MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE
MADANAPALLE

(UGC-AUTONOMOUS)

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MASTER OF TECHNOLOGY

ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE
&
DETAILED SYLLABI
For the students admitted to

Master of Technology in Electrical Power Systems from the academic year 2018-19 Batches onwards

M. Tech Regular Two Year P. G. Degree Course

CURRICULUM STRUCTURE

I Year I Semester

Sl.No.	Course Code	Name of the Course	Credits
1	18EPSP101	Modern Power System Analysis	3
2	18EPSP102	Power System Dynamics - I	3
	Discipline Elective - I		
3	18EPSP401	Renewable Energy System	3
	18EPSP402	Smart grids	
	18EPSP403	High Power Converters	
	18EPSP404	Wind and Solar Systems	
	18EPSP405	Modern Control Theory	
	Discipline Elective - II		
4	18EPSP406	Electrical Power Distribution System	3
	18EPSP407	Mathematical Methods for Power Engineering	
	18EPSP408	Pulse Width Modulation for PE Converters	
	18EPSP409	Electric and Hybrid Vehicles	
	18EPSP410	HVDC Transmission Systems	
5	18EPSP201	Power System Steady State Analysis Laboratory	2
6	18EPSP202	Renewable Energy Laboratory	2
7	18RMP101	Research Methodology and IPR	2
		Audit Course - I	
8	18AUP901	Disaster Management	0
	18AUP902	Sanskrit for Technical Knowledge	
	18AUP903	Constitution of India	
	18AUP904	Pedagogy Studies	
		Total Credits	18

I Year II Semester

Sl.No.	Course Code	Name of the Course	Credits
1	18EPSP103	Digital Protection of Power System	3
2	18EPSP104	Power System Dynamics - II	3
	Discipline Elective - III		
3	18EPSP411	Restructured Power Systems	3
	18EPSP412	Advanced Digital Signal Processing	
	18EPSP413	Dynamics of Electrical Machines	
	18EPSP414	Power Apparatus Design	
	18EPSP415	Static VAr Compensation and Harmonic Filtering	
	Discipline Elective - IV		
4	18EPSP416	Advanced Micro-Controller Based Systems	3
	18EPSP417	SCADA System and Applications	
	18EPSP418	Power Quality	
	18EPSP419	Artificial Intelligence Techniques	
	18EPSP420	Operation and Control of Power System	
5	18EPSP203	Power System Protection Laboratory	2
6	18EPSP204	Smart Grid Laboratory	2
7	18EPSP701	Mini Project	2
		Audit Course - II	
8	18AUP905	English for Research Paper Writing	0
	18AUP906	Value Education	
	18AUP907	Stress Management by Yoga	
	18AUP908	Personality Development through Life Enlightment Skills	
		Total Credits	18

II Year I Semester

Sl.No.	Course Code	Name of the Course	Credits
	Discipline Elective - V		
1	18EPSP421	Power System Transients	3
	18EPSP422	FACTS and Custom Power Devices	
	18EPSP423	Industrial Load Modeling and Control	
	18EPSP424	Dynamics of Linear Systems	
	18EPSP425	Computer Relaying and Phasor Measurement Unit	
	Open Elective		
2	18OEP301	Business Analytics	3
	18OEP302	Industrial Safety	
	18OEP303	Operations Research	
	18OEP304	Cost Management of Engineering Projects	
	18OEP305	Composite Materials	
	18OEP306	Waste to Energy	
3	18EPSP702	Dissertation Phase I	10
		Total Credits	16

II Year II Semester

Sl.No.	Course Code	Name of the Course	Credits
1	18EPSP703	Dissertation Phase II	16
		Total Credits	16

M. Tech I Year I Semester

M. Tech I Year I Semester

18EPSP101 MODERN POWER SYSTEM ANALYSIS

L	T	P	C
3	0	0	3

Course Prerequisite: Power System Analysis

Course Description:

This course deals with concept of load flow analysis in a power system, various types of faults and its analysis, power system security concepts, state estimation algorithms and voltage instability phenomenon.

Course Objectives:

1. Study various methods of load flow and their advantages and disadvantages.
2. Understand how to analyze various types of faults in a power system.
3. Understand power system security concepts and to study the methods to rank thecontingencies.
4. Understand the need of state estimation and to study simple algorithms for state estimation.
5. Study the voltage instability phenomenon.

UNIT I: LOAD FLOW ANALYSIS

Load flow: Overview of Newton-Raphson, Gauss-Siedel, fast decoupled methods, convergence properties, sparsity techniques, handling Q-maxviolations in constant matrix, inclusion in frequency effects.

AVR in load flow, handling of discrete variable in load flow. **(9)**

UNIT II: FAULT ANALYSIS

Fault Analysis: Simultaneous faults, open conductors faults, generalized method of fault analysis. **(9)**

UNIT III: SECURITY ANALYSIS

Security Analysis: Security state diagram, contingency analysis, generator shift distribution factors, line outage distribution factor, multiple line outages, overload index ranking. **(9)**

UNIT IV: POWER SYSTEM EQUIVALENTS & STATE ESTIMATION

Power System Equivalents: WARD, REI equivalents.

State Estimation: Sources of errors in measurement, Virtual and Pseudo, Measurement, Observability, Tracking state estimation, WSL method, bad data correction. **(9)**

UNIT V: VOLTAGE STABILITY

Voltage Stability: Voltage collapse, P-V curve, multiple power flow solution, continuation power flow, optimal multiplies load flow, voltage collapse proximity indices. **(9)**

Course Outcomes:

Upon successful completion of the course, students will be able to

1. Calculate the voltage phasors at all buses using various methods of load flow.
2. Carryout fault analysis in a power system.
3. Rank various contingencies according to their severity.
4. Estimate the bus voltage phasors using the details like power flow, voltages, taps, CB status etc.
5. Estimate closeness to voltage collapse and calculate PV curves using continuation power flow.

Text/Reference Books:

1. J.J. Grainger &W.D.Stevenson, "Power system analysis", McGraw Hill ,2003
2. A. R. Bergen & Vijay Vittal, "Power System Analysis", Pearson, 2000
3. L.P. Singh, "Advanced Power System Analysis and Dynamics", New Age International, 2006
4. G.L. Kusic, "Computer aided power system analysis",Prentice Hall India, 1986
5. A.J. Wood, "Power generation, operation and control", John Wiley, 1994
6. P.M. Anderson, "Faulted power system analysis", IEEE Press, 1995

Mode of Evaluation: Assignment, Written Examination

M. Tech I Year I Semester

18EPSP102 POWER SYSTEM DYNAMICS-I

L	T	P	C
3	0	0	3

Course Prerequisite: Electrical Machines

Course Description:

This course deals with the system dynamics and mathematical modeling of a synchronous machine and an induction motor.

Course Objectives:

1. Study of system dynamics and its physical interpretation
2. Development of mathematical models for synchronous machine
3. Modeling of induction motor

UNIT I: BASIC MACHINE MODELING

Synchronous Machines: Per unit systems - Park's Transformation (modified) -Flux-linkage equations. **(9)**

UNIT II: SYNCHRONOUS MACHINE MODELING I

Voltage and current equations, Formulation of State-space equations, Equivalent circuit. **(9)**

UNIT III: SYNCHRONOUS MACHINE MODELING II

Sub-transient and transient inductance and Time constants, Simplified models of synchronous machines. **(9)**

UNIT IV: SMALL SIGNAL MODELING

Small signal model: Introduction to frequency model.

Excitation systems and Philips-Heffron model, PSS Load modeling. **(9)**

UNIT V: INDUCTION MOTOR MODELING

Modeling of Induction Motors - Prime mover controllers. **(9)**

Course Outcomes:

Upon successful completion of the course, students will be able to

1. Understand the modeling of synchronous machine.
2. Carry out simulation studies related to power system dynamics using MATLAB-SIMULINK or MIPOWER
3. Carry out stability analysis with and without power system stabilizer (PSS)
4. Understand the load modeling in power system

Text/Reference Books:

1. P. M. Anderson & A. A. Fouad "Power System Control and Stability", Galgotia, New Delhi, 1981.
2. J. Machowski, J Bialek & J. R W. Bumby, "Power System Dynamics and Stability", John Wiley & Sons, 1997.
3. Model Curriculum of Engineering & Technology PG Courses [Volume-I].
4. P. Kundur, "Power System Stability and Control", McGraw Hill Inc., 1994.
5. E.W. Kimbark, "Power system stability", Vol. I & III, John Wiley & Sons, New York 2002.

Mode of Evaluation: Assignment, Written Examination

DISCIPLINE ELECTIVE – I

M. Tech. I Year I Semester

18EPSP401 RENEWABLE ENERGY SYSTEM

L	T	P	C
3	0	0	3

Course Prerequisite: Power Systems, Power Electronics

Course Description:

This course deals with various renewable energy sources, integrated operation of renewable energy sources and the need of Power Electronics Interface with the Grid.

Course Objectives:

1. To learn about various renewable energy sources.
2. To understand the concept of integrated operation of renewable energy sources.
3. To understand the need of Power Electronics Interface with the Grid.

UNIT I: INTRODUCTION TO DISTRIBUTED GENERATION

Introduction, Distributed vs Central Station Generation- Sources of Energy such as Micro-Turbines-Internal Combustion Engines. **(7)**

UNIT II: DISTRIBUTED GENERATION (DG) AND ITS INSTALLATION

Introduction to Solar Energy, Wind Energy, Combined Heat and Power - Hydro Energy, Tidal Energy, Wave Energy, Geothermal Energy, Biomass and Fuel Cells. Concept of distributed generations, topologies, selection of sources, regulatory standards/framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547, DG installation classes, security issues in DG implementations. Energy storage elements: Batteries, ultra-capacitors, flywheels, Captive power plants. **(11)**

UNIT III: POWER QUALITY

Power Electronic Interface with the Grid- Impact of Distributed Generation/ NCE sources on the Power System, Power Quality Disturbances. Requirements for grid interconnection, limits on operational parameters, voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. **(9)**

UNIT IV: OPERATION - PROTECTION OF DISTRIBUTED GENERATORS

Transmission System Operation - Protection of Distributed Generators – requirement – fuses and section analyzers-over current - Under voltage and under frequency protection – coordination of protective device. **(9)**

UNIT V: ECONOMICS OF DISTRIBUTED GENERATION

Economics and control aspects of Distributed Generation - Case Studies, Market facts, issues and challenges - Limitations of DGs. **(9)**

Course Outcomes:

Upon successful completion of the course, students will be able to

1. Understand the concept of renewable power generation.
2. Understand the working of distributed generation system in autonomous/grid connected modes.
3. Know the Impact of Distributed Generation on Power System.

Text/Reference Books:

1. Ranjan Rakesh, Kothari D.P, Singal K.C, "Renewable Energy Sources and Emerging Technologies",2nd Ed. Prentice Hall of India ,2011.
2. Math H. Bollen, Fainan Hassan, "Integration of Distributed Generation in the Power System", July2011, Wiley –IEEE Press.
3. Loi Lei Lai, Tze Fun Chan, "Distributed Generation: Induction and Permanent Magnet Generators",October 2007, Wiley-IEEE Press.
4. Roger A. Messenger, Jerry Ventre, "Photovoltaic System Engineering", 3rd Ed, 2010.
5. James F. Manwell, Jon G. Mc Gowan, Anthony L Rogers, "Wind energy explained: Theory Design and Application", John Wiley and Sons 2nd Ed, 2010.
6. Chetan Singh Solanki, "Solar Photo Voltaics", PHI learning Pvt. Ltd., New Delhi, 2009.
7. J.F. Manwell, "Wind Energy Explained, theory design and applications," J.G. McGowan Wiley publication, 2002.
8. D. D. Hall and R. P. Grover, "Biomass Regenerable Energy", John Wiley, New York, 1987.
9. John Twidell and Tony Weir, "Renewable Energy Resources" Taylor and Francis Publications, 2005.

Mode of Evaluation: Assignment, Written Examination

M. Tech. I Year I Semester

18EPSP402 SMART GRIDS

L	T	P	C
3	0	0	3

Course Prerequisite: Power Systems

Course Description:

This course deals with concept of smart grid, smart metering techniques, wide area measurement techniques, integration of distributed generation & its solution through smart grid.

Course Objectives:

1. Understand concept of smart grid and its advantages over conventional grid
2. Know smart metering techniques
3. Learn wide area measurement techniques
4. Understanding the problems associated with integration of distributed generation & its solution through smart grid.

UNIT I: SMART GRID

Introduction to Smart Grid, Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Concept of Robust & Self Healing Grid Present development & International policies in Smart Grid. **(9)**

UNIT II: SMART METERING

Introduction to Smart Meters, Real Time Prizing, Smart Appliances, Automatic Meter Reading(AMR), Outage Management System(OMS), Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation Smart Substations, Substation Automation, Feeder Automation. **(9)**

UNIT III: SMART STORAGE AND WIDE AREA MEASUREMENTS

Geographic Information System(GIS), Intelligent Electronic Devices(IED) & their application for monitoring & protection, Smart storage like Battery, SMES, Pumped Hydro, Compressed Air Energy Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU). **(9)**

UNIT IV: MICRO-GRID

Concept of micro-grid, need & applications of micro-grid, formation of micro-grid, Issues of interconnection, protection & control of micro-grid, Plastic & Organic solar cells, Thin film solar cells, Variable speed wind generators, fuel-cells, micro-turbines Captive power plants, Integration of renewable energy sources. **(9)**

UNIT V: POWER QUALITY

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit, Advanced Metering Infrastructure (AMI), Basics of CLOUD Computing & Cyber Security for Smart Grid. **(9)**

Course Outcomes:

Upon successful completion of the course, students will be able to

1. Appreciate the difference between smart grid & conventional grid
2. Apply smart metering concepts to industrial and commercial installations
3. Formulate solutions in the areas of smart substations, distributed generation and wide area measurements.
4. Come up with smart grid solutions using modern communication technologies.

Text/Reference Books:

1. Ali Keyhani, "Design of smart power grid renewable energy systems", Wiley IEEE, 2011
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response, CRC Press , 2009
3. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, "Smart Grid: Technology and Applications", Wiley 2012
4. Stuart Borlase, "Smart Grid: Infrastructure, Technology and solutions", CRC Press
5. A.G. Phadke, "Synchronized Phasor Measurement and their Applications", Springer

Mode of Evaluation: Assignment, Written Examination

M. Tech. I Year I Semester

18EPSP403 HIGH POWER CONVERTERS

L	T	P	C
3	0	0	3

Course Prerequisite: Power Electronics

Course Description:

This course provides understanding about the requirements of high power converters, operation of semiconductor devices and its characteristics, and provides idea to design protection circuits for these converters.

Course Objectives:

1. Understand the requirements of high power rated converters
2. To learn the operation of semiconductor devices and its characteristics.
3. Able to understand the design of protection circuits for these converters.

UNIT I: POWER ELECTRONIC SYSTEMS

Power electronic systems, an overview of PSDs, multipulse diode rectifier, multipulse, SCR rectifier. **(8)**

UNIT II: MULTILEVEL INVERTERS

Phase shifting transformers, multilevel voltage source inverters: two level voltage source inverter, cascaded, H bridge multilevel inverter, Diode clamped multilevel inverters, flying capacitor multilevel inverter. **(10)**

UNIT III: SWITCH MODE CONVERTERS

DC to DC switch mode converters - Buck converter, boost converter, buck - boost converter, averaged circuit modeling, input-output equations, ripple calculations, filter design, case studies, PWM current source inverters. **(9)**

UNIT IV: AC VOLTAGE CONTROLLERS

AC voltage controllers: single phase and three phase circuits employing Phase angle control, on-off control, case studies. Cyclo-converters, matrix converter, Power conditioners and UPS. **(10)**

UNIT V: DESIGN AND PROTECTION OF CONVERTERS

Design aspects of converters, protection of devices and circuits - heat sink design, snubber design drive and protection circuits, commutation circuits, Soft switching. **(9)**

Course Outcomes: -

Students will be able to:

1. Learn the characteristics of PSDs such as SCRs, GTOs, IGBTs and use them in practical systems
2. Knowledge of working of multi-level VSIs, DC-DC switched mode converters, cyclo-converters and PWM techniques and the ability to use them properly.
3. Acquire knowledge of power conditioners and their applications.
4. Ability to design power circuit and protection circuit of PSDs and converters

Text/Reference Books

1. N. Mohan, T. M. Undeland and W. P. Robbins, "Power Electronics: Converter, Applications and Design", John Wiley and Sons, 1989
2. M.H. Rashid, "Power Electronics", Prentice Hall of India, 1994
3. B. K. Bose, "Power Electronics and A.C. Drives", Prentice Hall, 1986
4. Bin Wu, "High power converters and drives", IEEE press, Wiley Enter science
5. Singh M.D., Khanchandani K. B., 'Power Electronics', Tata McGraw-Hill, 2nd Edition, 2008.
6. Umanand L., 'Power Electronics: Essentials & Applications', Wiley India

Mode of Evaluation: Assignment, Written Examination

M. Tech. I Year I Semester

18EPSP404 WIND AND SOLAR SYSTEMS

Course Prerequisite: Electrical Machines, Power Systems

L	T	P	C
3	0	0	3

Course Description:

This course is designed to obtain thorough knowledge on wind and solar systems and to understand the factors involved in installation and commissioning of a Solar or Wind plant. Also to understand the dynamics involved when interconnected with power system grid.

Course Objectives:

1. To get exposure to wind and solar systems
2. To understand the factors involved in installation and commissioning of a Solar or Wind plant.
3. Learning the dynamics involved when interconnected with power system grid.

UNIT I: WIND POWER GENERATION

Historical development and current status, Characteristics of wind power generation, network integration issues. **(9)**

UNIT II: WIND GENERATORS AND INTERCONNECTION STANDARDS

Generators and power electronics for wind turbines, power quality standards for wind turbines, Technical regulations for interconnections of wind farm and PV systems with power systems. **(9)**

UNIT III: REACTIVE POWER AND VOLTAGE CONTROL IN WIND SYSTEMS

Isolated wind systems, reactive power and voltage control, economic aspects. **(9)**

UNIT IV: SOLAR POWER GENERATION

Solar thermal power generation, PV power generation, Energy Storage device, Designing the solar system for small installations. **(9)**

UNITV: SOLAR SYSTEMS

Introduction of solar systems, merits and demerits, concentrators, various applications. **(9)**

Course Outcomes: -

Students will be able to:

1. Appreciate the importance of energy growth of the power generation from the renewable energy sources and participate in solving these problems

2. Demonstrate the knowledge of the physics of wind power and solar power generation and all associated issues so as to solve practical problems
3. Demonstrate the knowledge of physics of solar power generation and the associated issues
4. Identify, formulate and solve the problems of energy crises using wind and solar energy

Text/Reference Books:

1. Thomas Ackermann, Editor, “Wind power in Power Systems”, John Willy and sons ltd.2005
2. Siegfried Heier, “Grid integration of wind energy conversion systems”, John Willy and sons ltd., 2006
3. K. Sukhatme and S.P. Sukhatme, “Solar Energy”. Tata Mac Graw Hill, Second Edition, 1996

Mode of Evaluation: Assignment, Written Examination

M. Tech. I Year I Semester

18EPSP405 MODERN CONTROL THEORY

L	T	P	C
3	0	0	3

Course Prerequisite: Control Systems

Course Description:

This course is designed to provide knowledge in modern control theory. Course covers state space analysis, controllability, observability, non-linear systems, Lyapunov stability and optimal control of engineering problems.

Course Objectives:

1. To educate on system modeling and analysis in state space domain.
2. To educate on design of observers and system testing conditions.
3. To illustrate the controller design and effect of system parameters changes.
4. To educate on nonlinear system studies.
5. To educate on places where system theory concepts may be employed.

UNIT I: STATE SPACE ANALYSIS

State space representation of systems – solution to time-varying state equations – evaluation of state transition matrix (STM) – similarity transformation – minimal realization of SISO, SIMO and MISO transfer functions – discretization of a continuous time state space model. **(9)**

UNIT II: CONTROLLABILITY & OBSERVABILITY

Jordan canonical form and controllable canonical form – observable canonical form – controllability & observability test – pole assignment by state feedback using different techniques- Design of full order & reduced order observer. **(9)**

UNIT III: STATE FEEDBACK

Linear Quadratic Regulator (LQR) design – analysis of algebraic Riccati equation using Eigen value and Eigen vector methods, iterative method – controller design using output feedback – model decomposition and decoupling by state feedback – disturbance rejection, sensitivity and complementary sensitivity functions. **(9)**

UNIT IV: NON-LINEAR SYSTEMS

Introduction to non-linear system – describing function – stability analysis using describing function and phase plane analysis – Lyaponov stability analysis – Popov's stability analysis. **(9)**

UNIT V: CONTROL THEORY IN POWER SYSTEMS

Case study: Real time estimation of the state of a power system – design of stabilizing controllers of power system using pole assignment technique – adaptive nonlinear compensators for power plant control – adaptive multivariable control of a power plant boiler. **(9)**

Course Outcomes: -

Students will be able to:

1. Analyze the system behavior in state space model
2. Investigate the controllability and observability of LTI system
3. Design a controller for linear systems
4. analyze system stability condition in presence of nonlinearities
5. Use The system theory concepts in electrical power system applications

Text Books:

1. M. Gopal, Modern control systems theory, New Age International (p)Limited, Publishers.
2. Frederick Walker Fairman, Linear Control Theory – The state space approach, John Wiley & Sons Ltd., England, 1998.
3. T. Kailath, T., Linear Systems, Perntice Hall, Englewood Cliffs, NJ, 1980.
4. K. Ogata, Modern Control Engineering, Prentice Hall, India 1997.

Reference Books:

1. Panos J Antsaklis, and Anthony N. Michel, Linear Systems, New - age international (P) Ltd. Publishers, 2009.
2. John J DAzzo and C. H. Houpis , "Linear Control System Analysis and Design Conventional and Modern", McGraw - Hill Book Company, 1988.
3. B.N. Dutta, Numerical Methods for linear Control Systems - , Elsevier Publication, 2007.
4. C. T. Chen Linear System Theory and Design - PHI, India.
5. Richard C. Dorf and Robert H. Bishop, Modern Control Systems, 11th Edition, Pearson Edu, India, 2009.
5. Automatic control in power generation, distribution and protection, proceedings of the IFAC symposium, Pretoria, 1980, ISBN: 0-08-026709-2

Mode of Evaluation: Assignment, Written Examination

DISCIPLINE ELECTIVE – II

M. Tech. I Year I Semester

18EPSP406 ELECTRIC POWER DISTRIBUTION SYSTEM

L	T	P	C
3	0	0	3

Course Prerequisite: Power Systems

Course Description:

This course facilitates the students with the fundamentals of power distribution system, SCADA System and Distribution Automation

Course Objectives:

1. Learning about power distribution system
2. Learning of SCADA System
3. Understanding Distribution Automation

UNIT I: POWER DISTRIBUTION AND LOAD FORECASTING

Distribution of Power, Management, Power Loads, Load Forecasting Short-term & Long-term, Power System Loading, Technological Forecasting. **(9)**

UNIT II: DISTRIBUTION AUTOMATION

Advantages of Distribution Management System (D.M.S.) Distribution Automation: Definition, Restoration / Reconfiguration of Distribution Network, Different Methods and Constraints, Power Factor Correction. **(9)**

UNIT III: INTERCONNECTION OF DISTRIBUTION SYSTEMS AND METERING

Interconnection of Distribution, Control & Communication Systems, Remote Metering, Automatic Meter Reading and its implementation. **(9)**

UNIT IV: SCADA

SCADA: Introduction, Block Diagram, SCADA Applied to Distribution Automation, Common Functions of SCADA, Advantages of Distribution Automation through SCADA. **(9)**

UNIT V: DISTRIBUTION AUTOMATION

Calculation of Optimum Number of Switches, Capacitors, Optimum Switching Device Placement in Radial, Distribution Systems, Sectionalizing Switches –Types, Benefits, Bellman's Optimality Principle, Remote Terminal Units, Automation in Actual Practice, Urban/Rural Distribution, Energy Management, AI techniques applied to Distribution Automation. **(9)**

Course Outcomes:-

Students will be able to:

1. Knowledge of power distribution system
2. Study of Distribution automation and its application in practice
3. To learn SCADA system

Text/Reference Books:

1. A.S. Pabla, “Electric Power Distribution”, Tata McGraw Hill Publishing Co. Ltd., Fourth Edition.
2. M. K. Khedkar, G.M. Dhole, “A Text Book of Electrical power Distribution Automation”, University Science Press, New Delhi
3. Anthony J Panseni, “Electrical Distribution Engineering”, CRC Press
4. James Momoh, “Electric Power Distribution, automation, protection & control”, CRC Press

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech I Year I Semester

18EPSP407 MATHEMATICAL METHODS FOR POWER ENGINEERING

L	T	P	C
3	0	0	3

Course Prerequisite: Power Systems

Course Description:

This course facilitates the students with the mathematical methods to solve and apply engineering problems.

Course Objectives:

1. To understand the relevance of mathematical methods to solve engineering problems.
2. To understand how to apply these methods for a given engineering problem.

UNIT I: VECTOR SPACES AND LINEAR TRANSFORMATIONS

Vector spaces, linear transformations, Matrix representation of linear transformation. Eigen values and Eigen vectors of linear operator. **(9)**

UNIT II: LINEAR AND NONLINEAR PROGRAMMING

Linear Programming Problems, Simplex Method, Duality, Non Linear Programming problems. **(9)**

UNIT III: CONSTRAINED AND UNCONSTRAINED PROBLEMS

Unconstrained Problems, Search methods, Constrained Problems. **(9)**

UNIT IV: OPTIMIZATION TECHNIQUES I

Lagrange method, Kuhn-Tucker conditions, Random Variables, Distributions. **(9)**

UNIT V: OPTIMIZATION TECHNIQUES II

Independent Random Variables, Marginal and Conditional distributions, Elements of stochastic processes. **(9)**

Course Outcomes: -

Students will be able to:

1. Knowledge about vector spaces, linear transformation, eigenvalues and eigenvectors of linear operators.
2. To learn about linear programming problems and understanding the simplex method for solving linear programming problems in various fields of science and technology.
3. Acquire knowledge about nonlinear programming and various techniques used for solving constrained and unconstrained nonlinear programming problems.
4. Understanding the concept of random variables, functions of random variable and their probability distribution.

5. Understand stochastic processes and their classification.

Text/Reference Books:

1. Kenneth Hoffman and Ray Kunze, “Linear Algebra”, 2nd Edition, PHI, 1992.
2. Erwin Kreyszig, “Introductory Functional Analysis with Applications”, John Wiley & Sons, 2004.
3. Irwin Miller and Marylees Miller, John E. Freund’s “Mathematical Statistics”, 6th Edn, PHI, 2002.
4. J. Medhi, “Stochastic Processes”, New Age International, New Delhi., 1994.
5. A Papoulis, “Probability, Random Variables and Stochastic Processes”, 3rd Edition, McGraw Hill, 2002.
6. John B Thomas, “An Introduction to Applied Probability and Random Processes”, John Wiley, 2000.
7. Hillier F S and Liebermann G J, “Introduction to Operations Research”, 7th Edition, McGraw Hill, 2001.
8. Simmons D M, “Non Linear Programming for Operations Research”, PHI, 1975.

Mode of Evaluation: Assignment, Written Examination

M. Tech I Year I Semester

18EPSP408 PULSE WIDTH MODULATION FOR PE CONVERTER

Course Prerequisite: Power Electronics

L	T	P	C
3	0	0	3

Course Description:

This course facilitates the students with the necessity of PWM techniques and controllers

Course Objectives:

1. To understand Necessity and Importance of PWM techniques
2. Implementation of PWM controllers

UNIT I: PE CONVERTERS

Introduction to PE converters, Modulation of one inverter phase leg, Modulation of single phase VSI - Voltage control of single phase inverters - sinusoidal PWM – modified PWM –phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation, Modulation of 3 phase VSI -Voltage Control of Three-Phase Inverters- Sinusoidal PWM-Third Harmonic PWM. **(10)**

UNIT II: SPACE VECTOR MODULATION STRATEGIES, MODULATION OF CSI

Space Vector Modulation- Zero space vector placement modulation strategies, Losses-Discontinuous modulation, modulation of CSI. **(9)**

UNIT III: MODULATION OF CONVERTERS

Over modulation of converters, programmed modulation strategies. **(8)**

UNIT IV: MULTILEVEL INVERTERS

Introduction, Multilevel Concept, Types of Multilevel Inverters- Diode-Clamped Multilevel Inverter, Principle of Operation, Features of Diode-Clamped Inverter, Improved Diode-Clamped Inverter- Flying- Capacitors Multilevel Inverter- Principle of Operation, Features of Flying-Capacitors Inverter- Cascaded Multilevel Inverter- Principle of Operation- Features of Cascaded Inverter- Pulse width modulation for multilevel inverters, Implementation of modulation controller. **(10)**

UNIT V: PWM MODULATION

Continuing developments in modulation as random PWM, PWM for voltage unbalance. Effect of minimum pulse width and dead time. **(8)**

Course Outcomes: -

Students will be able to:

1. Appreciate importance of PWM techniques
2. Implement PWM using different strategies
3. Control CSI and VSI using PWM
4. Compare performance of converter for different PWM techniques

Text/Reference Books:

1. D. Grahame Holmes, Thomas A. Lipo, “Pulse width modulation of Power Converter: Principles and Practice”, John Wiley & Sons, 03-Oct-2003
2. Bin Vew, “High Power Converter”, Wiley Publication
3. Marian K. Kazimicrczuk, “Pulse width modulated dc-dc power converter”, Wiley Publication

Mode of Evaluation: Assignment, Written Examination

M. Tech I Year I Semester

18EPSP409 ELECTRIC AND HYBRID VEHICLES

L	T	P	C
3	0	0	3

Course Prerequisite: Power Electronics, Electric Drives and Control

Course Description: This subject aims to study electric and Hybrid Vehicles and design of storage and Energy Management Strategies

Course Objectives:

1. To study the power flow of electric and hybrid vehicles and control in Hybrid Vehicles
2. To study the operation and control of electric train
3. To study energy storage and energy management strategies

UNIT I: HYBRID AND ELECTRIC VEHICLES

History of hybrid and electric vehicles, Social and environmental importance of hybrid and electric vehicles, Impact of modern drive-trains on energy supplies, Basics of vehicle performance, vehicle power source characterization Transmission characteristics, Mathematical models to describe vehicle performance. **(9)**

UNIT II: CONCEPT OF HYBRID TRACTION & DRIVE-TRAIN TOPOLOGIES

Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies, Power flow control in hybrid drive-train topologies, Fuel efficiency analysis, Review of Toyota Prius.

(9)

UNIT III: ELECTRIC TRAINS

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency. **(9)**

UNIT IV: ENERGY STORAGE Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems. **(9)**

UNIT V: ENERGY MANAGEMENT STRATEGIES

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV). **(9)**

Course Outcomes: At the end of this course, students will able to

1. Understand the models to describe hybrid vehicles and their performance.
2. Understand the Principles of Hybrid electrical drives
3. Understand the principles and control of Electric trains
4. Understand the different possible ways of energy storage.
5. Understand the different energy management strategies related to energy storage systems.

Text Books:

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016

Reference Books:

1. Electric and Hybrid Vehicles: Design Fundamentals, Iqbal Husain, 2nd Edition, CRC Press, 2011.
2. G. K. Dubey, "Power Semiconductor Controlled Drives", Prentice Hall, 1989.

Mode of Evaluation: Assignment, Written Examination

M. Tech I Year I Semester

18EPSP410 HVDC TRANSMISSION SYSTEMS

L	T	P	C
3	0	0	3

Course Prerequisite: Power Systems

Course Description:
This course deals with the advantages of dc transmission over ac transmission, control strategies used in HVdc transmission system to improve the power system stability.

Course Objectives:
1. To understand the advantages of dc transmission over ac transmission.
2. To understand the operation of Line Commutated Converters and Voltage Source Converters.
3. To understand the control strategies used in HVdc transmission system.
4. To understand the improvement of power system stability using an HVdc system.

UNIT I: DC TRANSMISSION TECHNOLOGY
Comparison of AC and dc Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission. Types of HVdc Systems. Components of a HVdc system. Line Commutated Converter and Voltage Source Converter based systems. **(6)**

UNIT II: ANALYSIS OF LINE COMMUTATED AND VOLTAGE SOURCE CONVERTERS
Line Commutated Converters (LCCs): Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters. Inverter Operation. Effect of Commutation Overlap. Expressions for average dc voltage, AC current and reactive power absorbed by the converters. Effect of Commutation Failure, Misfire and Current Extinction in LCC links.
Voltage Source Converters (VSCs): Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six pulse converter. Equations in the rotating frame. Real and Reactive power control using a VSC. **(10)**

UNIT III: CONTROL OF HVDC CONVERTERS
Principles of Link Control in a LCCHVdc system. Control Hierarchy, Firing Angle Controls – Phase-Locked Loop, Current and Extinction Angle Control, Starting and Stopping of a Link. Higher level Controllers Power control, Frequency Control, Stability Controllers.
Reactive Power Control. Principles of Link Control in a VSC HVdc system: Power flow and dc Voltage Control. Reactive Power Control / AC voltage regulation. **(10)**

UNIT IV: COMPONENTS OF HVDC SYSTEMS AND STABILITY ENHANCEMENT USING HVDC CONTROL
Smoothing Reactors, Reactive Power Sources and Filters in LCC HVdc systems DC line: Corona Effects. Insulators, Transient Over-voltages. dc line faults in LCC systems. dc line faults in VSC systems. dc breakers. Monopolar Operation. Ground Electrodes.
Basic Concepts: Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles – synchronous and asynchronous links. Voltage Stability Problem in AC/dc systems. **(12)**

UNIT V: MTDC LINKS

Multi-Terminal and Multi-Infeed Systems. Series and Parallel MTdc systems using LCCs. MTdc systems using VSCs. Modern Trends in HVdcTechnology. Introduction to Modular Multi-level Converters. **(7)**

Course Outcomes:

At the end of the course, students will able to

1. Understand the advantages of dc transmission over ac transmission.
2. Understand the operation of Line Commutated Converters and Voltage Source Converters.
3. Understand the control strategies used in HVdc transmission system.
4. Understand the improvement of power system stability using an HVdc system.

Text Books:

1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 2011.
2. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., 1983.
3. E. W. Kimbark, "Direct Current Transmission", Vol.1, Wiley-Interscience, 1971.

Mode of Evaluation: Assignment, Written Examination

M. Tech I Year I Semester

18EPSP201 POWER SYSTEM STEADY STATE ANALYSIS LABORATORY

L	T	P	C
0	0	4	2

Course Prerequisite: Power System Laboratory

Course Objectives:

1. To analyze various faults in power system.
2. To carry out the load flow analysis of a power system.
3. To carry out the transient Stability Studies.

LIST OF EXPERIMENTS

1. Fault Analysis-I
   i) LG Fault
   ii) LL Fault
2. Fault Analysis-II
   i) LLG Fault
   ii) LLLG Fault
3. Gauss Seidal load flow analysis using MATLAB Software
4. Newton Raphson method of load flow analysis using MATLAB Software.
5. Formation of Y bus matrix by inspection / analytical method using MATLAB Software.
6. Fast decoupled load flow analysis using MATLAB Software.
7. Load Forecasting and Unit Commitment.
8. Transient Stability Studies.

Course Outcome:

At the end of the course, students will able to

1. Analyze the various faults in power system.
2. Obtain the Y bus and Z bus matrix using MATLAB software.
3. Carryout the various load flow analysis using MATLAB software.

Mode of Evaluation: Practical, Written Examination

M. Tech I Year I Semester

18EPSP202 RENEWABLE ENERGY LABORATORY

L	T	P	C
0	0	4	2

Course Prerequisite: 18EPSP404

Course Objectives:

1. To learn the basic modeling of a wind generator using MATLAB software.
2. To understand the operation of a wind generator/wind farm.
3. To understand the basic modeling and operation of a Solar PV System using MATLAB.
4. To test the capabilities of Solar Panels and Wind Turbines under different operating conditions.

List of experiments

1. Modeling of a wind generator system using MATLAB software.
2. Obtain the Power Vs Wind Velocity Curve of a Wind Turbine.
3. Build a Wind Farm using wind generators MATLAB software.
4. The Effect of load onWind Turbine Output.
5. Modeling of a Solar PV System using MATLAB software.
6. Effect of Temperature on Solar Panel Output.
7. Variables Affecting Solar Panel Output.
8. Effect of Load on Solar Panel Output.
9. Test the Capabilities of Solar Panels and Wind Turbines under different operating conditions (irradiation; wind velocity, grid distortions etc.).
10. Test the Capabilities of the Hydrogen Fuel Cells and Capacitors.

Course Outcome:

At the end of the course, students will able to

1. Model a Wind Generator using MATLAB software.
2. Model a Solar PV System using MATLAB software.
3. Testing of Wind Generator and Solar PV System under various operating conditions.

Mode of Evaluation: Practical, Written Examination

M. Tech I Year I Semester

18RMP101 RESEARCH METHODOLOGY AND IPR

L	T	P	C
2	0	0	2

Course Prerequisite: None

Course Description:
This course provides the fundamental aspects of data collection, analysis, and interpretation of research problem. it also provides the effective way of paper writing, intellectual property rights and process of patenting.

Course Objectives:
1. To obtain solution for research problem, data collection and analysis.
2. To know effective paper writing
3. To know the patenting process
4. To know the new developments in IPR

UNIT I: INTRODUCTION
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations, Effective literature studies approaches, analysis Plagiarism, Research ethics. **(6)**

UNIT II: EFFECTIVE PAPER WRITING
Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee. **(6)**

UNIT III: 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. **(6)**

UNIT IV: PATENT RIGHTS:
Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. **(6)**

UNIT V: NEW DEVELOPMENTS IN IPR
Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs. **(6)**

Course Outcomes:
Upon successful completion of the course, students will be able to
1. Analyze research related information
2. Follow research ethics
3. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.

4. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Text Books:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

References:

1. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
3. Mayall , "Industrial Design", McGraw Hill, 1992.
4. Niebel , "Product Design", McGraw Hill, 1974.
5. Asimov, "Introduction to Design", Prentice Hall, 1962.

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

AUDIT COURSE - I

AUDIT COURSE - I

18AUP901 DISASTER MANAGEMENT

	L	T	P	C
Course Prerequisite: None	**2**	**0**	**0**	**0**

Course Objectives:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches,
5. Planning and programming in different countries, particularly their home country or the countries they work in

UNIT I: DISASTER CLASSIFICATION

Disaster: definition, factors and significance; difference between hazard and
Disaster; natural disaster: earthquakes, volcanisms, cyclones, tsunamis, floods, droughts and famines, landslides and avalanches; man-made disasters: nuclear reactor meltdown, industrial accidents, oil slicks and spills, outbreaks of disease and epidemics, war and conflicts. **(6)**

UNIT II: REPERCUSSIONS OF DISASTERS

Economic damage, loss of human and animal life, destruction of ecosystem.

DISASTER PRONE AREAS IN INDIA:

Study of seismic zones; areas prone to floods and droughts, landslides and Avalanches; areas prone to cyclonic and coastal hazards with special reference to tsunami. **(6)**

UNIT III: DISASTER PREPAREDNESS AND MANAGEMENT

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. **(6)**

UNIT IV: RISK ASSESSMENT

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. **(6)**

UNIT V: DISASTER MITIGATION

Meaning, concept and strategies of disaster mitigation, emerging trends in Mitigation. Structural mitigation and non-structural mitigation, programs of Disaster mitigation in India. **(6)**

Course outcomes

After the completion of the subject following outcomes can be achieved-

1. Students will be able to understand disaster and its types in general.
2. They will understand the post disaster damage in terms of both like and commodity.

3. They will have clear picture of disaster prone zones.
4. They will be able to understand the pre and post disaster preparedness needed to mitigate the disaster impact in large scale.
5. Student will also understand to quantify the risk in terms of monetary for both commodity and life.
6. Student will also learn the structural and non-structural measures for risk mitigation

Reference Books:

1. Ghosh G.K., 2006, Disaster Management, APH Publishing Corporation

Text Books:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, Pardeep Et.Al. (Eds.)," Disaster Mitigation Experiences and Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L., Disaster Administration And Management Text and Case Studies" ,Deep & Deep Publication Pvt. Ltd., New Delhi

Mode of Evaluation: Assignments, Internal Mid Examinations.

AUDIT COURSE - I

18AUP902 SANSKRIT FOR TECHNICAL KNOWLEDGE

L	T	P	C
2	0	0	0

Course Prerequisite: None

Course Objectives

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects
4. For enhancing the memory power
5. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Unit-I

Alphabets- Vowels- Consonants - Māheśvara sutras - Combined alphabets- Verbs- Basic words **(6)**

Unit-II

Singular/Dual/Plural - Nominative case - Accusative case - Instrumental case - Dative case - Ablative case- Genitive case - Locative case **(6)**

Unit-III

Nouns and adjectives - Indeclinables - Present tense - Past tense - Future tense- Order and request - Prefixes - Number word - Combinations and cases **(6)**

Unit -IV

Sanskrit literature-Harsacaritasangrah-Kumarasambhava-sabdamanjari **(6)**

Unit -V

Technical concept of Architecture-Manasar text –logic- nyaya sutras –pramana-mathematics-sulva sutras-baudhyana theorem. **(6)**

Course Outcome:

Students will be able to

1. Understanding basic alphabets and vowels
2. Understanding the cases in Sanskrit language
3. Understanding of Nouns and tense

4. Understanding of some literature
5. Analyzing the observation through pramana, application of architecture and mathematics

Text/Reference Books:

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

Mode of Evaluation: Assignments, Internal Mid Examinations.

AUDIT COURSE - I

18AUP903 CONSTITUTION OF INDIA

	L	T	P	C
Course Prerequisite: None	**2**	**0**	**0**	**0**

Course Objectives:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.
4. To get knowledge about the Indian Federal System and Center – State Relations
5. To Understand the Election Commission functions and administration system

UNIT I: INTRODUCTION

Historical Background – Drafting Committee (Composition & Working) – Philosophical foundations of the Indian Constitution – Preamble – Fundamental Rights – Directive Principles of State Policy – Fundamental Duties – Citizenship – Constitutional Remedies for citizens. **(6)**

UNIT II: STRUCTURE AND FUNCTION OF CENTRAL GOVERNMENT

Union Government – Structures of the Union Government and Functions – President – Vice President – Prime Minister – Cabinet – Parliament – Supreme Court of India – Judicial Review. **(6)**

UNIT III: STRUCTURE AND FUNCTION OF STATE GOVERNMENT

State Government – Structure and Functions – Governor – Chief Minister – Cabinet – State Legislature –Judicial System in States – High Courts and other Subordinate Courts. **(6)**

UNIT IV: CONSTITUTION FUNCTIONS

Indian Federal System – Center – State Relations – President's Rule – Constitutional Amendments –Constitutional Functionaries - Assessment of working of the Parliamentary System in India. **(6)**

UNIT V: ELECTION COMMISSION

Central Election Commission - Role and functioning – Chief Election Commissioner and Election Commissioners – State Election Commission – Institute and Bodies for the welfare of SC/ST/OBC and Women. **(6)**

Course Outcomes:

Upon completion of the course, students will be able to:

1. Know about Human rights protection by Indian Constitution.
2. Understand the functions of the Indian government
3. Understand and abide the rules of the Indian constitution.
4. Role of Constitution in Socio-economic development and welfare activities of the Country.

Text Books:

1. Durga Das Basu, "Introduction to the Constitution of India ", Prentice Hall of India, New Delhi.
2. R.C.Agarwal, (1997) "Indian Political System", S.Chand and Company, New Delhi.

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, 7thEdn., Lexis Nexis, 204
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015

Mode of Evaluation: Assignments, Internal Mid Examinations.

AUDIT COURSE - I

18AUP904 PEDAGOGY STUDIES

L	T	P	C
2	0	0	0

Course Prerequisite: None

Course Objectives:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

UNIT I

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. **(6)**

UNIT II

- Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
- Curriculum, Teacher education. **(6)**

UNIT III

- Evidence on the effectiveness of pedagogical practices
- Methodology for the in depth stage: quality assessment of included studies.
- 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.
- Teachers' attitudes and beliefs and Pedagogic strategies. **(6)**

UNIT IV

- 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 **(6)**

UNIT V

- **Research gaps and future directions**
- Research design
- Contexts
- Pedagogy
- Teacher education
- Curriculum and assessment
- Dissemination and research impact. **(6)**

Course Outcomes
Students will be able to:

1. Understand what pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. Understand what is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. Understand how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy

Text/Reference Books:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, ‘learning to read’ campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

Mode of Evaluation: Assignments, Internal Mid Examinations.

M. Tech I Year II Semester

M. Tech. I Year II Semester

18EPSP103 DIGITAL PROTECTION OF POWER SYSTEM

L	T	P	C
3	0	0	3

Course Prerequisite: Power System Protection

Course Description:

This course facilitates the students with the necessity of digital protection of power system

Course Objectives:

1. Study of numerical relays
2. Developing mathematical approach towards protection
3. Study of algorithms for numerical protection

UNIT I: INTRODUCTION TO DIGITAL RELAYS

Evolution of digital relays from electromechanical relays, Performance and operational characteristics of digital protection. **(6)**

UNIT II: MATHEMATICAL MODEL OF PROTECTION ALGORITHMS

Mathematical background to protection algorithms, Finite difference techniques. **(6)**

UNIT III: FOURIER ANALYSIS

Interpolation formulae, Forward, backward and central difference interpolation, Numerical differentiation, Curve fitting and smoothing, Least squares method, Fourier analysis, Fourier series and Fourier transform, Walsh function analysis. **(8)**

UNIT IV: BASIC ELEMENTS OF DIGITAL PROTECTION

Basic elements of digital protection, Signal conditioning: transducers, surge protection, analog filtering, analog multiplexers, Conversion subsystem: the sampling theorem, signal aliasing, Error, sample and hold circuits, multiplexers, analog to digital conversion, Digital filtering concepts, The digital relay as a unit consisting of hardware and software Sinusoidal wave based algorithms, Sample and first derivative (Mann and Morrison) algorithm, Fourier and Walsh based algorithms. **(16)**

UNIT V: ADVANCES IN DIGITAL PROTECTION OF POWER SYSTEM

Fourier Algorithm: Full cycle window algorithm, fractional cycle window algorithm. Walsh function based algorithm. Least Squares based algorithms. Differential equation based algorithms. Traveling Wave based Techniques. Digital Differential Protection of Transformers. Digital Line Differential Protection. Recent Advances in Digital Protection of Power Systems.

(9)

Course Outcomes:

Students will be able to:

1. Learn the importance of Digital Relays
2. Apply Mathematical approach towards protection
3. Learn to develop various Protection algorithms

Text/Reference Books:

1. A. G. Phadke and J. S. Thorp, "Computer Relaying for Power Systems", Wiley/Research studies Press, 2009.
2. A.T. Johns and S. K. Salman, "Digital Protection of Power Systems", IEEE Press, 1999.
3. Gerhard Zeigler, "Numerical Distance Protection", Siemens Publicis Corporate Publishing, 2006.
4. S. R. Bhide "Digital Power System Protection" PHI Learning Pvt.Ltd.2014.

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech I Year II Semester

18EPSP104 POWER SYSTEM DYNAMICS-II

L	T	P	C
3	0	0	3

Course Prerequisite: Power Systems Dynamics-I

Course Description:

This course facilitates the students with the necessity understanding of power system dynamics-II.

Course Objectives:

1. Study of power system dynamics
2. Interpretation of power system dynamic phenomena
3. Study of various forms of stability

UNIT I: INTRODUCTION TO DYNAMIC SYSTEM AND STABILITY

Basic Concepts of Dynamic Systems and Stability Definition, Small Signal Stability (Low Frequency Oscillations) of Unregulated and Regulated System. **(8)**

UNIT II: FLUX VARIATION AND AVR

Effect of Damper, Flux Linkage Variation and AVR. **(8)**

UNIT III: STABILITY ENHANCEMENT TECHNIQUES

Large Signal Rotor Angle Stability, Dynamic Equivalents And Coherency, Direct Method of Stability Assessment, Stability Enhancing Techniques, Mitigation Using Power System Stabilizer. **(9)**

UNIT IV: ASYNCHRONOUS OPERATION AND MULTI MACHINE STABILITY

Asynchronous Operation and Resynchronization, Multi-Machine Stability. **(6)**

UNIT V: DYNAMIC ANALYSIS OF VOLTAGE STABILITY

Dynamic Analysis of Voltage Stability Voltage Collapse, Frequency Stability, Automatic Generation Control, Primary and Secondary Control, Sub-Synchronous Resonance and Counter Measures. **(14)**

Course Outcomes: -

Students will be able to:

1. Gain valuable insights into the phenomena of power system including obscure ones.
2. Understand the power system stability problem
3. Analyze the stability problems and implement modern control strategies.
4. Simulate small signal and large signal stability problems

Text/Reference Books:

1. P. Kundur, “Power System Stability and Control”, McGraw Hill Inc, 1994
2. J. Machowski, Bialek, Bumby, “Power System Dynamics and Stability”, John Wiley & Sons, 1997
3. L. Leonard Grigsby (Ed.); “Power System Stability and Control”, Second edition, CRC Press, 2007
4. V. Ajjarapu, “Computational Techniques for voltage stability assessment & control”; Springer, 2006 Course

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

DISCIPLINE ELECTIVE - III

M. Tech I Year II Semester

18EPSP411 RESTRUCTURED POWER SYSTEM

	L	T	P	C
Course Prerequisite: Power Systems	**3**	**0**	**0**	**3**

Course Description:

This course facilitates the students with the necessity understanding of restructured power system

Course Objectives:

1. Understand what is meant by restructuring of the electricity market
2. Understand the need behind requirement for deregulation of the electricity market
3. Understand the money, power & information flow in a deregulated power system

UNIT I: FUNDAMENTALS OF RESTRUCTURED POWER SYSTEM

Fundamentals of restructured system, Market architecture, Load elasticity, Social welfare maximization. (**8)**

UNIT II: CONGESTION MANAGEMENT

OPF: Role in vertically integrated systems and in restructured markets, congestion management. **(8)**

UNIT III: OPTIMAL BIDDING & TRANSMISSION PRICING

Optimal bidding, Risk assessment, Hedging, Transmission pricing, Tracing of power. **(8)**

UNIT IV: APPLICATIONS IN RESTRUCTURED POWER MARKETS

Ancillary services, Standard market design, Distributed generation in restructured markets Developments in India, IT applications in restructured markets. **(14)**

UNIT V: RECENT TRENDS IN RESTRUCTURING

Working of restructured power systems, PJM, Recent trends in Restructuring. **(7)**

Course Outcomes: -

Students will be able to:

1. Describe various types of regulations in power systems.
2. Identify the need of regulation and deregulation.
3. Define and describe the Technical and Non-technical issues in Deregulated Power Industry.
4. Identify and give examples of existing electricity markets.
5. Classify different market mechanisms and summarize the role of various entities in the market.

Text/Reference Books:

1. Lorrin Philipson, H. Lee Willis, “Understanding electric utilities and de-regulation”, Marcel Dekker Pub.,1998
2. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, “Operation of restructured power systems”, Kluwer Academic Pub., 2001.
3. Mohammad Shahidehpour, Muwaffaq Alomoush, “Restructured electrical power systems: operation, trading and volatility”, Marcel Dekker

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech I Year II Semester

18EPSP412 ADVANCED DIGITAL SIGNAL PROCESSING

L	T	P	C
3	0	0	3

Course Prerequisite: Digital Signal Processing

Course Description:

This course facilitates the students with the necessity understanding of Advanced Digital Signal Processing

Course Objectives:

1. To understand the difference between discrete-time and continuous-time signals
2. To understand and apply Discrete Fourier Transforms (DFT)

UNIT I: INTRODUCTION TO DISCRETE TIME FOURIER TRANSFORM AND Z TRANSFORM

Discrete time signals, Linear shift invariant systems, Stability and causality, Sampling of continuous time signals, Discrete time Fourier transform, Discrete Fourier series, Discrete Fourier transform, Z transform-Properties of different transforms. **(8)**

UNIT II: COMPUTATION OF DFT DESIGN

Linear convolution using DFT, Computation of DFT Design of IIR digital filters from analog filters, Impulse invariance method, Bilinear transformation method. **(8)**

UNIT III: FIR AND IIR FILTER DESIGN

FIR filter design using window functions, Comparison of IIR and FIR digital filters, Basic IIR and FIR filter realization structures, Signal flow graph representations Quantization process and errors, Coefficient quantisation effects in IIR and FIR filters. **(8)**

UNIT IV: POWER SPECTRUM ESTIMATION

A/D conversion noise- Arithmetic round-off errors, Dynamic range scaling, Overflow oscillations and zero Input limit cycles in IIR filters, Linear Signal Models All pole, All zero and Pole-zero models, Power spectrum estimation- Spectral analysis of deterministic signals, Estimation of power spectrum of stationary random signals. **(14)**

UNIT V: OPTIMAL LINEAR FILTERS

Optimum linear filters, Optimum signal estimation, Mean square error estimation Optimum FIR and IIR Filters. **(7)**

Course Outcomes: -

Students will be able to:

1. Knowledge about the time domain and frequency domain representations as well analysis of discrete time signals and systems
2. Study the design techniques for IIR and FIR filters and their realization structures.
3. Acquire knowledge about the finite word length effects in implementation of digital filters.
4. Knowledge about the various linear signal models and estimation of power spectrum of stationary random signals
5. Design of optimum FIR and IIR filters

Text/Reference Books:

1. Sanjit K Mitra, "Digital Signal Processing: A computer-based approach ",TataMc Grow-Hill Edition1998
2. Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, "Statistical and Adaptive Signal Processing", Mc Grow Hill international editions. -2000

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech I Year II Semester

18EPSP413 DYNAMICS OF ELECTRICAL MACHINES

L	T	P	C
3	0	0	3

Course Prerequisite: Electrical Machines, Control Systems

Course Description:

This course facilitates the students with the necessity understanding of dynamics of electrical machines

Course Objectives:

1. Learn Performance characteristics of machine
2. To understand the dynamics of the machine
3. To understand how to determine stability of machine
4. Learn the synchronous machine

UNIT I: STABILITY ANALYSIS OF COMMUTATOR MACHINE

Stability, Primitive 4 Winding Commutator Machine, Commutator Primitive Machine, Complete Voltage Equation of Primitive 4 Winding Commutator Machine. **(8)**

UNIT II: ANALYSIS OF 3-PHASE INDUCTION MOTORS

Torque Equation Analysis of Simple DC Machines using the Primitive Machine Equations, The Three Phase Induction Motor. Transformed Equations, Different Reference Frames for Induction Motor Analysis Transfer Function Formulation. (**9)**

UNIT III: ANALYSIS OF SYNCHRONOUS MACHINES

Three Phase Salient Pole Synchronous Machine, Parks Transformation, Steady State Analysis. (**8)**

UNIT IV: DYNAMIC ANALYSIS OF INTERCONNECTED MACHINES

Large Signal Transient, Small Oscillation Equations in State Variable form, Dynamical Analysis of Interconnected Machines. (**8)**

UNIT V: TRANSIENT ANALYSIS

Large Signal Transient Analysis using Transformed Equations, DC Generator /DC Motor System, Alternator /Synchronous Motor System. **(12)**

Course Outcomes: -

Students will be able to:

1. Formulation of electrodynamic equations of all electric machines and analyze the performance characteristics
2. Knowledge of transformations for the dynamic analysis of machines
3. Knowledge of determination of stability of the machines under small signal and transient conditions
4. Study about synchronous machine

Text/Reference Books:

1. D.P. Sengupta & J.B. Lynn," Electrical Machine Dynamics", The Macmillan Press Ltd. 1980
2. R Krishnan "Electric Motor Drives, Modeling, Analysis, and Control", Pearson Education., 2001
3. P.C. Kraus, "Analysis of Electrical Machines", McGraw Hill Book Company,1987
4. I. Boldia & S.A. Nasar, "Electrical Machine Dynamics", The Macmillan Press Ltd. 1992
5. C.V. Jones, "The Unified Theory of Electrical Machines", Butterworth, London. 1967

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech I Year II Semester

18EPSP414 POWER APPARATUS DESIGN

L	T	P	C
3	0	0	3

Course Prerequisite: Electrical Machines

Course Description:

This course facilitates the students with the necessity understanding of power apparatus design

Course Objectives:

1. Study the modelling analysis of rotating machine.
2. Learning electromagnetic energy conversion
3. To know about rating of machines.

UNIT I: PRINCIPLES OF DESIGN OF MACHINES

Principles of Design of Machines -Specific loadings, choice of magnetic and electric loadings, Real and apparent flux densities, temperature rise calculation, Separation of main dimension for DC machines, Induction machines and synchronous machines, Design of Transformers-General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling. **(9)**

UNIT II: INDUCTION MACHINES AND SYNCHRONOUS MACHINES

Specific loadings, choice of magnetic and electric loadings Real and apparent flux -densities, temperature rise calculation, Separation of main dimension for DC machines, Induction machines and synchronous machines, Heating and cooling of machines, types of ventilation, continuous and intermittent rating. **(8)**

UNIT III: CALCULATION OF EFFICIENCY AND REGULATION

General considerations, output equation, emf per turn, choice of flux density and current density, main dimensions, leakage reactance and conductor size, design of tank and cooling tubes Calculation of losses, efficiency and regulation, Forces winding during short circuit. **(8)**

UNIT IV: ESTIMATION OF HARMONIC TORQUE

General considerations, output equation, Choice of specific electric and magnetic loadings, efficiency, power factor, Number of slots in stator and rotor, Elimination of harmonic torques.

(8)

UNIT V: INTRODUCTION TO COMPUTER AIDED ELECTRICAL MACHINE DESIGN

Design of stator and rotor winding, slot leakage flux, Leakage reactance, equivalent resistance of squirrel cage rotor, Magnetizing current, efficiency from design data Types of alternators, comparison, specific loadings, output co-efficient, design of main dimensions, Introduction to Computer Aided Electrical Machine Design Energy efficient machines. **(12)**

Course Outcomes: -

Students will be able to:

1. To give a systematic approach for modeling and analysis of all rotating machines under both transient and steady state conditions with the dimensions and material used
2. Ability to model and design all types of rotation machines including special machines

Text/Reference Books:

1. Clayton A.E, "The Performance and Design of D.C. Machines", Sir I. Pitman & sons, Ltd.
2. M.G. Say, "The Performance and Design of A.C. Machines ", Pitman
3. Sawhney A.K, "A course in Electrical Machine Design", Dhanpat Rai & Sons, 5th Edition

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech I Year II Semester

18EPSP415 STATIC VAR COMPENSATION AND HARMONIC FILTERING

L	T	P	C
3	0	0	3

Course Prerequisite: Power Electronics

Course Description:
This course is designed to create awareness on power quality issues, sources of harmonics in distribution systems and their effects, reactive power compensators and their control, sub-synchronous resonance, standard modulation strategies, Multi-Level Inverters, and passive and active harmonic filtering.

Course Objectives:

1. To understand the power quality issues and sources of harmonics in distribution systems.
2. To study about different reactive power compensators and their control.
3. To study about Multi-Level Inverters.
4. To learn the passive and active harmonic filtering methods.

UNIT I: FUNDAMENTALS OF LOAD COMPENSATION AND POWER QUALITY
Fundamentals of Load Compensation, Steady-State Reactive Power Control in Electric Transmission Systems, Reactive Power Compensation and Dynamic Performance of Transmission Systems.
Power Quality Issues- Sags, Swells, Unbalance, Flicker, Distortion, Current Harmonics - Sources of Harmonics in Distribution Systems and Ill Effects. **(9)**

UNIT II: REACTIVE POWER COMPENSATORS
Static Reactive Power Compensators and their control. Shunt Compensators, SVCs of Thyristor Switched and Thyristor Controlled types and their control, STATCOMs and their control, Series Compensators of Thyristor Switched and Controlled Type and their Control, SSSC and its Control, Sub-Synchronous Resonance and damping, Use of STATCOMs and SSSCs for Transient and Dynamic Stability Improvement in Power Systems. **(11)**

UNIT III: CONVERTERS FOR STATIC COMPENSATION
Converters for Static Compensation - Single Phase and Three Phase Converters and Standard Modulation Strategies (Programmed Harmonic Elimination and SPWM). GTO Inverters. Multi-Pulse Converters and Interface Magnetics. **(8)**

UNIT IV: MULTI-LEVEL INVERTERS
Multi-Level Inverters of Diode Clamped Type and Flying Capacitor Type and suitable modulation strategies (includes SVM). Multi-level inverters of Cascade Type and their modulation. Current Control of Inverters. **(8)**

UNIT V: PASSIVE AND ACTIVE HARMONIC FILTERING
Passive Harmonic Filtering. Single Phase Shunt Current Injection Type Filter and its Control, Three PhaseThree-wire Shunt Active Filtering and their control using p-q theory and d-q modeling. Three-phase four-wire shunt active filters. Hybrid Filtering using Shunt Active Filters. Series Active Filtering in Harmonic Cancellation Mode. Series Active Filtering in Harmonic Isolation Mode. Dynamic Voltage Restorer and its control. Power Quality Conditioner. **(9)**

Course Outcomes:

At the end of this course, students will demonstrate the ability to

1. Understand the power quality issues and sources of harmonics in distribution systems.
2. Study about different reactive power compensators and their control.
3. Learn about Multi-Level Inverters.
4. Design passive and active harmonic filters.

Text Books:

1. T. J. E Miller, "Reactive Power Control in Electric Systems", John Wiley & Sons,1982.
2. N.G. Hingorani & L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press, 2000.
3. Ned Mohan et.al, "Power Electronics", John Wiley and Sons 2006
4. R. Sastry Vedam & Mulukutla S. Sarma, "Power quality VAR compensation in power systems", CRC press, 2009.
5. K.R. Padiyar, "FACTS controllers in power transmission and distribution", New age international publications, 2008.

Reference:

1. Hirofumi akagi, Edson hirokazu watanabe, Mauricio aredes, "Instantaneous power theory and applications to power conditioning" Wiley Inter Science, 2007.

Mode of Evaluation: Assignment, Written Examination

DISCIPLINE ELECTIVE - IV

M. Tech I Year II Semester

18EPSP416 ADVANCED MICRO-CONTROLLER BASED SYSTEMS

Course Prerequisite: Microprocessors and Microcontrollers

L	T	P	C
3	0	0	3

Course Description:

This course facilitates the students with the necessity understanding of advanced micro controller based systems

Course Objectives:

1. To understand the architecture of advance microcontrollers
2. To understand the applications of these controllers
3. To get some introduction to FPGA

UNIT I: BASIC COMPUTER ORGANIZATION

Basic Computer Organization, Accumulator based Processes-Architecture, Memory Organization-I/O Organization. **(8)**

UNIT II: MICROCONTROLLERS 8051/8056

Micro-Controllers-Intel 8051, Intel 8056- Registers, Memories, I/O Ports, Serial Communication Timers, Interrupts, Programming. **(9)**

UNIT III: INTERRUPTS

Intel 8051 – Assembly language programming, Addressing-Operations, Stack &Subroutines, Interrupts-DMA. **(8)**

UNIT IV: PIC MICROCONTROLLER

PIC 16F877- Architecture Programming, Interfacing Memory/ I/O Devices, Serial I/O and data communication. **(8)**

UNIT V: DIGITAL SIGNAL PROCESSOR

Digital Signal Processor (DSP), Architecture-Programming, Introduction to FPGA, Microcontroller development for motor control applications, Stepper motor control using micro controller. **(12)**

Course Outcomes: -

Students will be able to:

1. To learn how to program a processor in assembly language and develop an advanced processor based system.
2. To learn configuring and using different peripherals in a digital system.
3. To compile and debug a Program.
4. To generate an executable file and use it.

Text/Reference Books:

1. John. F. Wakerly: "Microcomputer Architecture and Programming", John Wiley and Sons 1981
2. Ramesh S. Gaonker: "Microprocessor Architecture, Programming and Applications with the 8085", Penram International Publishing (India), 1994
3. Raj Kamal: "The Concepts and Features of Microcontrollers", Wheeler Publishing, 2005
4. Kenneth J. Ayala, "The 8051 microcontroller", Cengage Learning, 2004
5. John Morton," The PIC microcontroller: your personal introductory course", Elsevier, 2005
6. Dogan Ibrahim," Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F Series", Elsevier, 2008
7. Microchip datasheets for PIC16F877

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech I Year II Semester

18EPSP417 SCADA SYSTEM AND APPLICATIONS

Course Prerequisite: Computer Architecture

L	T	P	C
3	0	0	3

Course Description:

This course facilitates the students with the necessity understanding of SCADA systems and applications

Course Objectives:

1. To understand what is meant by SCADA and its functions
2. To know SCADA communication
3. To get an insight into its application

UNIT I: INTRODUCTION TO SCADA

Introduction to SCADA, Data acquisition systems, Evolution of SCADA, Communication technologies. **(8)**

UNIT II: SCADA APPLICATIONS

Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries SCADA. **(6)**

UNIT III: SCADA SYSTEM COMPONENTS

Industries SCADA System Components, Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems. **(9)**

UNIT IV: SCADA ARCHITECTURE

SCADA Architecture, Various SCADA architectures, advantages and disadvantages of each system, single unified standard architecture -IEC 61850. **(8)**

UNIT V: SCADA COMMUNICATION

SCADA Communication, various industrial communication technologies, wired and wireless methods and fiber optics, Open standard communication protocols SCADA Applications: Utility applications, Transmission and Distribution sector operations, monitoring, analysis and improvement, Industries - oil, gas and water. **(14)**

Course Outcomes: -

Students will be able to:

1. Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications
2. Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system
3. Knowledge about single unified standard architecture IEC 61850

Text/Reference Books:

1. Stuart A. Boyer: “SCADA-Supervisory Control and Data Acquisition”, Instrument Society of America Publications,USA,2004
2. Gordon Clarke, Deon Reynders: “Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems”, Newnes Publications, Oxford, UK,2004
3. William T. Shaw, “Cybersecurity for SCADA systems”, Penn Well Books, 2006
4. David Bailey, Edwin Wright, “Practical SCADA for industry”, Newnes, 2003
5. Michael Wiebe, “A guide to utility automation: AMR, SCADA, and IT systems for electric power”, Penn Well 1999

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech I Year II Semester

18EPSP418 POWER QUALITY

L	T	P	C
3	0	0	3

Course Prerequisite: Power Electronics

Course Description:

This course facilitates the students with the necessity understanding of power quality

Course Objectives:

1. Understand the different power quality issues to be addressed
2. Understand the recommended practices by various standard bodies like IEEE,IEC, etc on voltage& frequency, harmonics
3. Understanding STATIC VAR Compensators

UNIT I: INTRODUCTION TO POWER QUALITY

Introduction-power quality-voltage quality-overview of power quality phenomena, classification of power quality issues-power quality measures and standards-THD-TIF-DIN-C, message weights-flicker factor transient phenomena-occurrence of power quality problems, power acceptability curves-IEEE guides, standards and recommended practices. **(8)**

UNIT II: HARMONICS ANALYSIS

Harmonics-individual and total harmonic distortion, RMS value of a harmonic waveform, Triplex harmonics-important harmonic introducing devices-SMPS, Three phase power converters, arcing devices saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads. **(8)**

UNIT III: MATHEMATICAL MODELLING OF NETWORKS AND COMPONENTS

Modeling of networks and components under non-sinusoidal conditions transmission and distribution systems, Shunt capacitors-transformers-electric machines-ground, systems loads that cause power quality problems, power quality problems created by drives and its impact on drive. **(8)**

UNIT IV: POWER FACTOR IMPROVEMENT

Power factor improvement- Passive Compensation, Passive Filtering, Harmonic, Resonance, Impedance Scan Analysis- Active Power Factor Corrected Single Phase Front End, Control Methods for Single Phase APFC, Three Phase APFC and Control Techniques, PFC, Based on Bilateral Single Phase and Three Phase Converter. **(9)**

UNIT V: DESIGN OF STATIC VAR COMPENSATORS AND STATCOMS

Static VAR compensators-SVC and STATCOM Active Harmonic Filtering-Shunt Injection, Filter for single phase, three-phase three-wire and three-phase fourwire systems, d-q domain control of three phase shunt active filters uninterruptible power supplies constant voltage, transformers, series active power filtering techniques for harmonic cancellation and isolation, Dynamic Voltage Restorers for sag , swell and flicker problems. Grounding and wiring introduction, NEC grounding requirements-reasons for grounding, typical grounding and wiring problems solutions to grounding and wiring problems. **(12)**

Course Outcomes:

Students will be able to:

1. Acquire knowledge about the harmonics, harmonic introducing devices and effect of harmonics on system equipment and loads
2. To develop analytical modeling skills needed for modeling and analysis of harmonics in networks and components
3. To introduce the student to active power factor correction based on static VAR compensators and its control techniques
4. To introduce the student to series and shunt active power filtering techniques for harmonics

Text/Reference Books:

1. G.T. Heydt, "Electric power quality", McGraw-Hill Professional, 2007
2. Math H. Bollen, "Understanding Power Quality Problems", IEEE Press, 2000
3. J. Arrillaga, "Power System Quality Assessment", John wiley, 2000
4. J. Arrillaga, B.C. Smith, N.R. Watson & A. R. Wood ,"Power system Harmonic Analysis", Wiley, 1997

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech I Year II Semester

18EPSP419 ARTIFICIAL INTELLIGENCE TECHNIQUES

L	T	P	C
3	0	0	3

Course Prerequisite: Control Systems

Course Description:

This course facilitates the students with the necessity understanding of artificial intelligence techniques

Course Objectives:

1. Understanding fuzzy logic, ANN
2. Understanding GA & EP

UNIT I: INTRODUCTION TO INTELLIGENT SYSTEM

Biological foundations to intelligent Systems, Artificial Neural Networks, Single layer and Multilayer Feed Forward NN, LMS and Back Propagation Algorithm, Feedback networks and Radial Basis Function Networks. **(10)**

UNIT II: FUZZY LOGIC CONTROL SYSTEM

Fuzzy Logic Knowledge Representation and Inference Mechanism Defuzzification Methods. **(6)**

UNIT III: FUZZY NEURAL NETWORKS

Fuzzy Neural Networks, some algorithms to learn the parameters of the network like GA, System Identification using Fuzzy and Neural Network. **(14)**

UNIT IV: GENETIC ALGORITHM

Genetic algorithm, Reproduction cross over, mutation, Introduction to evolutionary program. (**8)**

UNIT V: APPLICATIONS OF ARTIFICIAL INTELLIGENCE TECHNIQUES

Applications of above mentioned techniques to practical problems. (**7)**

Course Outcomes: -

Students will be able to:

1. Learn the concepts of biological foundations of artificial neural networks
2. Learn Feedback networks and radial basis function networks and fuzzy logics
3. Identifications of fuzzy and neural network
4. Acquire the knowledge of GA

Text/Reference Books:

1. J M Zurada , “An Introduction to ANN”, JaicoPublishing House
2. Simon Haykins, “Neural Networks”, Prentice Hall
3. Timothy Ross, “Fuzzy Logic with Engg. Applications”, McGraw. Hill
4. Driankov, Dimitra, “An Introduction to Fuzzy Control”, Narosa Publication
5. Golding, “Genetic Algorithms”, Addison-Wesley Publishing Com

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech I Year II Semester

18EPSP420 OPERATION AND CONTROL OF POWER SYSTEM

L	T	P	C
3	0	0	3

Course Prerequisite: Power Systems

Course Description:
The course is intended to understand fundamentals as well as state-of-the-art techniques for economic operation and concept of control areas. This course provides knowledge about hydrothermal scheduling, Unit commitment and solution techniques and role of SCADA.

Course Objectives:

1. To know the general concepts of economic operation and unit commitment.
2. To impart the concepts of hydro thermal scheduling.
3. To analyze automatic generation control and AGC implementation.
4. To gain the knowledge on inter change of power and energy.
5. To explain power system security

UNIT I: ECONOMIC DISPATCH & UNIT COMMITMENT

Economic operation- Load forecasting – Economic dispatch problem of thermal Units–Unit Commitment and Solution Methods: Optimal Unit Commitment, Constraints in Unit commitment, spinning reserve, Thermal Unit Constraints, Other constraints, Hydro constraints, Must Run, Fuel constraints, Unit commitment Solution methods: Priority-List methods, Dynamic Programming solution. Backward DP Approach, Forward DP Approach. **(10)**

UNIT II: HYDROTHERMAL SYSTEMS

Hydrothermal co-ordination: Short-term hydrothermal scheduling problem - gradient approach - Hydro Units in series - pumped storage hydro plants-hydro-scheduling using Dynamic programming and linear programming. (**8)**

UNIT III: LOAD FREQUENCY CONTROL

Automatic generation control: Review of LFC and Economic Dispatch control (EDC) using the three modes of control viz. Flat frequency – tie-line control and tie-line bias control-AGC implementation – AGC features - static and dynamic responses of uncontrolled & controlled two area system. **(9)**

UNIT IV: INTERCONNECTED SYSTEMS

Interchange of Power & Energy: Economic interchange between interconnected utilities – Inter utility energy evaluation – Power pools – Transmission effects and Issues: Limitations – Wheeling. **(9)**

UNIT V: CONTINGENCY ANALYSIS & SCADA

Power system security-Contingency analysis–linear sensitivity factors – AC power flow methods – contingency selection –Introduction to Supervisory Control and Data Acquisition. SCADA

functional requirements and Components-General features, Functions, Applications and Benefits. **(9)**

Course Outcomes: -

Students will be able to:

1. Explain the economic operation, load forecasting and optimal unit commitment methods.
2. Analyze the hydrothermal systems through various techniques.
3. Assess static and dynamic responses of two-area system.
4. Examine the interchange of power and energy.
5. Investigate power system security.

Text Books:

1. Allen J. Wood and Wollenberg B.F., 'Power Generation Operation and control', John Wiley & Sons, Second Edition.
2. Nagrath, I. J. and Kothari D. P., 'Modern Power System Analysis', TMH, New Delhi, 1980.
3. D. P. Kothari & J. S. Dhillon, Power System Optimization, PHI, 2004.
4. Supervisory Control And Data Acquisition by Stuart A. Boyer, Isa, 2009

Reference Books:

1. Electric Power systems by S.A. Nasar, Schaum's outline series, Revised 1st Edition, TMH, 2005.
2. Power System Analysis and Design 3rd Edition, J. Duncan Glover and M.S. Sharma, Thomson, 2008.
3. Electric Energy System Theory, Olle Ingemar Elgerd, Mc Graw Hill, 1982.
4. Power System Analysis Operation and Control 3rd Edition, A. Chakravarthy and S. Halder, PHI, 2012.

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech I Year II Semester

18EPSP203 POWER SYSTEM PROTECTION LABORATORY

L	T	P	C
0	0	4	2

Course Prerequisite: Power System Protection

Course Objectives:

1. To interpret the operating characteristics of various protective relays.
2. To understand the transformer protection and feeder protection concepts.

List of experiments

1. Modelling of Relay using MATLAB (Differential Relay).
2. Characteristics of IDMT over Current Relay.
3. Characteristics of Static Negative Sequence Relay.
4. Characteristics of Over Voltage Relay.
5. Principle of Reverse Power Protection.
6. Differential Protection of Transformer.
7. Radial Feeder Protection.
8. Parallel Feeder Protection.
9. Relay co-ordination of radial transmission/distribution system
10. Impact of Induction Motor Starting on Power System.

Course Outcome:

At the end of the course, students will able to

1. Analyze the operating characteristics of various protective relays.
2. Understand the transformer protection and feeder protection concepts.

Mode of Evaluation: Practical, Written Examination

M. Tech I Year II Semester

18EPSP204 SMART GRID LABORATORY

L	T	P	C
0	0	4	2

Course Prerequisite: Smart Grids

Course Objectives:

1. To understand the operation of smart grid and smart metering aspects.
2. To understand the concept of smart energy storage, measurement and protection of smart grids.

List of experiments

1. Operation of Smart appliances.
2. Smart metering.
3. Smart Energy storage.
4. Protection equipment's for Smart Grid.
5. Monitoring and measurement equipment.
6. Wide area monitoring – Phasor Measurement Units (PMUs).

Course Outcome:

At the end of the course, students will able to

1. Understand the operation of smart grid and smart metering aspects.
2. Understand the concept of smart energy storage, measurement and protection of smart grids.

Mode of Evaluation: Practical, Written Examination

AUDIT COURSE - II

M. Tech. AUDIT COURSE -II

18AUP905 ENGLISH FOR RESEARCH PAPER WRITING

L	T	P	C
2	0	0	0

Course Prerequisite: None

Course Objectives:

At the end of the course the learners will be able to:

1. Conceptualize various components of academic writing
2. Enhance and use academic vocabulary
3. Plan and write quality research papers in their respective field

Ensure the good quality of paper at very first-time submission

Unit I: Scientific Writing: An Introduction

What is scientific writing – Language in scientific writing – Use and miss-use of English – Elements of scientific writing - Paraphrasing and Plagiarism - Hedging and Criticizing – How to identify research problem. **(6)**

Unit II: Writing Title and Abstract

Strategies for writing effective title –Planning and preparing your abstract - Things to consider while writing abstract – Useful phrases for writing abstract. **(6)**

Unit III: Organising Review of the Literature; Methods of Data Collection and Data Analysis

What is review of the literature - Techniques of reading and citing various studies relevant to the study – Things to consider while organising review of the literature – useful phrases while writing review of the literature. Introduction to various methods of data collection –Preparing tools and describing them - How to interpret and analyse data. **(6)**

Unit IV: Writing Findings, Discussion and Conclusion

Useful vocabulary while writing findings, discussion, and conclusion –elaboration of the findings - Preparing and describing charts and graphs –how to organise your discussion section – Discussing the findings of your study with the literature available. **(6)**

Unit V: Preparing References, Appendixes and proofreading the paper

Various styles of referencing and bibliography (APA, MLA, Oxford, Harvard, Chicago), – Organising and preparing Appendixes – Various strategies of proofreading. **(6)**

Course Outcomes:

At the end of the course the learners will be able to:

1. Become aware of various components of academic writing
2. Improve and use academic vocabulary while writing a research papers
3. Plan and write quality research papers in their respective field

Text Books:

1. Adrian Wallwork, (2011). English for Writing Research Papers. Springer New York

2. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)

3. Day, R. (2006) How to Write and Publish a Scientific Paper, Cambridge University Press

4. Highman, N. (1998), Handbook

5. Research Papers, Springer New York Dordrecht

6. Kate L. Turabian, (2007).A Manual for Writers of Research Papers, Theses, and Dissertations, Seventh Edition: Chicago Style for Students and Researchers *[7th ed.]*Chicago Guides to Writing, Editing, and Publishing

Mode of Evaluation: Assignments, Internal Mid Examinations.

AUDIT COURSE-II

18AUP906 VALUE EDUCATION

L	T	P	C
2	0	0	0

Course Prerequisite: None

Course Objectives:

1. Understand value of education
2. Understand value of self- development
3. Imbibe personality development
4. Imbibe spiritual development and to about the importance of character
5. Incorporate good emotional intelligence with self control

UNIT I

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles.Value judgements. **(6)**

UNIT II

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 **(6)**

UNIT III

Personality and Behavior Development - 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. True friendship.
Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature **(6)**

UNIT IV

Character-Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. **(6)**

UNIT V

Competence- Emotional Intelligence- Mind your Mind, Self-control-.Honesty, Studying effectively **(6)**

Course Outcomes:

Students will be able to

1. Knowledge of self-development
2. Learn the importance of Human values

3. Developing the moral personality
4. Development of spiritual personality
5. Development of emotional personality for efficiency in work

Text/Reference Books:

1. Chakroborty, S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

Mode of Evaluation: Assignments, Internal Mid Examinations.

AUDIT COURSE - II

18AUP907 STRESS MANAGEMENT BY YOGA

L	T	P	C
2	0	0	0

Course Prerequisite: None

Course Objectives

1. To know the human psyche: Yogic and modern concepts
2. To have the importance for mental health
3. To know the relationship between mind and body
4. To understand the concept of stress according to modern science and yoga
5. To achieve overall health of mind through yoga

UNIT-I: Scientific Foundations of Stress

Concept of stress – Sources of stress - Types of Stress – Personality factors and Stress – Stress and the college student. **(6)**

UNIT-II: Consequences of stress on human mind

Human Psyche: Yogic and Modern concepts, behavior and consciousness – Frustation – Conflicts – Psychosomatic Disorders. **(6)**

UNIT-III: Mental hygiene and Yoga

Mental health: A Yogic Perspective – Mental hygiene and role of Yoga in mental hygiene – Yogic principles for the management of stress (Prayer and meditation for mental health). **(6)**

UNIT-IV: Ashtanga Yoga Introduction

Introduction to Ashtanga Yoga – Concepts and techniques of stress management in Ashtanga yoga of Patanjali Yoga sutra (i.e. Benefits of Meditation for stress management). **(6)**

UNIT-V: Yogic management of stress

Specific practices for stress management: Yogasana, breath awareness, shvasana, yoganidra, pranayama and meditation. **(6)**

Course Outcomes:

Students will be able to:

1. Understand the role of yoga in stress management
2. Understanding the role of yoga in life management
3. Understanding the role of yoga in mental hygiene
4. To Develop strong mental health
5. To Develop healthy mind and there by improve efficiency

Text/Reference Books:

1. 'Certification of yoga professionals, Official guide book for Level 1 and Level 2" Excel books private limited, Noida

2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama

(Publication Department), Kolkata

Mode of Evaluation: Assignments, Internal Mid Examinations.

AUDIT COURSE - II

18AUP908 PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

L	T	P	C
2	0	0	0

Course Prerequisite: None

Course Description:

This course intends and aims to enhance the confidence of the students by exposing them to various situations and contexts they face in their career. It is imperative for students to start preparing for the ever growing competition in the Job market. This course focuses on the practical aspects of soft skills relevant to the requirements of the prospective employers in view of globalization.

Course Objectives:

1. To expose the students to those soft skills which are crucial to an employee's ability to work smarter.
2. To enhance Art of Communication, Team Skills, GD handling skills and preparing resume & Interview Skills

UNIT I: VERBAL COMMUNICATION - Active listening - Non Verbal Communication - Body Language. **(6)**

UNIT II: DEVELOPING EMOTIONAL INTELLIGENCE –
Importance of Team work - Leadership skills, self-realization (Identifying strengths and weaknesses). **(6)**

UNIT III: TIME MANAGEMENT –
GD skills – Roles in a GD – Do's & Don'ts – Mock GD. **(6)**

UNIT IV: RESUME PREPARATION - Tips in writing resume - Interview Handling Skills Interview skills – Do's & Don'ts - Goal setting. **(6)**

UNIT V:
Grooming etiquette, Professional Electronic Communication-Telephone etiquette, Email etiquette. **(6)**

Course Outcomes:

1. After completion of this course the students shall be able to communicate effectively and enhance their interpersonal relationship and building skills with renewed self-confidence.
2. Work together in teams and accomplish objectives in a cordial atmosphere.
3. Face Group Discussion with confidence
4. Prepare resume and face interviews.
5. Understand and develop the necessary etiquette to present oneself in a professional setting.

Text Books: “Soft Skills”. Dr K Alex. S Chand Publications, New Delhi

References Books:

1. The Seven Habits Of Highly Effective People By Stephen R. Covey, Covey Leadership Center, 2005.
2. Negotiate To Close By Gary Karnass, Simon And Schuster, 1987.
2. The Greatest Miracle In The World – Ogmandino, Random House Publishing Group, 2009.
3. Working With Emotional Intelligence - Daniel Goleman, A&C Black, 2009.
4. Developing Communication Skills By Krishna Mohan And Meera Banerji; Macmillan India Ltd., Delhi, 2000.
5. Essentials Of Effective Communication, Ludlow And Panthon; Prentice Hall Of India, 1993.
6. Effective Presentation Skills (A Fifty-Minute Series Book) By Steve Mandel, Crisp Publications, 1996.
7. “Strategic Interviewing” By Richard Camp, Mary E. VielhaberAnd Jack L. Simonetti – Published By Wiley India Pvt. Ltd, 2007.
8. “Effective Group Discussion: Theory And Practice” By Gloria J. Galanes, Katherine Adams, John K. Brilhart, Tata Mcgraw-Hill, 2010.

Mode of Evaluation: Assignments, Internal Mid Examinations.

DISCIPLINE ELECTIVE - V

M. Tech. II Year I Semester

18EPSP421 POWER SYSTEM TRANSIENTS

L	T	P	C
3	0	0	3

Course Prerequisite: Power System Dynamics

Course Description:

This course facilitates the students with the necessity understanding of power system transients

Course Objectives:

1. Learn the reasons for occurrence of transients in a power system
2. Understand the change in parameters like voltage & frequency during transients
3. To know about the lightning phenomenon and its effect on power system

UNIT I: FUNDAMENTALS OF CIRCUIT ANALYSIS AND TRANSIENTS

Fundamental circuit analysis of electrical transients Laplace Transform method of solving simple Switching transients, Damping circuits -Abnormal switching transients, Three-phase circuits and transients, Computation of power system transients. (**8)**

UNIT II: PRINCIPLES OF DIGITAL COMPUTATION AND LIGHTING

Principle of digital computation – Matrix method of solution, Modal analysis-Z transform-Computation using EMTP, Lightning, switching and temporary over voltages, Lightning, Physical phenomena of lightning. (**8)**

UNIT III: ANALYSIS OF POWER SYSTEM TRANSIENTS

Interaction between lightning and power system Influence of tower footing resistance and Earth Resistance Switching: Short line or kilometric fault Energizing transients - closing and re-closing of lines, line dropping, load rejection – over voltages induced by faults. **(8)**

UNIT IV: HVDC

Switching HVDC line Travelling waves on transmission line, Circuits with distributed Parameters Wave Equation, Reflection, Refraction, Behaviour of Travelling waves at the line Terminations Lattice Diagrams – Attenuation and Distortion, Multi-conductor system and Velocity wave. (**9)**

UNIT V: INSULATION CO-ORDINATION

Insulation co-ordination: Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS) Coordination between insulation and protection level Statistical approach Protective devices, Protection of system against over voltages lightning arresters, substation earthling. **(12)**

Course Outcomes: -

Students will be able to:

1. Knowledge of various transients that could occur in power system and their mathematical formulation
2. Ability to design various protective devices in power system for protecting equipment andpersonnel
3. Coordinating the insulation of various equipments in power system
4. Modelling the power system for transient analysis

Text/Reference Books:

1. Allan Greenwood, “Electrical Transients in Power System”, Wiley & Sons Inc. New York, 1991

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech. II Year I Semester

18EPSP422 FACTS AND CUSTOM POWER DEVICES

L	T	P	C
3	0	0	3

Course Prerequisite: Power Systems, Power Electronics

Course Description:

This course facilitates the students with the necessity understanding of FACTS and custom power devices

Course Objectives:

1. To learn the active and reactive power flow control in power system
2. To understand the need for static compensators
3. To develop the different control strategies used for compensation

UNIT I: REACTIVE POWER FLOW IN POWER SYSTEM

Reactive power flow control in Power Systems, Control of dynamic power unbalances in Power System - Power flow control, Constraints of maximum transmission line loading, Benefits of FACTS Transmission line compensation, Uncompensated line -Shunt compensation, Series compensation Phase angle control, Reactive power compensation Shunt and Series compensation principles, Reactive compensation at transmission and distribution level. (**8)**

UNIT II: STATIC COMPENSATORS

Static versus passive VAR compensator, Static shunt compensators: SVC and STATCOM Operation and control of TSC, TCR and STATCOM -Compensator control, Comparison between SVC and STATCOM. (**8)**

UNIT IV: STATIC SERIES COMPENSATION

Static series compensation: TSSC, SSSC -Static voltage and phase angle regulators, TCVR and TCPAR Operation and Control, Applications, Static series compensation, GCSC,TSSC, TCSC and Static synchronous series compensators and their Control. (**9)**

UNIT IV: BASIC PRINCIPLES OF ACTIVE AND REACTIVE POWER CONTROL

SSR and its damping Unified Power Flow Controller Circuit Arrangement, Operation and control of UPFC Basic Principle of P and Q control Independent real and reactive power flow control- Applications. **(8)**

UNIT V: MODELLING & ANALYSIS OF FACTS

Introduction to interline power flow controller. Modelling and analysis of FACTS Controllers Simulation of FACTS controllers Power quality problems in distribution systems, harmonics, loads that create harmonics modelling, harmonic propagation, series and parallel resonances mitigation of harmonics passive filters, active filtering – shunt, series and hybrid and their control Voltage swells, sags, flicker, unbalance and mitigation of these problems by power line conditioners, IEEE standards on power quality. (**12)**

Course Outcomes: -

Students will be able to:

1. Acquire knowledge about the fundamental principles of Passive and Active Reactive Power Compensation Schemes at Transmission and Distribution level in Power Systems.
2. Learn various Static VAR Compensation Schemes like Thyristor/GTO Controlled Reactive Power Systems, PWM Inverter based Reactive Power Systems and their controls.
3. To develop analytical modeling skills needed for modeling and analysis of such Static VAR Systems.

Text/Reference Books:

1. K R Padiyar, "FACTS Controllers in Power Transmission and Distribution", New Age International Publishers, 2007
2. X P Zhang, C Rehtanz, B Pal, "Flexible AC Transmission Systems- Modelling and Control", Springer Verlag, Berlin, 2006
3. N.G. Hingorani, L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press Book, Standard Publishers and Distributors, Delhi, 2001.
4. K. S. Suresh kumar, S. Ashok , "FACTS Controllers & Applications", E-book edition, Naland Digital Library, NIT Calicut,2003
5. G T Heydt , "Power Quality", McGraw-Hill Professional, 2007
6. T J E Miller, "Static Reactive Power Compensation", John Wiley and Sons, Newyork, 1982.

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech. II Year I Semester

18EPSP423 INDUSTRIAL LOAD MODELING AND CONTROL

	L	T	P	C
Course Prerequisite: Power Systems	**3**	**0**	**0**	**3**

Course Description:

This course facilitates the students with the necessity understanding of industrial load modelling and control

Course Objectives:

1. To understand the energy demand scenario
2. To understand the modeling of load and its ease to study load demand industrially
3. To know Electricity pricing models
4. Study Reactive power management in Industries

UNIT I: ELECTRICITY MARKET AND DEMAND SIDE MANAGEMENT

Electric Energy Scenario-Demand Side Management-Industrial Load, Management, Load Curves-Load Shaping Objectives, Methodologies-Barriers, Classification of Industrial, Loads, Continuous and Batch processes -Load Modeling. **(8)**

UNIT II: OPTIMIZATION AND CONTROL ALGORITHMS

Electricity pricing – Dynamic and spot pricing –Models, Direct load control- Interruptible load control, Bottom up approach- scheduling- Formulation of load, Models, Optimization and control algorithms - Case studies. **(9)**

UNIT III: REACTIVE POWER MANAGEMENT

Reactive power management in industries controls-power quality impacts application of filters Energy saving in industries. **(8)**

UNIT IV: OPTIMAL OPERATION

Cooling and heating loads, load profiling Modelling- Cool storage Types-Control strategies, optimal operation Problem formulation- Case studies. **(8)**

UNIT V: INDUSTRIAL CO-GENERATION

Captive power units, Operating and control strategies, Power Pooling- Operation models, Energy banking, Industrial Cogeneration Selection of Schemes Optimal Operating Strategies, Peak load saving, Constraints Problem formulation- Case study, Integrated Load management for Industries. **(12)**

Course Outcomes: -

Students will be able to:

1. Knowledge about load control techniques in industries and its application
2. Learn different types of industrial processes and optimize the process using tools like LINDO and LINGO
3. Apply load management to reduce demand of electricity during peak time
4. Apply different energy saving opportunities in industries

Text/Reference Books:

1. C.O. Bjork " Industrial Load Management - Theory, Practice and Simulations", Elsevier, the Netherlands,1989
2. C.W. Gellings and S.N. Talukdar,. Load management concepts. IEEE Press, New York, 1986, pp. 3-28
3. Y. Manichaikul and F.C. Schweppe ," Physically based Industrial load", IEEE Trans. on PAS, April 1981
5. H. G. Stoll, "Least cost Electricity Utility Planning", Wiley Interscience Publication, USA, 1989.
6. I. J. Nagarath and D. P. Kothari, .Modern Power System Engineering., Tata McGraw Hill publishers, New Delhi, 1995
7. IEEE Bronze Book- "Recommended Practice for Energy Conservation and cost effective planning in Industrial facilities", IEEE Inc, USA

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech. II Year I Semester

18EPSP424 DYNAMICS OF LINEAR SYSTEMS

L	T	P	C
3	0	0	3

Course Prerequisite: Control Systems

Course Description:

This course facilitates the students with the necessity understanding of dynamics of linear system

Course Objectives:

1. To understand the linear system and its functions
2. To understand the stability analysis of linear systems and implement the same in MATLAB

UNIT I: STATE VARIABLE REPRESENTATION OF SYSTEMS

State variable representations of systems transfer function and transfer function matrix solutions of state equations. **(7)**

UNIT II: ANALYSIS OF LINEAR TIME VARYING SYSTEMS

Observability and controllability, minimal realization of MIMO systems, analysis of linear time varying systems, the concepts of stability. **(8)**

UNIT III: LYAPUNOV STABILITY ANALYSIS

Lyapunov stability analysis, Lyapunov function and its properties, controllability by state variable feedback. **(8)**

UNIT IV: OBSERVER DESIGN

Ackerman's Formula-stabilisation by output feedback, asymptotic observers for state measurement, observer design. **(8)**

UNIT V: STATE SPACE REPRESENTATION OF DISCRETE SYSTEM

State space representation of discrete systems, solution of state equations, controllability and observability, stability, analysis using Lyapunov method, State feedback of linear discrete time systems, design of observers - MATLAB Exercises. **(14)**

Course Outcomes: -

Students will be able to:

1. To learn linear system modeling, analysis and design so as to obtain the ability to apply the same to engineering problems in a global perspective
2. Knowledge on carrying out detailed stability analysis of both linear and nonlinear systems
3. Design observers and controllers for linear systems
4. Acquire knowledge of discrete time linear systems modeling, analysis and design
5. Develop and utilize modern software tools for analysis and design of linear continuous and discrete time systems.

Text/Reference Books:

1. Thomas Kailath, “Linear Systems”, Prentice Hall Inc., Englewood Cliffs, N.J. 1980.
2. K. Ogata, “State Space Analysis of Control Systems”, Prentice Hall Inc., Englewood Cliffs, N.J.,1965.
3. K. Ogata, “Modern Control Engineering, (second edition)” , Prentice Hall Inc., Englewood Cliffs,N.J., 1990
4. M. Gopal, “Digital Control and State Variable Methods”, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997
5. C.T. Chen, “Linear System Theory and Design”, New York: Holt Rinehart and Winston ,1984
6. R.C. Dorf, and R. T. “Bishop, Modern Control Systems”, Addison Wesley Longman Inc., 1999.

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech. II Year I Semester

18EPSP425 COMPUTER RELAYING AND PHASOR MEASUREMENT UNIT

L	T	P	C
3	0	0	3

Course Prerequisite: Digital Electronics, Analog Electronics

Course Description:
This course deals with the basic architecture of Digital Relay, basics of Phasor Measurement unit (PMU) and its applications in power system.

Course Objective:
1. To understand and analyze the basic architecture of Digital Relay.
2. To understand the basics of Phasor Measurement unit (PMU).
3. To study the applications of PMUs in power system**.**

UNIT I: **MATHEMATICAL BACKGROUND TO PROTECTION ALGORITHMS**
Mathematical background to protection algorithms-Finite difference technique-Numerical differentiation-Least Squares Method-Fourier analysis-Fourier analysis of analogue signals-Fourier analysis of discrete signals-Walsh function analysis. **(8)**

UNIT II: BASIC OF DIGITAL PROTECTION
Basic elements of digital protection-Signal conditioning subsystem-Transducers-Surge protection circuits-Analogue filtering-Analog multiplexers-Conversion subsystem-Sampling theorem-Signal aliasing error-Sample and hold circuit-Digital multiplexing-Digital to Analogue Conversion-Analogue to Digital Conversion-Processor-Data and Program memory-Digital relay hardware unit. **(9)**

UNIT III: **PHASOR MEASUREMENT UNIT**
Phasor Measurement Unit– Introduction- Phasor representation of sinusoids- Phasor Estimation of Nominal Frequency Signals- Formulas for updating phasors – Nonrecursive updates-Recursive updates- Frequency Estimation. **(9)**

UNIT IV: **STATE ESTIMATION**
Phasor Measurement Applications-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. **(12)**

UNIT V: **ADAPTIVE PROTECTION**
Adaptive protection- Differential and distance protection of transmission lines- Adaptive out-of-step protection. **(7)**

Course Outcomes: At the end of this course, students will demonstrate the ability to
1. Understand the operation of computer relay.
2. Understand the basics of phasor measurement unit.
3. Understand the different applications of PMUs on power system.

Text Books:

1. Arun G. Phadke, James S. Thorp, 'Computer Relaying for Power Systems', A John Wiley and Sons Ltd., Research Studies Press Limited, 2009.
2. A. G. Phadke, J.S. Thorp, 'Synchronized Phasor Measurements and Their Applications', Springer, 2008.

Reference:

1. A. T. Johns and S. K. Salman, 'Digital Protection For Power Systems', Peter Peregrinus Ltd, 1997.

Mode of Evaluation: Assignment, Written Examination

OPEN ELECTIVE

M. Tech. II Year I Semester

18OEP301 BUSINESS ANALYTICS

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:
Course delves into commonly encountered business situations requiring optimization of business resources and provides basic solutions methods using traditional and advanced methods.

Course objective:
1. To refresh basic statistics
2. To explain the importance of statistics in business analytics
3. To introduce predictive modeling for business decisions
4. To explain the tools for predictive modeling
5. To explain the use of simulation to make business decision
6. To explain the use of data mining techniques for making business decision

UNIT I: INTRODUCTION TO BUSINESS ANALYTICS

Introduction to Business Analytics (BA). Evolution and Scope of Business Analytics. Data for Business Analytics. Analyzing uncertainty and model assumptions – What if analysis, Data tables, Scenario manager and Goal Seek. Regression modelling. **(9)**

UNIT II: STATISTICS FOR BUSINESS ANALYTICS

Brief overview of descriptive statistics, graphical representation of data, and overview of hypothesis testing, Introduction to R statistical software. **(9)**

UNIT III: PREDICTIVE ANALYTICS METHODS

Forecasting techniques – Statistical forecasting techniques. Decomposition model – Estimation of trend, seasonality and cyclical components. Smoothing models for forecasting – moving average, exponential smoothing methods, time series analysis. **(9)**

UNIT IV: SIMULATION, RISK ANALYSIS AND DATA MINING

Simulation and Risk Analysis – Monte Carlo simulation Examples of simulation models, Introduction to Data Mining – Scope of Data Mining. Data exploration and reduction. Classification – Measuring classification performance. Classification techniques – K nearest neighbor, Discriminant Analysis, factor analysis, and Logistic regression. **(9)**

UNIT V: DECISION ANALYSIS

Decision making with uncertain information. Decision strategies for a minimize objective. Decision strategies for a maximize objective. Decision Tress. Building a decision tree. Decision trees and risk. Sensitivity analysis, Baye‘s Rule. **(9)**

Case Study: Compulsory and Relevant Cases have to be discussed in each unit.
Assignment: Two relevant assignments have to be given to the students

Course Outcomes

At the end of this course students will be able to

1. Understand the need and significance of business analytics for decision making
2. Use statistical tools to extract information from raw data
3. Use regression technique to build predictive models
4. Apply simulation technique to predict business scenarios
5. Use data mining techniques to make business decisions

Text Books:
Essentials of Business Analytics, Jeffrey Camm, James Cochran, Michael Fry, Jeffrey Ohlmann, David Anderson

References:

1. Albright C. S., Winston Wayne L. and Zappe C. J (2009). *Decision Making Using Microsoft Excel (India Edition).* Cengage Learning.
2. Evans J. R (2013). Business Analytics *Methods, Models and Decisions.* Pearson, Upper Saddle River, New Jersey.

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech. II Year I Semester

18OEP302 INDUSTRIAL SAFETY

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:

This course facilitates the students with the aspects of Industrial safety, fundamentals of maintenance engineering, Wear and Corrosion and their prevention and Periodic and preventive maintenance.

UNIT I:
Industrial safety: 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. **(9)**

UNIT II:
Fundamentals of maintenance engineering: 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. **(9)**

UNIT III:
Wear and Corrosion and their prevention: 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. **(9)**

UNIT IV:
Fault tracing: 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. **(9)**

UNIT V:
Periodic and preventive maintenance: 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. **(9)**

Text/Reference Books:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech. II Year I Semester

18OEP303 OPERATIONS RESEARCH

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:

This course facilitates the students with the aspects of different Optimization Techniques.

UNIT I
Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques,Sensitivity Analysis, Inventory Control Models. **(9)**

UNIT II
Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplexmethod - sensitivity analysis - parametric programming. **(9)**

UNIT III
Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT. **(9)**

UNIT IV
Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming. **(9)**

UNIT V
Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation. **(9)**

Course Outcomes:

At the end of the course, the student should be able to

1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.

Text/Reference Books:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech. II Year I Semester

18OEP304 COST MANAGEMENT OF ENGINEERING PROJECTS

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:

This course facilitates the students with the aspects of the Strategic Cost Management Process.

UNIT I
Introduction and Overview of the Strategic Cost Management Process. **(6)**

UNIT II
Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunitycost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control;Provision of data for Decision-Making. **(9)**

UNIT III
Project: meaning, Different types, why to manage, cost overruns centres, various stages of projectexecution: conception to commissioning. Project execution as conglomeration of technical and nontechnicalactivities. Detailed Engineering activities. Pre project execution main clearances anddocuments 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 Networkdiagram. Project commissioning: mechanical and process. **(12)**

UNIT IV
Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-makingproblems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing,Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning,Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-BasedCost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control;Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitabilitypricing decisions including transfer pricing. **(12)**

UNIT V
Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory. **(6)**

Text/Reference Books:

1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
4. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher

5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech. II Year I Semester

18OEP305 COMPOSITE MATERIALS

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:

This course facilitates the students with the basics of composite materials and its Manufacturing methods.

UNIT I:
INTRODUCTION: Definition – Classification and characteristics of Composite materials.Advantages and application of composites. Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance. **(9)**

UNIT II:
REINFORCEMENTS: 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 Isostress conditions. **(9)**

UNIT III:
Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix
Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carboncomposites: Knitting, Braiding, Weaving. Properties and applications. **(9)**

UNIT IV:
Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications. **(9)**

UNIT – V:
Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygro thermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations. **(9)**

Text Books:

1. Material Science and Technology – Vol 13 – Composites by R. W. Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

Reference Books:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K. K. Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.

M. Tech. II Year I Semester

18OEP306 WASTE TO ENERGY

L	T	P	C
3	0	0	3

Course Prerequisite: None

Course Description:

This course facilitates the students with the basics of how energy can be generated from waste materials.

UNIT I:
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors. **(9)**

UNIT II:
Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods – Yields and application – Manufacture of pyrolytic oils and gases, yields and applications. **(9)**

UNIT III:
Biomass Gasification: 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 consideration in gasifier operation. **(9)**

UNIT IV:
Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors. **(9)**

UNIT V:
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. **(9)**

References:

1. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.
2. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

Mode of Evaluation: Assignments, Internal Mid Examinations, External End Examination.