40	60	100	2	0	0	0
6	23PSACZ6	Stress Management by Yoga	AC	40	60	100	2	0	0	0
7	23PSACZ7	Personality Development Through Life Enlightenment Skills	AC	40	60	100	2	0	0	0
8	23PSACZ8	Sanskrit For Technical Knowledge	AC	40	60	100	2	0	0	0

CURRICULUM DESIGN

Sl. No	Course Work Subject Area	No. of Credits					Percentage
		I	II	III	IV	Total	
1.	Foundation Courses	6	-	-	-	06	8.7%
2.	Professional Cores	15	11	-	-	26	37.7 %
3.	Professional Electives	-	9	3	-	12	17.4 %
4.	Open Elective Courses	-	-	3	-	03	4.3%
5.	Audit Courses	0	0	--	--	00	0%
6.	Employability Enhancement Courses	-	2	8	12	22	31.9 %
Total Credits		**21**	**22**	**14**	**12**	**69**	**100%**

23PSFCZ1	RESEARCH METHODOLOGY AND IPR (Common to all programmes)	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	K2
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**
CO1	-	2	3	1
CO2	2	-	3	-
CO3	2	2	3	-
CO4	-	3	2	-
CO5	-	2	3	2
23PSFCZ1	2	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	40%	40%	20%	-	-	-	100%
CAT2	40%	40%	20%	-	-	-	100%
Individual Assessment1/ Case study1/ Seminar 1/Project1	-	50%	30%	20%	-	-	100%
Individual Assessment2/ Case study2/ Seminar 2 /Project2	-	50%	30%	20%	-	-	100%
ESE	30%	30%	20%	20%	-	-	100%

23PSFCZ2	OPTIMIZATION TECHNIQUES FOR ELECTRICAL ENGINEERING		SEMESTER I			
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		FC	3	0	0	3
Course Objectives	To comprehend the fundamental concepts and principles of optimization, different types of optimization problems, algorithms, and optimization criteria.					
UNIT – I	**INTRODUCTION TO OPTIMIZATION**					**9 Periods**
Introduction - Historical Development, Engineering Applications of Optimization, Statement of an Optimization Problem, Classification of Optimization Problems, Optimization Techniques, Optimization Techniques, Engineering Optimization Literature. Case studies.						
UNIT – II	**LINEAR PROGRAMMING**					**9 Periods**
Introduction, Applications of Linear Programming, Standard Form of a Linear Programming Problem, Geometry of Linear Programming Problems, Definitions and Theorems, Solution of a System of Linear Simultaneous Equations, Pivotal Reduction of a General System of Equations, Motivation of the Simplex Method, Simplex Algorithm, Revised Simplex Method, Duality in Linear Programming, Transportation Problem, Karmarkar's Interior Method, Quadratic Programming, Engineering Optimization Literature. Case studies.						
UNIT – III	**NON-LINEAR PROGRAMMING**					**9 Periods**
Elimination Methods-Unrestricted Search, Exhaustive Search; Interpolation Methods-Quadratic Interpolation Method, Cubic Interpolation Method. Unconstrained Optimization Techniques-Direct Search Methods: Random Search Methods, Grid Search Method, Powell's Method- Conjugate Directions, Algorithm, Simplex Method. Indirect Search Methods: Gradient of a Function, Steepest Descent Method, Newton's Method, Marquardt Method. Constrained Optimization Techniques - Direct Methods: Random Search Methods, Complex Method, Sequential Linear Programming. Indirect Methods - Transformation Techniques, Basic Approach of the Penalty Function Method, Interior Penalty Function Method, Case studies.						
UNIT – IV	**DYNAMIC PROGRAMMING**					**9 Periods**
Introduction, Multistage Decision Processes, Definition and Examples, Representation of a Multistage Decision Process, Conversion of a Non-serial System to a Serial System, Types of Multistage Decision Problems, Concept of Sub-optimization and Principle of Optimality, Computational Procedure in Dynamic Programming, Conversion of a Final Value Problem into an Initial Value Problem, Linear Programming as a Case of Dynamic Programming, Continuous Dynamic Programming, Additional Applications - Design of Continuous Beams, Optimal Layout (Geometry) of a Truss, Optimal Design of a Gear Train, Design of a Minimum-Cost Drainage System, Engineering Optimization Literature. Case studies.						
UNIT – V	**MODERN METHODS OF OPTIMIZATION**					**9 Periods**
Introduction, Procedure and Algorithm of Modern methods of optimization: Genetic Algorithm, Simulated Annealing, Particle Swarm Optimization, Ant Colony Optimization, Optimization of Fuzzy Systems, Neural-Network-Based Optimization, Engineering Optimization Literature. Case studies.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*Singiresu S. Rao, **"Engineering Optimization: Theory and Practice"**, 12 June 2009.*
2	*G.Srinivasan,**"Operations Research-Principles and Applications"**, second edition,2010.*
3	*Osman Güler, **"Foundations of Optimization"**, Springer New York, 2010.*
4	*Mykel J. Kochenderfer, Tim A. Wheeler, **"Algorithms for Optimization"**, MIT Press, 2019*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the basic concepts and terminology of optimization theory, mathematical models for optimization problems.	K2
CO2	Apply different optimization algorithms, such as linear programming, dynamic programming, nonlinear programming and modern optimization techniques.	K3
CO3	Realize the applications of optimization in various fields, such as engineering, economics, and operations research.	K6
CO4	Utilize optimization software to solve real-world problems.	K3
CO5	Analyze and interpret optimization results.	K4

Course Articulation Matrix				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	3	2
CO2	3	-	3	2
CO3	3	-	3	2
CO4	3	-	3	2
CO5	3	2	3	2
23PSFCZ2	3	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%	30%	-	-	100%
CAT2	30%	20%	30%	20%	-	-	100%
Individual Assessment1/ Case study1/ Seminar 1/Project1	20%	30%	20%	30%	-	-	100%
Individual Assessment2/ Case study2/ Seminar 2 /Project2	30%	20%	30%	20%	-	-	100%
ESE	30%	30%	20%	20%	-	-	100%

23PSPC01	ELECTRIC DISTRIBUTION SYSTEMS	SEMESTER I

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

Course Objectives	To facilitate the students in understanding the configuration and components of the Electric Distribution Network, the modeling of the distribution system components & analyzing the distribution system under normal and abnormal conditions.

UNIT – I	INTRODUCTION TO ELECTRICAL DISTRIBUTION SYSTEM	9 Periods

Introduction to Electrical Distribution System - Components of Distribution System Substation and Busbar Layouts – Feeder configurations - Nature of Loads in a Distribution System - Load Allocation in a Distribution System - K Factors and Their Applications - Analysis of Uniformly Distributed - Lumping Loads in Geometric Configurations Rectangular and Triangular - Impedance of Distribution Lines and Feeders

UNIT – II	MODELLING OF DISTRIBUTION SYSTEM COMPONENTS	9 Periods

Models of Distribution Lines and Cables - Modelling of Single-Phase and Three-Phase Transformers - Modelling of Step Voltage Regulators - Load Models in Distribution System - Modelling of Distributed Generation - Applications and Modeling of Capacitor Banks

UNIT – III	LOAD FLOW ANALYSIS OF DISTRIBUTION SYSTEMS	9 Periods

Backward/Forward Sweep Load Flow Analysis - Direct Approach Based Load Flow Analysis - radial system, Weakly Meshed System - Gauss Implicit Z-matrix Method

UNIT – IV	SHORT CIRCUIT ANALYSIS OF DISTRIBUTION SYSTEMS	9 Periods

Sequence Component Based Short Circuit Analysis - Thevenin's Equivalent and Phase Variable Based Short Circuit Analysis - Direct Approach for Short-Circuit Analysis: Introduction and LG, LL, LLG and LLLG Fault Analysis - Direct Approach for Short-Circuit Analysis for Weakly Meshed System.

UNIT – V	RELIABILITY STUDY AND POWER QUALITY OF DISTRIBUTION SYSTEMS	9 Periods

Different reliability indices used in distribution networks - Mathematical concept of reliability - Reliability evaluation of multiple units connected to series and/or parallel - Power quality problems in distribution systems

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

REFERENCES

1	*T. Gonen. **"Electric Power Distribution System Engineering"**; CRC Press, 3rd Edition, 2014.*
2	*Brown R., Wills H., **"Electric power Distribution Reliability"**, Second Edition, Boca Raton CRC Press, 2008.*
3	*W.H. Kresting, **"Distribution System Modeling and Analysis"**, CRC Press, New York, 2002.*
4	*T.A. Short, **"Electric Power Distribution Handbook"**, CRC Press, Boca Raton, 2003*
5	*B. Das, **"Power Distribution Automation"**, IET Power and Energy Series, 75, London, 2016.*
6	*J.H.teng, **"A direct approach for distribution system load flow solution"**, IEEE Transactions on Power Delivery vol. 18, no.3, pp 882-887, July 2003.*
7	*A.A. Sallam and O.P. Malik, **"Electric Distribution System"**, IEEE Press, Picataway, NJ, 2011.*
8	*J.M.Gers, **"Distribution System Analysis and Automation"**, IET Power and Energy Series, 68, London, 2013.*
9	*R.F.Arritt and R.C.Dugan, **"Distribution system analysis and the future smart grid",** IEE Transactions on Industry applications, vol. 47, no. 6, pp. 2343-2350, Nov-Dec. 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Summarize the configuration and components of Electric Distribution Network	K2
CO2	Model different distribution system components	K3
CO3	Analyze the distribution system under normal and abnormal conditions	K4
CO4	Evaluate the distribution systems through reliability study	K5
CO5	Design the distribution systems with quality supply	K6

Course Articulation Matrix				
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**
CO1	2	-	2	-
CO2	2	-	2	-
CO3	3	-	3	-
CO4	3	-	3	-
CO5	3	-	3	2
23PSPC01	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%	20%	20%	20%	-	100%
CAT2	10%	20%	30%	20%	20%	-	100%
Individual Assessment1 / Case study1/ Seminar 1/Project1	10%	30%	20%	20%	20%	-	100%
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20%	30%	30%	10%	10%	-	100%
ESE	10%	30%	20%	30%	10%	-	100%

23PSPC02	COMPUTER AIDED POWER SYSTEM ANALYSIS				SEMESTER I
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PC**	**2**	**0**	**2**	**3**

Course Objectives	To realize the various solution techniques as applied to power system networks and to perform steady state and transient analysis of the power system networks and hence explore the shades of optimal power flow and analyze the system stability.

UNIT – I	**POWER SYSTEM SOLUTION TECHNIQUES**	**06+06 Periods**

Sparse Matrix techniques for large scale power systems - Optimal ordering schemes for preserving sparsity - Flexible packed storage scheme for storing matrix as compact arrays - Factorization by Bi-factorization and Gauss elimination methods – Gauss Elimination Solutions using Left and Right factors and L and U matrices.

LAB COMPONENT: Simulation of Gauss elimination Technique

UNIT – II	**POWER FLOW ANALYSIS**	**06+06 Periods**

Power flow equation in rectangular and polar forms - Formation of Y-Bus Matrix - Newton Raphson method - Adjustment of P-V buses - Fast Decoupled Power Flow method - Sensitivity factors for P-V bus adjustment. - AC-DC System Power Flow Analysis - Incorporating Load Models and FACTS devices in Power Flow Algorithm - Incorporating HVDC converter control in power flow - Sequential and Simultaneous Solution Algorithms.

LAB COMPONENT: Simulation for formation of Ybus & Zbus matrices

UNIT – III	**OPTIMAL POWER FLOW**	**06+06 Periods**

Problem statement - Solution of Optimal Power Flow (OPF) - The gradient method - Newton's method - Linear Sensitivity Analysis - LP methods - With real power variables only - LP method with AC power flow variables and detailed cost functions - Security constrained Optimal Power Flow - Interior point algorithm - Bus Incremental costs.

LAB COMPONENT: Simulation of Gradient methods for solving non-linear equations

UNIT – IV	**FAULT ANALYSIS**	**06+06 Periods**

Formation of bus impedance matrix with mutual coupling (single phase basis and three phase basis) - Computer method for fault analysis using ZBUS and sequence components - Derivation of equations for bus voltages -fault current and line currents - both in sequence and phase - symmetrical and unsymmetrical faults - Analysis of Open Circuit faults.

LAB COMPONENT: Simulation of symmetrical components computations

UNIT – V	**STABILITY ANALYSIS**	**06+06 Periods**

Classification of Power System Stability - Classical Model of Synchronous Machines and Excitation System - Transient Stability Analysis of Multi-Machine Systems - Eigen Analysis of Dynamical Systems - Small Signal Stability Analysis using Classical Model - Basic Concepts of Voltage Stability Analysis, Solution of swing equation using numerical integration approaches.

LAB COMPONENT: Simulation of numerical integration techniques

Contact Periods:

Lecture: 30 Periods Tutorial: 0 Periods Practical: 30 Periods Total: 60 Periods

REFERENCES:

1	*D. P. Kothari and I. J. Nagrath,* ***"Modern Power System Analysis"****, Fourth Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2011.*
2	*Prabha Kundur,* ***"Power System Stability and Control"****, Publisher: McGraw Hill Education, January 2006.*
3	*M. A. Pai "****Computer Techniques in Power System Analysis****", Tata McGraw Hill Publishing Company Limited, New Delhi, 2006.*
4	*Grainger J.J. and Stevenson W.D., "****Power System Analysis****", McGraw-Hill, New York, 1994.*
5	*Glover J.D., Sarma M. and Overbye T.J., "****Power System Analysis and Design****", Fifth Edition CL Engineering Press, 2012.*
6	*Bergen A.R. and Vijay Vittal, "****Power Systems Analysis****", Pearson Education Asia, III edition, 2009.*
7	*A. J. Wood and B. F. Wollenberg, "****Power Generation Operation and Control****", John Wiley and sons, New York, 2016*

COURSE OUTCOMES: Upon completion of the course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Apply the various matrix algebra-based solution techniques to power system networks	K3
CO2	Analyze the steady state of power system under normal conditions	K4
CO3	Devise transient analysis of power system networks under faulty conditions	K3
CO4	Illustrate the nuances of optimal power flow of the system	K1
CO5	Evaluate the system stability through modal analysis	K5

Course Articulation Matrix				
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	3	-
CO2	3	-	3	2
CO3	3	-	3	2
CO4	3	-	3	2
CO5	3	-	3	3
23PSPC02	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%	10%	10%	30%	20%	-	100%
CAT2	20%	20%	20%	20%	20%	-	100%
Individual Assessment1/ Case study1/ Seminar 1/Project1	30%	10%	30%	30%	-	-	100%
Individual Assessment2/ Case study2/ Seminar 2 /Project2	30%	10%	20%	20%	20%	-	100%
ESE	30%	10%	20%	20%	20%	-	100%

23PSPC03	ADVANCED POWER SYSTEM OPERATION AND CONTROL				SEMESTER I
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PC**	3	0	0	3

Course Objectives	To impart the knowledge on various operational and control activities as applied to the power system, articulate the economic nuances and modern control techniques & estimate the states of the power system under normal and abnormal conditions.

UNIT – I	**REAL POWER AND FREQUENCY CONTROL**	**9 Periods**

Fundamentals of speed governing mechanism and modelling: Speed-load characteristics – Load sharing between two synchronous machines in parallel - concept of control area - LFC control of a single-area system: Static and dynamic analysis of uncontrolled and controlled cases - Economic Dispatch Control - Multi-area systems: Two-area system modelling - static analysis, uncontrolled case - tie line with frequency bias control of two-area system derivation - state variable model.

UNIT – II	**REACTIVE POWER AND VOLTAGE CONTROL**	**9 Periods**

Production and absorption of reactive power- Methods of Voltage Control – Shunt reactors – Shunt Capacitors – Series Capacitors – Synchronous condensers – Static VAR systems – Principles of Transmission system compensation – Modeling of reactive compensating devices – Application of tap changing transformers to transmission systems – Distribution system voltage regulation - Modeling of transformer ULTC control systems.

UNIT – III	**UNIT COMMITMENT AND ECONOMIC DISPATCH**	**9 Periods**

Statement of Unit Commitment (UC) problem – Constraints in unit commitment – Solution using Priority List method, Dynamic programming method - Forward DP approach, Lagrangian relaxation method - The Economic dispatch problem – Thermal system dispatching with network losses considered – The Lambda iteration method – Gradient method of economic dispatch – Economic dispatch with Piecewise Linear cost functions – Transmission system effects – A two generator system – coordination equations – Incremental losses and penalty factors - Hydro Thermal Scheduling using DP

UNIT – IV	**MODERN CONTROL OF POWER SYSTEMS**	**9 Periods**

System operating states by security control functions – Monitoring, evaluation of system state by contingency analysis – Contingency Analysis – Linear Sensitivity Factor – Line Outage Sensitivity Factor – Generation Outage Sensitivity Factor – Analysis of multiple contingencies – Corrective controls (Preventive, emergency and restorative) - Energy control center – SCADA system – Functions – monitoring , Data acquisition and controls – EMS system

UNIT – V	**STATE ESTIMATION**	**9 Periods**

Maximum likelihood Weighted Least Squares Estimation: Concepts - Matrix formulation - Example for Weighted Least Squares state estimation - State estimation of an AC network: Typical results of state estimation on an AC network – State Estimation by Orthogonal Decomposition algorithm – Introduction to Advanced topics : Detection and Identification of Bad Measurements - Estimation of Quantities not being measured, Network Observability and Pseudo measurements – Application of Power System State Estimation.

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

REFERENCES

1	*A. J. Wood and B. F. Wollenberg, "**Power Generation Operation and Control**", John Wiley and sons, New York, 2016*
2	*KundurP ; "**Power System Stability and Control**", Tata McGraw Hill, 5th reprint, 2008.*
3	*Elgerd O.I, "**Electric Energy System Theory - An Introduction**", - Tata McGraw Hill, New Delhi 2002.*
4	*D.P. Kothari and I.J. Nagrath, "**Modern Power System Analysis**", Fourth Edition, Tata McGraw Hill Publishing Company Limited, New Delhi, 2003.*
5	*L.L. Grigsby, "**The Electric Power Engineering, Hand Book**", CRC Press & IEEE Press, 2001.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify various operational activities as applied to power system for the normal operating conditions	K1
CO2	Summarize various control activities as applied to power system for the normal and abnormal operating conditions	K2
CO3	Articulate the economic nuances of the power system network.	K3
CO4	Illustrate modern control techniques for power systems.	K4
CO5	Evaluate the states of the power system under normal and abnormal conditions.	K5

Course Articulation Matrix

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	3	-
CO2	3	-	3	2
CO3	3	-	3	2
CO4	3	-	3	2
CO5	3	-	3	3
23PSPC03	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%	10%	10%	-	100%
CAT2	20%	20%	20%	20%	10%	-	100%
Individual Assessment1/ Case study1/ Seminar 1/Project1	30%	30%	20%	10%	10%	-	100%
Individual Assessment2/ Case study2/ Seminar 2 /Project2	20%	20%	20%	20%	20%	-	100%
ESE	20%	20%	20%	20%	20%	-	100%

23PSPC04	GRAPH THEORY APPLICATION TO POWER SYSTEM				SEMESTER I
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PC**	3	0	0	3

Course Objectives	Upon completion of this course, the students will be familiar with the algorithms of graph theory and applications of graph theory to power system problems	
UNIT – I	**INTRODUCTION**	**9 Periods**
Introduction – Network terminologies, Graph Terminologies - Types of Graphs - Sub Graph- Multi Graph - Regular Graph - Isomorphism - Isomorphic Graphs - Sub-graph - Euler graph - Hamiltonian Graph - Directed Graph and undirected Graph		
UNIT – II	**TREES AND CUTSETS**	**9 Periods**
Trees -Properties- Distance and Centres - Types - Rooted Tree-- Tree Enumeration- Labeled Tree - Unlabeled Tree - Spanning Tree: Minimum spanning tree and maximum spanning tree - Fundamental Circuits- Cut Sets - Properties - Fundamental Circuit and Cut-set- Connectivity- Separability -Related Theorems.		
UNIT – III	**NETWORK FLOWS**	**9 Periods**
Network Flows - Planar Graph - Representation - Detection –- Dual Graph - Geometric and Combinatorial Dual - Related Theorems - Digraph - Properties - Euler Digraph		
UNIT – IV	**MATRIX REPRESENTATION**	**9 Periods**
Matrix Representation - Adjacency matrix- Primitive matrices-Incidence matrix- Cut-set matrix - Path Matrix- Properties - Related Theorems - Correlations. Graph Coloring - Chromatic Polynomial - Chromatic Partitioning - Matching - Covering - Related Theorems.		
UNIT – V	**POWER SYSTEM APPLICATIONS**	**9 Periods**
Graph algorithms: Optimal path finding algorithm, Depth first search, Breadth first search, Dijkstra algorithms – Belman ford and Ford Fulkerson algorithms - Programming Practices for power system problems.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES

1	*Narsingh Deo, "**Graph Theory with Application to Engineering and Computer Science**", Prentice-Hall of India Pvt. Ltd, 2003.*
2	*Diestel, R, "**Graph Theory**", Springer, 3rd Edition, 2006.*
3	*Bondy, J. A. and Murty, U.S.R., "**Graph Theory with Applications**", North Holland Publication,2008.*
4	*West, D. B., "**Introduction to Graph Theory**", Pearson Education, 2011.*
5	*John Clark, Derek Allan Holton, "**A First Look at Graph Theory"**, World Scientific Publishing Company, 1991.*
6	*Clark J. and Holton D.A, "**A First Look at Graph Theory**", Allied Publishers, 1995.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand fundamentals of graph theory.	K2
CO2	Study techniques related to various concepts in graphs	K1
CO3	Explore modern applications of graph theory	K6
CO4	Analyze the algorithms in graph theory	K4
CO5	Apply graph algorithms to power system	K3

Course Articulation Matrix				
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	3	1	1
CO2	3	2	3	2
CO3	3	2	3	2
CO4	3	2	3	1
CO5	3	2	1	2
23PSPC04	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%	30%	30%	20%	-	-	100%
CAT2	30%	20%	20%	20%	10%	-	100%
Individual Assessment1 / Case study1/ Seminar 1/Project1	20%	30%	20%	20%	10%	-	100%
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20%	20%	20%	20%	10%	10%	100%
ESE	20%	30%	20%	20%	10%	-	100%

23PSPC05	POWER SYSTEM SIMULATION LABORATORY	SEMESTER I

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

Course Objectives	To analyze the performance of power system under normal and abnormal conditions using simulation software

LIST OF EXPERIMENTS

1. AC Power flow analysis-Fast decoupled method
2. AC-DC Power flow analysis
3. Transient stability analysis of single machine-infinite bus system using classical machine model
4. Optimal load dispatch using lambda-iteration method
5. Solution to Unit commitment Problem: Priority-list schemes and dynamic programming
6. Contingency analysis
7. Load flow analysis with STATCOM
8. Harmonic analysis of power system with non-linear load
9. Study of protective relaying schemes of Power Apparatus
10. Demand Side Management in Smart Power Grid network
11. Determination of Sequence Impedances of Power Network
12. Study of SCADA based 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	Acquire expertise in usage of simulation software as applied to power system	K1
CO2	Apply tools to simulate the mathematical model of power network for power system analysis	K3
CO3	Analyze the power system through various numerical methods under normal and abnormal conditions	K4
CO4	Suggest methods for economic operation of power system for improved resource utilization	K4
CO5	Evaluate the existing power system for its reliable operation.	K5

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4
CO1	2	2	3	1
CO2	2	2	3	1
CO3	2	2	3	1
CO4	-	-	3	1
CO5	3	2	3	2
23PSPC05	2	2	3	1

1 – Slight, 2 – Moderate, 3 – Substantial

23PSPC06	RENEWABLE ENERGY LABORATORY (Common to PSE and 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
CO1	3	3	3	-
CO2	3	3	3	1
CO3	3	3	2	1
CO4	3	3	2	2
CO5	3	3	-	-
23PSPC06	3	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

23PSPC07	POWER SYSTEM DYNAMICS AND CONTROL		SEMESTER II			
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PC**	2	0	2	3
Course Objectives	To summarize theoretical modeling concepts of various power system components for the stability analysis and hence evaluating the existing system for its satisfactory operation					
UNIT – I	**ANALYSIS OF DYNAMICAL SYSTEMS**		**06+06 Periods**			
Concept of Equilibria, Small and Large Disturbance Stability, Example: Single Machine Infinite Bus System, Modal Analysis of Linear Systems, Analysis using Numerical Integration Techniques, Issues in Modeling: Slow and Fast Transients, Stiff Systems. **LAB COMPONENT: Simulation of Numerical Integration Techniques using Scilab**						
UNIT – II	**MODELING OF SYNCHRONOUS MACHINE**		**06+06 Periods**			
Physical Characteristics, Rotor Position Dependent model, D-Q Transformation, Model with Standard Parameters, Steady State Analysis of Synchronous Machine, Short Circuit Transient Analysis of a Synchronous Machine, Synchronous Machine Connected to Infinite Bus. **LAB COMPONENT: Simulation of synchronous machine using Scilab**						
UNIT – III	**MODELING OF EXCITATION AND PRIME MOVER SYSTEMS**		**06+06 Periods**			
Physical Characteristics and Models, Control system components, Excitation System Controllers, Prime Mover Control Systems. **LAB COMPONENT: Simulation of excitation and prime mover systems using Scilab**						
UNIT – IV	**MODELING OF TRANSMISSION LINES AND LOADS**		**06+06 Periods**			
Transmission Line Physical Characteristics, Transmission Line Modeling, Load Models - Induction machine model, Other Subsystems - HVDC, protection systems. **LAB COMPONENT: Simulation of transmission lines protection using Scilab**						
UNIT – V	**STABILITY ISSUES IN INTERCONNECTED POWER SYSTEMS**		**06+06 Periods**			
Single Machine Infinite Bus System, Multi-machine Systems, Stability of Relative Motion, Frequency Stability: Centre of Inertia Motion, Concept of Load Sharing: Governors, Single Machine Load Bus System: Voltage Stability, Torsional Oscillations **LAB COMPONENT: Simulation of stability analysis using Scilab**						
Contact Periods: **Lecture: 30 Periods Tutorial: 0 Periods Practical: 30 Periods Total: 60 Periods**						

REFERENCES

1	*K. R. Padiyar, Anil M. Kulkarni, **"Dynamics and Control of Electric Transmission and Microgrids"**, Wiley, 2019*
2	*Ramanujam, R. **"Power System Dynamics: Analysis and Simulation",** PHI Learning Pvt. Ltd., 2010*
3	*Peter W Sauer and M A Pai and Joe H Chow, John Wiley, "**Power System Dynamics And Stability : With Synchrophasor Measurement And Power System Toolbox**", John Wiley, Second edition, 2017*
4	*Jan Machowski, Zbigniew Lubosny, Janusz W. Bialek, James R. Bumby, **"Power System Dynamics - Stability and Control"**, Wiley, 2020*
5	*Kundur P., **"Power System Stability and Control"**, McGraw Hill Inc., New York,1995*
6	*Padiyar K.R., **"Power System Dynamics, Stability & Control"**, 2nd Edition, B.S. Publications, Hyderabad, 2008*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply modal analysis to any dynamical system	K3
CO2	Model the various power system components.	K6
CO3	Analyze the dynamics and stability issues in power system	K4
CO4	Interprete the complete response of power system under normal/abnormal operating conditions	K2
CO5	Plan stabilized interconnected power systems.	K5

Course Articulation Matrix				
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	3	3
CO2	3	-	3	-
CO3	3	-	3	1
CO4	3	-	3	2
CO5	3	1	3	3
23PSPC07	3	1	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%	40%	30%	10%	10%	-	100%
CAT2	10%	30%	30%	20%	10%	-	100%
Individual Assessment1 / Case study1/ Seminar 1/Project1	-	20%	50%	30%	-	-	100%
Individual Assessment2 / Case study2/ Seminar 2 /Project2	-	30%	30%	20%	20%	-	100%
ESE	20%	20%	30%	20%	10%	-	100%

23PSPC08	RESTRUCTURED POWER SYSTEM AND DEREGULATION		SEMESTER II			
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PC**	3	0	0	3
Course Objectives	To explore objectives of national and regional planning of electricity, understand criteria of generation planning, impart learning about optimal power system expansion and its planning, also to learn about un-integrated and bundled power systems					
UNIT – I	**FUNDAMENTALS AND ARCHITECTURE OF POWER MARKETS**		**9 Periods**			
Introduction – Unbundling – Wheeling - Reform motivations-Fundamentals of Deregulated Markets – Types (Future, Day-ahead and Spot) – Participating in Markets (Consumer and Producer Perspective) – Bilateral markets – Pool markets. Independent System Operator (ISO) – Components -Types of ISO - Role of ISO - Lessons and Operating Experiences of Deregulated Electricity Markets in various Countries (UK, Australia, Europe, US, Asia), Regulation and policies for restructured power system.						
UNIT – II	**TECHNICAL CHALLENGES**		**9 Periods**			
Total Transfer Capability – Limitations - Margins – Available transfer capability (ATC) – Procedure - Methods to compute ATC – Static and Dynamic ATC – Effect of contingency analysis – Case Study. Concept of Congestion Management – Bid, Zonal and Node Congestion Principles - Inter and Intra zonal congestion – Generation Rescheduling - Transmission congestion contracts – Case Study.						
UNIT – III	**TRANSMISSION NETWORKS AND SYSTEM SECURITY SERVICES**		**9 Periods**			
Transmission expansion in the New Environment – Introduction – Role of transmission planning – Physical Transmission Rights – Limitations – Flow gate - Financial Transmission Rights – Losses – Managing Transmission Risks – Hedging – Investment. Ancillary Services – Introduction – Describing Needs – Compulsory and Demand - Side provision – Buying and Selling Ancillary Services – Standards.						
UNIT – IV	**MARKET PRICING**		**9 Periods**			
Transmission pricing in open access system – Introduction – Spot Pricing – Uniform Pricing – Zonal Pricing – Locational Marginal Pricing – Congestion Pricing – Ramping and Opportunity Costs, Embedded cost based transmission pricing methods (Postage stamp, Contract path and MW-mile) – Incremental cost based transmission pricing methods (Short run marginal cost, Long run marginal cost) - Pricing of Losses on Lines and Nodes.						
UNIT – V	**INDIAN POWER MARKET**		**9 Periods**			
Current Scenario - Regions – Restructuring Choices – Statewise Operating Strategies - Salient features of Indian Electricity Act 2003 – Transmission System Operator – Regulatory and Policy development in Indian power Sector – Opportunities for IPP and Capacity Power Producer. Availability based tariff – Necessity – Working Mechanism – Beneficiaries – Day Scheduling Process – Deviation from Schedule – Unscheduled Interchange Rate – System Marginal Rate – Trading Surplus Generation – Applications.						
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**						

REFERENCES

1	*Loi Lei Lai, **"Power system Restructuring and Deregulation"**, John Wiley & sons, 2001.*
2	*Kankar Bhattacharya, Math H.J. Bollen and Jaap E. Daalder, **"Operation of Restructured Power Systems"**, Kluwer Academic Publishers, 2012.*
3	*Shahidehpour M and Alomoush M, **"Restructuring Electrical Power Systems"**, Marcel Decker Inc., 2001.*
4	*Daniel S. Kirschen and GoranStrbac, **"Fundamentals of Power System Economics"**, John Wiley & Sons Ltd., 2004.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Review the deregulation and restructuring of power markets	K1
CO2	Analyze the way of secured and reliable operation of power systems.	K4
CO3	Design the efficient economic planning of electricity.	K6
CO4	Understand the Indian Electricity Act	K2
CO5	Know the technical issues in Indian Power Marke**t**	K2

Course Articulation Matrix				
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	3	-
CO2	3	-	3	-
CO3	3	-	1	2
CO4	3	-	2	3
CO5	3	-	3	3
23PSPC08	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%	30%	10%	-	-	100%
CAT2	10%	20%	30%	20%	20%	-	100%
Individual Assessment1 / Case study1/ Seminar 1/Project1	-	30%	50%	20%	-	-	100%
Individual Assessment2 / Case study2/ Seminar 2 /Project2	-	20%	30%	20%	30%	-	100%
ESE	30%	20%	30%	10%	10%	-	100%

23PSPC09	DIGITAL POWER SYSTEM PROTECTION				SEMESTER II
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PC**	3	0	0	3

Course Objectives	To impart learning about the recent trends in power system protection schemes and enable the students to design and work using digital relaying concepts

UNIT – I	**NUMERICAL PROTECTION**	**9 Periods**

Essential qualities of protection- Primary and Backup protection – Zones of protection – basic protective schemes - Block diagram of numerical relay - Sampling theorem - Correlation with a reference wave - Least Error Squared technique - Digital filtering and numerical over- Current protection.

UNIT – II	**DIGITAL PROTECTION OF TRANSMISSION LINE**	**9 Periods**

Introduction - Protection scheme of transmission line – Distance relays - Three-stepped protection of three-phase line against shunt type faults- Traveling wave relays - Digital protection scheme based upon fundamental signal - Hardware design - Software design - Digital protection of EHV/UHV transmission line based upon traveling wave phenomenon - New relaying scheme using amplitude comparison.

UNIT – III	**DIGITAL PROTECTION OF SYNCHRONOUS GENERATOR AND TRANSFORMER**	**9 Periods**

Synchronous generator: Stator and Rotor faults – Protection schemes -Digital protection of Synchronous Generator.

Transformer: Differential Protection –Percentage Differential Bias –Inrush phenomena– High resistance Ground Faults– Restricted Earth fault Protection - Inter-turn faults – Incipient faults- Schemes for Transformer Protection – Digital Protection of Transformer.

UNIT – IV	**DISTANCE AND OVERCURRENT RELAY SETTING AND CO-ORDINATION**	**9 Periods**

Directional instantaneous IDMT over current relay - Directional multi-Zone distance relay - Distance relay setting - Co-ordination of distance relays - Co-ordination of overcurrent relays – concept of modern coordinated control system-Computer graphics display – Man-machine interface subsystem – Integrated operation of national power system

UNIT – V	**PC APPLICATIONS FOR DESIGNING PROTECTIVE RELAYING SCHEME**	**9 Periods**

Types of faults – Assumptions - Development of algorithm for short circuit (SC) studies - PC based integrated software for SC studies - Transformation to component quantities - SC studies of multiphase systems- Ultra high-speed protective relaying scheme for HV long transmission line.

Contact Periods:

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

REFERENCES

1	*L. P. Singh, "**Digital Protection – Protective Relaying from Electromechanical to Microprocessor**", New Age International Ltd., New Delhi, Second Edition, 2006.*
2	*Paithankar and Bhide, "**Fundamentals of Power System Protection**", Prentice Hall of India Pvt. Ltd., New Delhi, Second Edition, 2013.*
3	*Rao T.S.M., "**Digital Relay / Numerical relays**", Tata McGraw Hill, New Delhi, 2005.*
4	*Badri Ram and D.N. Vishwakarma, "**Power System Protection and Switchgear**", Tata McGraw- Hill Publishing Company, 2002.*
5	*S.R.Bhide, "**Digital Power System Protection**", PHI, 2014*
6	*Power system protection, Vol.IV: Digital Protection and Signalling, The Institution of Electrical Engineers, UK*
7	*Related e-Journals and books for advanced work* *(i) IEEE Transactions on Power System* *(ii) IEEE Transactions on Power Delivery* *(iii) IET Research Journal on Generation, Trans and Distribution* *(iv) NPTEL Course on Digital Protection of Power System*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Know the underlying principle of digital techniques for power system protection	K2
CO2	Design the relaying scheme for protection of power apparatus using digital techniques	K4
CO3	Evaluate and interpret relay coordination	K5
CO4	Develop PC based algorithm for short circuit studies	K6
CO5	Analyze the performance of modern protection schemes	K4

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4
CO1	2	-	2	-
CO2	2	2	2	-
CO3	3	2	3	2
CO4	3	2	3	1
CO5	3	2	3	2
23PSPC09	3	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%	10%	30%	10%	-	100%
CAT2	20%	25%	15%	30%	10%	-	100%
Individual Assessment1/ Case study1/ Seminar 1/Project1	10%	25%	15%	20%	30%	-	100%
Individual Assessment2/ Case study2/ Seminar 2 /Project2	10%	25%	15%	20%	20%	10%	100%
ESE	20%	20%	15%	25%	20%	-	100%

23PSPC10	ADVANCED POWER SYSTEM SIMULATION LABORATORY				SEMESTER II
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	PC	0	0	4	2

Course Objectives	To get exposure to modern techniques for solving Power System Problems

LIST OF EXPERIMENTS

1. Study of Neural Network and Fuzzy tool boxes
2 Solution of Unit commitment Problem through Evolutionary algorithm
3. Solution of Economic Dispatch using Evolutionary algorithm
4. Fuzzy logic based Power System Stabilizer
5. Study of Co-ordination of over-current and distance relays for radial line protection
6. Power System Planning-Circuit Breaker Rating
7. Simulation study of Automatic Generation Control using intelligent control techniques
8. Application of Soft Computing Technique for Power System Problems
9. State Estimation of Power System
10.Analysis of Integrated Renewable Energy Sources with Power grid
11.Design of active filter for harmonics mitigation
12.Available Transfer Capability calculation
13.Simulation of faults for multi machine systems.

Out of the above, a minimum of ten experiments are to be conducted.

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	Acquire expertise in usage of modern techniques as applied to Power System Issues	K1
CO2	Apply soft computing techniques to Power System problems and evaluate the solution	K3
CO3	Analyze the solution obtained through soft computing techniques	K4
CO4	Evaluate the existing power system for its reliable operation.	K5
CO5	Suggest suitable technique as applicable to power system problem	K3

Course Articulation Matrix

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**
CO1	2	2	2	1
CO2	2	1	3	1
CO3	3	2	3	1
CO4	3	2	3	2
CO5	2	2	3	2
23PSPC10	2	2	3	1

1 – Slight, 2 – Moderate, 3 – Substantial

23PSEE01	MINI PROJECT	SEMESTER II

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

Course Objectives	To develop student‘s ability to transmit technical information clearly and test the same through Seminar presentation based on their Mini Project.

Students can choose problems in the field of Power System Engineering as mini projects. It can be related to providing solutions to an engineering problem, verification and analysis of experimental, simulation data available, conducting experiments on various domains in the field of PSE, material characterization, familiarizing the software tools for the solution of an engineering problem etc.

A project work note should be maintained by the students for proper documentation of the details of work done, challenges faced, technique chosen and solutions evolved etc. and present the same to the committee members during reviews and to answer the questions put forth by the committee

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

The End Semester Examination for Mini Project Work shall consist of evaluation of the Project Report submitted by the student and viva-voce examination by an external examiner and internal examiner.

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	Acquire practical knowledge within the chosen area of technology for project development	K2
CO2	Plan, Identify and implement the hardware/ software project with a comprehensive and Systematic approach	K3
CO3	Develop effective communication skills for presentation of project	K6
CO4	Develop skills to write technical reports, present and defend the work	K6
CO5	Assess on their own, reflect on their learning and take appropriate action to improve it	K5

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4
CO1	2	1	2	1
CO2	2	1	2	2
CO3	2	3	1	1
CO4	2	3	1	1
CO5	2	3	1	2
23PSEE01	2	3	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

23PSEE02	INTERNSHIP/INDUSTRIAL TRAINING	SEMESTER III

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

Course Objectives	To get the exposure for the application of theoretical concepts studied, identify the domain specific demands with respect to societal needs and renovate the existing domain specific technology by the cutting-edge technology.

Common guidelines are:

1. Duration: Industrial training is typically conducted during the summer break or semester break and may last **4 weeks** for postgraduate students.
2. Approval: The industrial training placement must be approved by the institution to ensure that it meets the academic requirements of the program.
3. Report: Students are required to submit a report on their industrial training experience, detailing their activities and learning outcomes.
4. Assessment: Students may be assessed based on their performance during the industrial training period, including attendance, participation, and completion of assigned tasks.
5. Safety: The institution and the industrial training company must ensure that the students are provided with a safe working environment and appropriate training on health and safety.
6. Code of conduct: Students must adhere to the code of conduct of the industrial training company, as well as the rules and regulations of the institution.
7. Certification: Students may be awarded a certificate of completion after successful completion of their industrial training program from the Industry.

Contact Periods:

Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 160 hours** **Total: 160 hours**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the theoretical concepts studied	K3
CO2	Analyze the theoretical concepts for the existing methodologies followed by the industrial sector	K4
CO3	Evaluate the theoretical concepts for the existing methodologies followed by the industrial sector	K5
CO4	Sketch the state of art to replace existing technologies.	K2
CO5	Design the cutting-edge technology as per the societal needs	K6

Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4
CO1	3	-	2	2
CO2	3	-	2	2
CO3	3	-	2	2
CO4	3	2	2	2
CO5	3	2	2	2
23PSEE02	3	2	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

** Duration of four weeks

23PSEE03	PROJECT PHASE I				SEMESTER III
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	EEC	0	0	12	6

Course Objectives	To identify the societal problem related to Power Systems Engineering, undertake detailed technical work in the chosen area through simulations for the benefit of Society and hence analyze, evaluate the technical work done.

Guidelines for a project in Power Systems Engineering:

1. Choose a relevant topic: project should be related to a real-world problem or challenge in Power Systems Engineering.
2. Define your objectives: Clearly define the objectives of the project.
3. Conduct a literature review: Research existing literature related to the chosen topic. This will help to identify current trends, technologies, and best practices, as well as gaps in knowledge that the project can fill.
4. Develop a methodology: Define the methodology for the project, including the data sources, the analysis methods, and the simulation software (if applicable). Make sure the methodology aligns with the objectives.
5. Collect and analyze data: Collect relevant data and analyze it using chosen methodology. If the work involves conducting simulations, make sure to validate the results against real-world data.
6. Interpret and present results: Interpret the results and draw conclusions based on the analysis. Present the findings in a clear and concise manner, using data visualizations and graphs to help illustrate the results.
7. Discuss implications and future directions: Discuss the implications of the findings and how they can be applied to address the original problem or challenge. Identify potential areas for future research and development.
8. Conclude and summarize: Conclude the project by summarizing the findings and emphasizing their importance. Make sure to highlight how the project can contribute to the field of Power Systems Engineering.
9. Consider ethics: Make sure to consider any ethical implications of the project, including potential social, environmental, and economic impacts.

By following these guidelines, student can develop a well-designed project that addresses a relevant problem in Power Systems Engineering and contributes to the advancement of the field.

Contact Periods:

Lecture: 0 Periods Tutorial: 0 Periods Practical: 180 Periods Total: 180 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 a detailed Literature Survey.	K1
CO2	Design and system using software tools.	K5
CO3	Evaluate the designed system through simulation/hardware implementation	K6
CO4	Develop expertise in the interpretation of simulation and experimentation.	K6
CO4	Articulate the technical presentation and documentation of the work	K3

Course Articulation Matrix				
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	3	3
CO2	3	-	3	2
CO3	3	-	3	2
CO4	3	-	3	2
CO5	-	3	3	2
23PSEE03	3	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial				

23PSEE04	PROJECT PHASE II					SEMESTER IV
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		EEC	0	0	24	12
Course Objectives	To identify the societal problem related to Power Systems Engineering, undertake detailed technical work in the chosen area through simulations for the benefit of Society and hence analyze, evaluate the technical work done through hardware implementation (if applicable)					

Guidelines for a project in Power Systems Engineering:

1. Choose a relevant topic: project should be related to a real-world problem or challenge in Power Systems Engineering.
2. Define your objectives: Clearly define the objectives of the project.
3. Conduct a literature review: Research existing literature related to the chosen topic. This will help to identify current trends, technologies, and best practices, as well as gaps in knowledge that the project can fill.
4. Develop a methodology: Define the methodology for the project, including the data sources , the analysis methods, and the simulation software (if applicable). Make sure the methodology aligns with the objectives.
5. Collect and analyze data: Collect relevant data and analyze it using chosen methodology. If the work involves conducting simulations, make sure to validate the results against real-world data.
6. Interpret and present results: Interpret the results and draw conclusions based on the analysis. Present the findings in a clear and concise manner, using data visualizations and graphs to help illustrate the results.
7. Discuss implications and future directions: Discuss the implications of the findings and how they can be applied to address the original problem or challenge. Identify potential areas for future research and development.
8. Conclude and summarize: Conclude the project by summarizing the findings and emphasizing their importance. Make sure to highlight how the project can contribute to the field of Power Systems Engineering.
9. Consider ethics: Make sure to consider any ethical implications of the project, including potential social, environmental, and economic impacts.

By following these guidelines, student can develop a well-designed project that addresses a relevant problem in Power Systems Engineering and contributes to the advancement of the field.

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 a detailed Literature Survey.	K1
CO2	Design and system using software tools.	K5
CO3	Evaluate the designed system through simulation/hardware implementation	K6
CO4	Develop expertise in the interpretation of simulation and experimentation.	K6
CO4	Articulate the technical presentation and documentation of the work	K3

Course Articulation Matrix				
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	3	3
CO2	3	-	3	2
CO3	3	-	3	2
CO4	3	-	3	2
CO5	-	3	3	2
23PSEE04	3	3	3	2
1 – Slight, 2 – Moderate, 3 – Substantial				

23PSPE01	LINEAR AND NON-LINEAR CONTROL SYSTEM (Common to PSE & 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 behavioural 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**
CO1	2	-	1	2
CO2	3	-	2	2
CO3	2	-	1	1
CO4	3	-	2	2
CO5	3	1	2	2
23PSPE01	3	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	-	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%

23PSPE02	POWER SYSTEM TRANSIENTS AND SURGE PROTECTION				SEMESTER II
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	PE	3	0	0	3

Course Objectives	To familiarize students about the power system transients due to internal and external factors and surge protection methods	
UNIT – I	**INTRODUCTION**	**9 Periods**
Review of various types of power system transients - Lightning surges, Switching surges : Inductive energy transient and capacitive energy transient – Effect of transients on power systems - Relevance of the study and computation of power system transients – Surge voltage and surge current specifications (As per BIS).		
UNIT – II	**LIGHTNING SURGES**	**9 Periods**
Lightning – Overview- Lightning surges - Electrification of thunderclouds – Simpson's theory of thunderclouds – Direct and Indirect strokes – Stroke to conductor, midspan and tower – Conventional lightning protection technique: Collection Volume method.		
UNIT – III	**SWITCHING SURGES**	**9 Periods**
Closing and reclosing of lines – Load rejection – Fault initiation – Fault clearing – Short line faults – Ferro Resonance – Isolator switching surges – Temporary overvoltages – Surges on an integrated system – Switching – Harmonics – Protection scheme.		
UNIT – IV	**TRANSIENT CALCULATION**	**9 Periods**
Travelling wave concepts – Telegraphic Equation, Wave Propagation, Reflections – Bewley's Lattice diagrams for various cases – Analysis in time and frequency domain – Eigen value approach – Z-transform.		
UNIT – V	**INSULATION CO-ORDINATION**	**9 Periods**
Principles of insulation co-ordination – Recent advancements in insulation co-ordination - BIL, Design of EHV system – Insulation co-ordination as applied to transformer, substations – Examples.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

REFERENCES :

1	*Indulkar C.S., and Kothari D.P., **"Power System Transients"**- A Statistical approach, Prentice Hall 2004.*
2	*Allan Greenwood, **"Electrical Transients in power Systems",** Willey Interscience, Newyork, Second Edition, 2010.*
3	*Klaus Ragaller. **"Surges in High Voltage Networks"**, Plenum Press, NewYork, 1980.*
4	*Bewely L.V., **"Travelling waves and Transmission Systems"**, Dover Publications, New York, 1963.*
5	*SubirRay, **"Electrical Power Systems – Concepts, Theory and Practice",** Prentice Hall of India, NewDelhi, 2007.*
6	*Chakrabarthy A, Soni M.L, Gupta P.V. and Bhatnagar U.S. **"A Text Book on Power System Engineering"**, DhanpatRai & Sons, NewDelhi, 2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the various types of power system transients	K2
CO2	Understand the concept of transients and surges occur in power system	K2
CO3	Evaluate surge and transient specification through different techniques	K5
CO4	Analyze the impact of transient and surges on power system	K4
CO5	Perform insulation co-ordination as applied to power system components	K3

Course Articulation Matrix				
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	3	1
CO2	3	-	3	1
CO3	3	-	3	1
CO4	2	-	3	1
CO5	3	-	3	1
23PSPE02	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	-	40%	30%	10%	20%	-	100%
CAT2	-	20%	30%	20%	30%	-	100%
Individual Assessment1/ Case study1/ Seminar 1/Project1	-	20%	50%	20%	10%	-	100%
Individual Assessment2/ Case study2/ Seminar 2 /Project2	-	20%	30%	20%	30%	-	100%
ESE	-	20%	30%	20%	30%	-	100%

23PSPE03	HYBRID POWER SYSTEM ECONOMICS				SEMESTER II
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	PE	3	0	0	3

Course Objectives	To give an understanding of the economic principles underlying the operation and planning of the electricity systems including concepts of electricity markets and competition in electricity generation and supply, and the opening of the transmission and distribution systems to third party access

UNIT – I	**POWER MARKET**	**9 Periods**

Market Structure and operation:- Objective of market operation, Electricity market models, Power market types, Market power, Key components in market operation. Demand and supply, Demand analysis – Theory, elasticity of demand, Demand forecasting –Types, techniques. Costs: Short run – Long run - Relationship between short run and long run costs, perfect competition – Monopoly-Monopolistic and Oligopolistic, Determination of market price, Price discrimination

UNIT – II	**ELECTRICITY PRICE**	**9 Periods**

Price volatility, ancillary services in electricity power market, automatic generation control and its pricing, Generation assets valuation and risk analysis. -Introduction, VAR for Generation Asset Valuation, Generation Capacity Valuation.

UNIT – III	**TRANSMISSION CONGESTION MANAGEMENT AND PRICING**	**9 Periods**

Transmission cost allocation methods, LMP, FTR and Congestion Management. Role of FACTS devices in competitive power market, Available Transfer Capability, Distributed Generation in restructured markets.

UNIT – IV	**REACTIVE POWER MARKET MANAGEMENT**	**9 Periods**

Reactive power requirements under steady state voltage stability and dynamic voltage stability, reactive power requirements to cover transient voltage stability, System losses and loss reduction methods, Power tariffs and Market Forces shaping of reactive power, reactive power requirement of the utilities.

UNIT – V	**GENERATION SYSTEM CHARACTERISTICS, COST & RELIABILITY ANALYSIS**	**9 Periods**

Characteristic operation of power plants - Choice of power plants - Hydro, Thermal and Nuclear - Size of plant – Input / Output curves. Economic Planning - Generation system - Cost analysis - Capacity cost -Production cost - Plant cost - Timing of unit additions - System cost analysis. Load forecasting and system reliability: Load forecasting - Generation system reliability - Co-ordination methods - Economic operation of power systems - Simple problems.

Contact Periods:

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

REFERENCES

1	*KirchmayerL.K., **"Economic Operation of Power System**", John Wiley, New York, vol.II, 1958.*
2	*RR Barathwal- Professor IIT Kanpur, "**Industrial Economics-an Introductory text book**"*
3	*S.K.Jain,"**Applied economics for Engineers and Managers**", Vikas Publishing House.*
4	*Turner,Wayne.C."**Energy Management**", Hand Book., 2nd Edition.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Elaborate the principles of power system economics	K5
CO2	Know market/managerial economic aspects	K1
CO3	Understand the social efficiency concepts.	K2
CO4	Analyze power systems with application of economics considerations.	K4
CO5	Assess electric power system for socio-economic standpoint.	K6

Course Articulation Matrix				
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**
CO1	2	-	3	1
CO2	3	-	3	1
CO3	2	-	3	1
CO4	2	-	3	1
CO5	3	-	3	2
23PSPE03	2	-	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%	20%	20%	10%	20%	-	100%
CAT2	20%	20%	20%	20%	30%	-	100%
Individual Assessment1/ Case study1/ Seminar 1/Project1	30%	20%	-	20%	10%	20%	100%
Individual Assessment2/ Case study2/ Seminar 2 /Project2	20%	20%	-	20%	20%	20%	100%
ESE	30%	20%	30%	10%	10%	-	100%

23PSPE04	POWER SYSTEM PLANNING AND RELIABILITY	SEMESTER II

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

Course Objectives	To teach the concepts of load forecasting, short term and long term planning and methodology of reactive power planning	
UNIT – I	**LOAD FORECASTING**	**9 Periods**
Objectives of forecasting - Load growth patterns and their importance in planning – Load forecasting Based on discounted multiple regression technique-Weather sensitive load forecasting-Determination of annual forecasting-Use of AI in load forecasting.		
UNIT – II	**GENERATION SYSTEM RELIABILITY ANALYSIS**	**9 Periods**
Probabilistic generation and load models- Determination of LOLP and expected value of demand not served –Determination of reliability of isolated and interconnected generation systems.		
UNIT – III	**TRANSMISSION SYSTEM RELIABILITY ANALYSIS**	**9 Periods**
Deterministic contingency analysis- Probabilistic load flow-Fuzzy load flow probabilistic transmission system reliability analysis-Determination of reliability indices like LOLP and expected value of demand not served.		
UNIT – IV	**EXPANSION PLANNING**	**9 Periods**
Basic concepts on expansion planning- Procedure followed for integrate transmission system planning, current practice in India - Capacitor placement problem in transmission system and radial distributions system.		
UNIT – V	**DISTRIBUTION SYSTEM PLANNING OVERVIEW**	**9 Periods**
Introduction, sub transmission lines and distribution substations-Design of primary and secondary systems- Distribution system protection and coordination of protective devices.		

Contact Periods:

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

REFERENCES

1	*Roy Billinton and Allan Ronald, "**Power System Reliability**" Gardon & Breach, Newyork, 1970.*
2	*Proceeding of work shop on "**Energy systems planning & manufacturing**", CI.*
3	*Sullivan R.L., "**Power System Planning**", Mc Graw Hill Inc., US 1997.*
4	*TuranGonen, "**Electric Power Distribution System Engineering**", Second Edition, CRC press, 2007.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Estimate the trend of power consumption by end users.	K1
CO2	Perform efficient short term planning of power systems	K5
CO3	Carry out long term planning of power systems.	K3
CO4	Apply suitable control techniques to meet the constraints of reactive power consumption.	K4
CO5	Know expansion and distribution system planning.	K2

Course Articulation Matrix				
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	2	2
CO2	3	-	2	1
CO3	2	-	3	2
CO4	3	-	3	1
CO5	3	-	1	2
23PSPE04	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%	10%	20%	-	100%
CAT2	20%	20%	10%	20%	30%	-	100%
Individual Assessment1 / Case study1/ Seminar 1/Project1	30%	30%	20%	10%	10%	-	100%
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20%	20%	20%	20%	20%	-	100%
ESE	30%	30%	20%	10%	10%	-	100%

23PSPE05	POWER SYSTEM SECURITY				SEMESTER II
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	PE	3	0	0	3

Course Objectives	To enhance the security of the power system through the study of various assessment techniques.

UNIT – I	**BASICS OF POWER SYSTEM SECURITY**	**9 Periods**

Basic concepts: Power system stability – Security-Observability and reliability, deregulation, factors affecting power system security, decomposition and multilevel approach, state estimation, system monitoring, security assessment, static and dynamic – Online and offline, security enhancement.

UNIT – II	**POWER SYSTEM STATE ESTIMATION**	**9 Periods**

Power system state estimation: DC and AC network, orthogonal decomposition algorithm, detection identification of bad measurements, network observability and pseudo measurements, application of power system state estimation, introduction to supervisory control and data acquisition.

UNIT – III	**SECURITY ASSESSMENT**	**9 Periods**

Power system security assessment: contingency analysis, network sensitivity factors, contingency selection, performance indices, security constrained optimisation, SCOPF, basis of evolutionary optimization techniques, preventive, emergency and restorative controls though non-linear programming (NLP) and linear programming (LP) methods.

UNIT – IV	**SECURITY IN DEREGULATED ENVIRONMENT**	**9 Periods**

Need and conditions for deregulation, electricity sector structure model, power wheeling transactions, congestion management methods, available transfer capability (ATC), system security in deregulation.

UNIT – V	**SECURITY ENHANCEMENT AND RECENT TECHNIQUES**	**9 Periods**

Correcting the generator dispatch by sensitivity methods, compensated factors, security constrained optimization, preventive, emergency and restorative control through LP Method. Voltage Security Assessment – Transient Security Assessment – Methods – Comparison.

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

REFERENCES

1	*Allen J. Wood, Bruce F. Wollenberg, Gerald B. Sheblé.,* ***"Power generation, Operation and Control"****, Third Edition, John Wiley and Sons, 2013.*
2	*P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan,* ***"Electrical Power Systems: Analysis, Security and Deregulation"****, Second Edition, PHI Learning Pvt. Ltd., 2017.*
3	*Wood, A.J. and Woolenberg,* ***"Power generation operation for security"****, John Wiley and sons, 1989.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explore the basics of power system security	K1
CO2	Develop the mathematical models for power system state estimation.	K3
CO3	Analyze the security assessment and enhancement of power system through appropriate technique	K4
CO4	Evaluate the different control techniques for secured operation of the power system	K5
CO5	Comprehend the recent techniques in power system security	K2

Course Articulation Matrix				
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**
CO1	1	-	2	2
CO2	3	-	3	2
CO3	3	-	3	3
CO4	3	-	3	3
CO5	2	-	2	1
23PSPE05	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	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%	25%	10%	25%	20%	-	100%

23PSPE06	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**
CO1	3	-	3	2
CO2	2	-	2	2
CO3	3	-	3	3
CO4	2	-	2	2
CO5	3	-	3	1
23PSPE06	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	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%

23PSPE07	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**
CO1	2	-	-	2
CO2	3	-	2	-
CO3	3	1	-	3
CO4	3	-	1	1
CO5	3	1	3	-
23PSPE07	3	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	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%

23PSPE08	HVDC AND FACTS (Common to PSE & 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**
CO1	1	-	-	-
CO2	2	1	1	1
CO3	3	-	3	-
CO4	-	1	-	2
CO5	1	-	2	3
23PSPE08	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	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%

23PSPE09	FEM MODELING OF HIGH VOLTAGE APPARATUS AND SYSTEMS		SEMESTER II			
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	3	0	0	3
Course Objectives	To acquire knowledge and skills about modelling of high voltage apparatus and systems using FEM					
UNIT – I	**GENERAL CONCEPT**					**8 Periods**
Introduction to Finite Element method – Discretisation - Advantages and disadvantages - History of development and applications - Recent trends.						
UNIT – II	**VARIATIONAL AND WEIGHTED RESIDUAL FORMULATION**					**10 Periods**
Boundary value problem - Approximate method of solution - Review of variational calculus - The Euler - Lagrange equation - Boundary conditions - Method of weighted residuals - Rayleigh Ritz and Galerkin methods of finite element formulations.						
UNIT – III	**GENERAL APPROACH TO FIELD ANALYSIS**					**9 Periods**
Problem definition - Field properties - Maxwell's equations in the Dynamic, Quasi-static and static cases - Static fields in unbounded regions- Continuity conditions of fields at a medium discontinuity.						
UNIT – IV	**ELEMENT SHAPE FUNCTIONS**					**8 Periods**
Parametric functions - Shape functions for 1-D, 2-D and 3-D simplex and complex elements - Asymmetric elements – Isoparametric element formulations.						
UNIT – V	**FIELD MODELING OF HIGH VOLTAGE APPARATUS**					**10 Periods**
Finite element formulation for interior and exterior problems - Static electric field and magnetic field problems - Eddy current problems - Field computation in high voltage apparatus - Electro thermal analysis - Transient field analysis.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*Charles W.Steels, "**Numerical Computation of Electric and Magnetic fields**", Van Nostrand Reinhold Company, New York, 2013.*
2	*G. Ramamurty, "**Applied Finite Element Analysis**", I K International Publishing House Pvt. Ltd, 2013.*
3	*Zienkiewicz.O.C.,"**The Finite Element Method**", Tata McGraw Hill Publishing Co., New Delhi, 2000.*
4	*Reddy.J.N., "**An Introduction to the Finite Element Method**", McGraw Hill Book Co., New York, 2006.*
5	*Matthew. N.O. Sadiku, S.V. Kulkarni, "**Elements of Electromagnetics**", Sixth Edition, Oxford University Press, Asian Edition 2015*
6	*Selected reference papers in IEEE Transactions and IEEE Proceedings.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire the knowledge of Finite Element Method and formation methods.	K2
CO2	Familiarize the use of field analysis and element shape functions for HV systems.	K1
CO3	Comprehend the concepts of finite element formulations	K2
CO4	Realize the field modelling techniques of High Voltage Apparatus.	K3
CO5	Analyze the HV apparatus using Finite Element Method	K3

Course Articulation Matrix				
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**
CO1	1	-	2	1
CO2	1	-	2	1
CO3	1	-	2	2
CO4	2	-	2	2
CO5	2	-	3	2
23PSPE09	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	30%	30%	40%	-	-	-	100%
CAT2	20%	20%	20%	40%	-	-	100%
Individual Assessment1 / Case study1/ Seminar 1/Project1	20%	30%	20%	20%	10%	-	100%
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20%	20%	20%	20%	20%	-	100%
ESE	20%	20%	20%	30%	10%	-	100%

23PSPE10	HIGH VOLTAGE AND INSULATION SYSTEMS		SEMESTER II			
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	3	0	0	3
Course Objectives	To familiarize students about high voltage materials and testing techniques					
UNIT – I	**INSULATING MATERIALS IN POWER SYSTEM**		**9 Periods**			
Review of insulating materials: Gases, Vacuum, liquids and solids - Characterization of insulation condition – Permittivity, capacitance, resistivity and insulation resistance, dielectric dissipation factors - Partial discharges sources, forms and effects - Ageing effects - Electrical breakdown and operating stresses - Standards relating to insulating materials. Application of Insulating Materials.						
UNIT – II	**BREAKDOWN MECHANISMS OF DIELECTRICS**		**9 Periods**			
Breakdown mechanisms of gases- Townsend Breakdown –Streamer Mechanism of Spark-Paschen's Law-Penning Effect-Corona discharge-Breakdown in Electronegative Gases. Breakdown mechanism in Solid Dielectrics-Intrinsic Breakdown -Electromechanical Breakdown - Breakdown due to Treeing and Tracking-Thermal Breakdown - Electrochemical Breakdown. Breakdown mechanisms of liquid: Suspended Solid Particle Mechanism and Cavity Breakdown- Breakdown in Vacuum						
UNIT – III	**GENERATION OF TEST SIGNALS AND MEASUREMENT**		**9 Periods**			
Generation of high voltage AC: cascaded transformers and series resonant circuit - Generation of high DC voltages: rectifier circuit, voltage multiplier circuit and Electrostatic Generator - Generation of impulse voltages and Currents: multistage impulse generator circuit and Impulse Current Generation. Measurement of high AC, DC and impulse voltages: voltage divider circuits, Electrostatic Voltmeter and Generating Voltmeter - Digital Storage Oscilloscope for impulse voltage and current measurements (Spectrum Analysis)						
UNIT – IV	**INSULATION TESTING OF ELECTRICAL EQUIPMENT**		**9 Periods**			
Necessity for high voltage testing - Testing of transformers - Bushings – Overhead line and substation insulators - Surge arresters – High voltage cables – Power Capacitors-Circuit breakers and isolators – IEC and Indian standards.						
UNIT – V	**NON-DESTRUCTIVE TESTING**		**9 Periods**			
Insulation resistance measurement - Measurement of tan delta and capacitance of dielectrics –Schering Bridge Method for Grounded Test Specimen– Measurement of Partial discharges - Bridge Circuit– Oscilloscope as PD Measuring Device - Testing of Transformer oil.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*Kuffel,E. and Zaengl, W.S, "**High Voltage Engineering Fundamentals"**, Pergamon Press Oxford, New York, 2013.*
2	*Naidu,M.S. and Kamaraju,V, "**High Voltage Engineering"**, Tata McGraw Hill,New Delhi,2009.*
3	*C.L.Wadwa,"**High Voltage Engineering Fundamentals"** ,New Age International Publishers, Second Edition, 2017*
4	*Gallagher,T.J., and Permain,A., "**High Voltage Measurement, Testing and Design"**, John Wiley Sons, New York, 1983.*
5	*IEC & IS Standards on HV testing: website: https://archive.org/details/gov.in*
6	*Adrianus, J.Dekker, "**Electrical Engineering Materials**", Prentice Hall of India, New Delhi, 2007.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire the knowledge of insulating materials and suggest suitable materials to power Apparatus.	K2
CO2	Comprehend the mechanism of breakdown in dielectric.	K2
CO3	Analyze the methods of generation of high voltages in power system	K3
CO4	Realize the different techniques for measuring the electrical quantities in power system	K3
CO5	Evaluate the condition of High voltage apparatus through appropriate testing method	K4

Course Articulation Matrix				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	1	-	2	2
CO2	1	-	2	2
CO3	2	-	3	3
CO4	2	-	3	3
CO5	2	-	3	3
23PSPE10	2	-	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	30%	30%	20%	20%	-	-	100%
CAT2	20%	20%	20%	40%	-	-	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%	30%	10%	-	100%

23PSPE11	BIG DATA ANALYTICS FOR POWER SYSTEMS				SEMESTER III
PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	PE	3	0	0	3
Course Objectives	To monitor, analyze, and optimize power system operations, leading to improved efficiency, enhancing grid reliability, Predictive Maintenance, Renewable Energy Integration, Demand Response, Regulatory Compliance and Cost Reduction through Big data analytics				
UNIT – I	**BIG DATA FROM POWER SYSTEMS**				**9 Periods**
Introduction – Harness the data from power systems: Holistic approach - Emerging Security and Data Privacy Challenges for Utilities - cognitive computing on big data Bottom of Form – frameworks for big data integration					
UNIT – II	**DATA ANALYTICS FOR POWER SYSTEMS-I**				**9 Periods**
Agile Machine Learning for Data Analytics in Power Systems- Unsupervised Learning Methods for Power System Data Analysis - Deep Learning for Power System Data Analysis					
UNIT – III	**DATA ANALYTICS FOR POWER SYSTEMS-II**				**9 Periods**
Compressive Sensing for Power System Data Analysis - Time-Series Classification Methods - Review and Applications to Power Systems Data, R Programming.					
UNIT – IV	**BIG DATA APPLICATIONS IN POWER SYSTEM**				**9 Periods**
Supervised Learning-Based Fault Location in Power Grids - Data-Driven Voltage Unbalance Analysis in Power Distribution Networks - Predictive Analytics for Comprehensive Energy Systems State Estimation					
UNIT – V	**DATA ANALYTICS IN ENERGY MARKETING**				**9 Periods**
Data Analytics for Energy Disaggregation: Methods and Applications - Energy Disaggregation and the Utility-Privacy Tradeoff					
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**					

REFERENCES

1	*Reza Arghandeh, Yuxun Zhou, **"Big Data Application in Power Systems"**, Elsevier Science, 2017, ISBN 10: 0128119683*
2	*Ali Tajer, Samir M. Perlaza ,H. Vincent Poor **"Advanced Data Analytics for Power Systems"**, Cambridge University Press, 2021, ISBN 10:1108494757*
3	*Hasmat Malik, Md. Waseem Ahmad, D.P. Kothari, **"Intelligent Data Analytics for Power and Energy Systems ",** Springer, 2022, ISBN 10: 9811660808*
4	*Ahmed F. Zobaa, Trevor J. Bihl, **"Big Data Analytics in Future Power Systems"**, CRC Press, 2018, ISBN:9781351601283, 1351601288*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the fundamentals of big data analytics and its applications in power systems and the concepts of data pre-processing and cleaning of power system data	K1
CO2	Learn the basics of power systems, including power generation, transmission, and distribution.	K2
CO3	Explore different types of data sources available in power systems and their characteristics.	K6
CO4	Evaluate critical thinking and problem-solving skills in the context of big data analytics for power systems.	K5
CO5	Realize the ethical and legal considerations related to the collection, storage, and use of power system data.	K6

Course Articulation Matrix				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	3	2
CO2	3	-	2	2
CO3	3	-	3	2
CO4	3	-	3	2
CO5	3	-	3	2
23PSPE11	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	20%	20%	20%	20%	20%	-	100%
Individual Assessment 1/ Case study1/ Seminar 1/Project1	30%	30%	20%	20%	-	-	100%
Individual Assessment 2/ Case study2/ Seminar 2 /Project2	20%	20%	20%	20%	20%	-	100%
ESE	20%	20%	20%	20%	20%	-	100%

23PSPE12	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 CONTROLLERS**					**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**
CO1	3	-	2	2
CO2	3	-	3	2
CO3	3	-	3	3
CO4	3	-	3	2
CO5	3	-	2	2
23PSPE12	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%	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%

23PSPE13	COMPUTER RELAYING AND WIDE AREA MEASUREMENT SYSTEM		SEMESTER II			
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	3	0	0	3
Course Objectives	To interpret the operating principles of a computer relays and wide area measurement systems, articulate the computer hierarchy in the substation, system relaying and control and update the power grids with the state-of-art technologies					
UNIT – I	**INTRODUCTION**					**9 Periods**
Historical background - Expected benefits - Computer relay architecture - Analog to digital converters - Anti-aliasing filters - Substation computer hierarchy - Fourier series Exponential fourier series - Sine and cosine fourier series – Phasor.						
UNIT – II	**FILTERS IN COMPUTER RELAYING**					**9 Periods**
Walsh functions - Fourier transforms - Discrete fourier transform - Random processes - Filtering of random processes - Kalman filtering - Digital filters - Windows and windowing - Linear phase Approximation - Filter synthesis – Wavelets - Elements of artificial intelligence.						
UNIT – III	**REPRESENTATION OF PHASORS**					**9 Periods**
Introduction - Phasor representation of sinusoids - Fourier series and Fourier transform and DFT Phasor representation - Phasor Estimation of Nominal Frequency Signals - Formulas for updating phasors - Nonrecursive updates - Recursive updates - Frequency Estimation.						
UNIT – IV	**PHASOR MEASUREMENT UNITS**					**9 Periods**
A generic PMU - The global positioning system - Hierarchy for phasor measurement systems - Functional requirements of PMUs and PDCs - Transient Response of: Phasor Measurement Units, of instrument transformers, filters. Transient response during electromagnetic transients and power swings, Optimal number of PMUs in the grid, WAMPAC.						
UNIT – V	**PHASOR MEASUREMENT APPLICATIONS**					**9 Periods**
State Estimation - History, Operator's load flow - Weighted least square: least square, Linear weighted least squares, Nonlinear weighted least squares - Static state estimation - State estimation with Phasors measurements - Linear state estimation – Protection system with phasor inputs: Differential and distance protection of transmission lines - Adaptive protection - Adaptive out-of-step protection.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

REFERENCES

1	*A.G. Phadke, J.S. Thorp,* ***"Computer Relaying for Power Systems"****, John Wiley and Sons Ltd., Research Studies Press Limited, 2nd Edition, 2009.*
2	*A.G. Phadke, J.S. Thorp,* ***"Synchronized Phasor Measurements and Their Applications"****, Springer*
3	*Antonello Monti, Carlo Muscas, Ferdinanda Ponci,****"Phasor Measurement Units and Wide Area Monitoring Systems"****, Academic Press, 09-Jun-2016*
4	*Stanley H. Horowitz, Arun G. Phadke,* ***"Power System Relaying"****, John Wiley & Sons, 25- Oct-2013*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Demonstrate knowledge of fundamental theories, principles of relaying and measurement systems	K2
CO2	Practice computer relaying, Wide area measurement system	K3
CO3	Analyze the power system with computer relaying and Wide area measurement system	K4
CO4	Validate the recent relaying technologies which work towards smart grid	K5
CO5	Design wide area measurement systems for Smart grid.	K6

Course Articulation Matrix				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	2	-	2	-
CO2	3	-	2	-
CO3	3	-	2	2
CO4	3	-	3	2
CO5	-	-	-	-
23PSPE13	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%	40%	10%	10%	-	100%
CAT2	10%	30%	30%	20%	10%	-	100%
Individual Assessment1 / Case study1/ Seminar 1/Project1	10%	30%	30%	10%	20%	-	100%
Individual Assessment2 / Case study2/ Seminar 2 /Project2	-	30%	50%	20%	-	-	100%
ESE	10%	20%	40%	20%	10%	-	100%

23PSPE14	INTELLIGENT TECHNIQUES IN POWER SYSTEMS					SEMESTER II
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		PE	3	0	0	3
Course Objectives	To enhance the security of the power system through the study of various assessment techniques.					
UNIT – I	**INTRODUCTION AND EXPERT SYSTEMS**					**9 Periods**
Introduction to intelligent systems- Soft computing techniques- Conventional Computing versus Soft Computing - Classification of meta-heuristic techniques - Application domain - Discrete and continuous problems - Single objective and multi-objective problems Expert Systems : Concepts and theory - Knowledge representation techniques - Structure of a rule-based expert system - Forward and backward chaining inference techniques.						
UNIT – II	**ARTIFICIAL NEURAL NETWORKS AND ASSOCIATIVE MEMORY**					**9 Periods**
Artificial Neuron and its model- activation functions- Neural network architecture- single layer and multilayer feed forward networks- McCulloch Pitts neuron model- perceptron model- Adaline and Madaline- back propagation learning methods. Counter propagation network- architecture- functioning & characteristic - Hopfield/ Recurrent network configuration - stability constraints associative memory and characteristics- limitations and applications- Hopfield v/s Boltzman machine- Adaptive Resonance Theory- Architecture- classifications- Implementation and training - Associative Memory.						
UNIT – III	**FUZZY SYSTEMS**					**9 Periods**
Basic fuzzy set operation and approximate reasoning - Membership Functions and Fuzzy sets - Fuzzy rules - Fuzzy inference -Defuzzification methods- Building a fuzzy expert system. Fuzzy modeling and control schemes for nonlinear systems-. Self organizing fuzzy logic control						
UNIT – IV	**GENETIC ALGORITHM**					**9 Periods**
Concepts of Evolutionary computing - Genetic Algorithm (GA) versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- Various types of crossover and mutation operators –Application of GA to Optimization problems with discrete and continuous variables - Single objective and multi-objective problems						
UNIT – V	**HYBRID CONTROL TECHNIQUES AND APPLICATIONS**					**9 Periods**
Fuzzification and rule base using ANN–Neuro fuzzy systems-ANFIS – Fuzzy Neuron - Optimization of membership function and rule base using Genetic Algorithm –Overview of Support Vector Machine and Particle Swarm Optimization - Case study – Familiarization of NN, FLC and ANFIS solver.						
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**						

REFERENCES

1	*K.Y. Lee and M.A. El-Sharkawi, "**Modern Heuristic Optimization Techniques: Theory and Applications to Power Systems**", Wiley-IEEE Press, 2008.*
2	*S N Sivanandam., S N Deepa, "**Principles of Soft Computing**", Wiley India Pvt. Ltd., 2nd Ed., 2011*
3	*David E.Goldberg, "**Genetic Algorithms in Search, Optimization, and Machine Learning**", Pearson Education, 2009.*
4	*Zimmermann H.J. "**Fuzzy set theory and its Applications**" Springer international edition, 2011.*
5	*Timothy J. Ross, "**Fuzzy Logic with Engineering Applications**" Wiley India, 2008.*
6	*D.P.Kothari, " **Power system optimization**", PHI Learning Pvt. Ltd, 2010*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Familiarize the basic architectures of Neural Networks and Fuzzy sets	K1
CO2	Design and implement ANN architectures, algorithms and know their limitations.	K3
CO3	Analyze the different operations on fuzzy sets.	K4
CO4	Develop ANN and fuzzy logic based models and control schemes for non-linear systems.	K6
CO5	Explore the suitable hybrid intelligent techniques to real world problem	K2

Course Articulation Matrix				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	1	-	2	-
CO2	2	-	3	2
CO3	2	-	3	1
CO4	2	-	3	2
CO5	2	-	3	2
23PSPE14	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%	30%	20%	-	-	100%
CAT2	20%	20%	20%	20%	20%	-	100%
Individual Assessment1 / Case study1/ Seminar 1/Project1	20%	25%	20%	20%	15%	-	100%
Individual Assessment2 / Case study2/ Seminar 2 /Project2	20%	25%	20%	20%	15%	-	100%
ESE	20%	20%	20%	30%	10%	-	100%

23PSPE15	MODERN COMMUNICATION SYSTEMS FOR POWER SYSTEMS	SEMESTER II

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

Course Objectives	Understanding the importance and challenges of communication in modern power systems through familiarization with modern communication technologies, Learning about the architecture of communication systems, Exploring applications of modern communication systems and analyzing the impact of communication on power system performance

UNIT – I	STANDARDS AND COMMUNICATION SYSTEMS	9 Periods

Smart Grid Communication Standards - Communication for Substation Automation: IEC 61850, Communication for Telecontrol: IEC 60870-5, IEC 60870-6 Standards for Inter-Control Center Communications, IEC 60834 Standards for Teleprotection Equipment, IEC 61970 Standards for Energy Management Services Application Program Interface (EMS-API), IEC 61968—Application Integration at Electric Utilities—System Interfaces for Distribution Management Systems, IEC 62351 Standard for Cyber Security, IEEE 1815-2012 Standard for Electric Power Systems Communications- Distributed Network Protocol (DNP3). Smart Grid Communication Systems- Wired and wireless Communication Systems.

UNIT – II	5G COMMUNICATION SYSTEMS	9 Periods

Fundamentals and State of the Art, Challenges of 5G Networks and Some Potential Solution, Promising Key Technologies for 5G Networks , Massive Multiple-Input Multiple-Output (Massive MIMO) Technology, Beamforming Techniques for 5G Mobile Communication Systems, Channel Characteristics for 5G Mobile Communication Networks, Potential Application Areas of the 5G Networks, 5G Modulation Schemes.

UNIT – III	OPTICAL COMMUNICATIONS AND MODULATION TECHNIQUES IN 5G	9 Periods

Introduction, Optical Fiber Communications, Fiber Characteristics for Communications, Optical Modulation and Modulators, Multiplexing Technologies in Optical Fiber Telecommunications, Features of Optical Fiber Communications in 5G Networks, Key Technologies of 5G Optical Transmission Networks, Optical Wireless Communications in 5G, Modulation Technologies in 5G.

UNIT – IV	INTERNET OF THINGS ON POWER LINE COMMUNICATIONS	9 Periods

PLC Specifications and Regulations, Security Mechanisms in PLC, Evaluation Using PLC Modems as "Black Boxes", Evaluation on a Supervised Electrical Line, IoT and Artificial Intelligence.

UNIT – V	ADVANCED METERING INFRASTRUCTURES AND CYBER SECURITY	9 Periods

Advanced Metering Infrastructures- Introduction, AMI Communication Architectures and Requirements, Network Planning for AMI, Routing and Communication Reliability, Fault Tolerance and Redundancy. Cyber Security—Objectives and Requirements for Smart Grid, Attacks and countermeasures against Smart Grid, Assessing the Vulnerabilities Associated with Smart Grid Components and Their Potential Impact, Honeypots—Concept and Classification.

Contact Periods:

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

REFERENCES

1	*Ersan Kabalci, Yasin Kabalci,* ***"Smart Grids and Their Communication Systems"****, Springer- Energy Systems in Electrical Engineering, 2019.*
2	*Mohamamad Shahidehpour and Yaoyu Wang,* ***"Communication and Control in Electric Power Systems: Application of Parallel and Distributed Processing"****, IEEE Wiley Interscience, 2003.*
3	*Akhtar Kalam, D.P. Kothari,* ***"Power System Protection and Communication"****, New Age Science Lim, 2010.*
4	*Andrea M. Tonello, Lutz Lampe, Theo G. Swart,* ***"Power Line Communications-Principles, Standards and Applications from Multimedia to Smart Grid"****, Wiley, 2016.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understanding the fundamental concepts of communication systems in power systems, including communication protocols, architectures, and technologies.	K1
CO2	Analyzing the challenges of communication in power systems and developing strategies to mitigate these challenges.	K4
CO3	Familiarizing with the types of communication networks used in power systems, including wired, wireless, and hybrid networks, and their applications	K2
CO4	Developing skills to design and evaluate modern communication systems for power systems based on system requirements, performance criteria, and network topologies	K5
CO5	Exploring the role of communication systems in the integration of renewable energy sources into power grids and developing strategies for efficient energy management.	K2

Course Articulation Matrix				
COs/Pos	**PO1**	**PO2**	**PO3**	**PO4**
CO1	3	-	2	3
CO2	3	-	2	2
CO3	3	-	2	3
CO4	3	-	2	2
CO5	3	-	2	3
23PSPE15	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	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%

23PSPE16	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**
CO1	2	-	2	1
CO2	2	-	2	1
CO3	2	-	2	1
CO4	2	-	2	1
CO5	2	-	2	1
23PSPE16	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	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%

23PSPE17	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-Sitting 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 microgrid.

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**
CO1	3	-	-	3
CO2	3	-	3	-
CO3	3	-	3	-
CO4	3	-	3	-
CO5	3	-	3	3
23PSPE17	3	-	3	3
1 – Slight, 2 – Moderate, 3 – Substantial				

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Rememberin g (K1) %**	**Understandin g (K2) %**	**Applyin g (K3) %**	**Analyzin g (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%

23PSPE18	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 Method – 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**
CO1	2	-	2	1
CO2	2	-	2	1
CO3	2	1	2	1
CO4	2	1	2	1
CO5	2	1	2	1
23PSPE18	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	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%

23PSPE19	MODERN POWER ELECTRONICS FOR TRACTION APPLICATIONS (Common to PSE & PED)		SEMESTER II			
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 3rdedition 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**
CO1	2	1	1	2
CO2	-	-	1	2
CO3	2	-	-	3
CO4	3	-	-	3
CO5	2	1	3	2
23PSPE19	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	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 Assessment2/ Case study2/ Seminar 2 /Project2	-	20%	20%	30%	20%	10%	100%
ESE	10%	20%	30%	20%	20%	10%	100%

23PSPE20	POWER QUALITY ASSESSMENT AND MITIGATION (Common to PSE & PED)					SEMESTER II
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**
CO1	3	1	2	2
CO2	3	2	3	3
CO3	2	-	2	2
CO4	3	-	3	2
CO5	2	1	3	2
23PSPE20	3	1	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%	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 , Pharma Med 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	*Anand Rajaraman, 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: The Science 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 and responsibility 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: 0 Periods 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, 1stEdition, 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., New Jersey, 1995.*
3	*VolneiA. Pedroni,"**Circuit Design with VHDL**", PHILearning,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**"PrenticeHallofIndia,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"**, Addison Wesley, 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**", Springer, 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 domain.					
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 150ehavior 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 Swarupananda Advaita Ashram "**Srimad Bhagavad Gita**", Advaita Ashrama, Kolkata,2016*
2	*P.Gopinath, Rashtriya Sanskrit Sansthanam "**Bhartrihari's Three Satakam**" (Niti-sringar-vairagya), New Delhi, 1986.*
3	*Swami Mukundananda, Jagadguru Kripaluji Yog "**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