MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE, MADANAPALLE

(UGC-AUTONOMOUS)

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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

CURRICULUM
AND
SYLLABI

M.TECH. ELECTRICAL POWER SYSTEMS

VISION AND MISSION OF THE INSTITUTION

Vision

Become a globally recognized research and academic institution and thereby contribute to technological and socio-economic development of the nation

Mission

To foster a culture of excellence in research, innovation, entrepreneurship, rational thinking and civility by providing necessary resources for generation, dissemination and utilization of knowledge and in the process create an ambience for practice-based learning to the youth for success in their careers.

VISION AND MISSION OF THE DEPARTMENT

Vision

To become a Department recognized for its ability to provide quality education to the students and make them excel in the domain of electrical engineering, with research proficiency and ethics, to meet the challenges from society.

Mission

- To impart quality education and advancements in program of studies for producing engineers with scientific temperament and moral values in the field of electrical engineering
- To create and develop research culture with deep sense of commitment, so as to enable the industries to adopt the research outputs
- To enhance the technical dexterity, so as to find the suitable solutions in their respective domain, for welfare of the society

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

The graduates will

PEO1: work in electric power industries, energy sectors, reputed institutions and allied fields.

PEO2: pursue higher education and involve in research activities.

PEO3: exhibit intellectual skills with ethics through life-long learning to cater the societal needs.

PROGRAMME OUTCOMES (POs)

At the end of the programme, graduates will be able to

PO1: analyze problems related to power systems in-depth and be able to utilize the domain knowledge and principles for the design and enhancement of the state of art solutions

PO2: examine critically the power system problems and make theoretical, practical and policy decisions

PO3: think laterally and originally on solving power system problems to arrive feasible, optimal solutions

PO4: identify the unfamiliar power system problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools to enhances the domain knowledge

PO5: apply modern engineering tools to complex power system studies with an understanding of the limitations

PO6: participate in collaborative-multidisciplinary scientific research to work as a team member in power system domain in order to achieve common goals.

PO7: understand the engineering and management principles and demonstrate leadership qualities after consideration of economical and financial intricacies.

PO8: communicate effectively with engineering community, and demonstrate its ideas clearly

PO9: engage in life-long learning with self-motivation to improve knowledge and competence continuously

PO10: practice professional ethics with intellectual integrity, code of conduct and serve towards the sustainable development of the society

PO11: examine critically the outcomes of research and development activities independently to make corrective measures subsequently

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Course Structure and Syllabi
M.Tech. Electrical Power Systems [EPS]

I YEAR - I Semester

S. No	Course code	Subject	Theory	Lab.	Credits	I.M	E.M	M.M
1.	14EPS11T01	Modern Control Theory	4	0	4	40	60	100
2.	14EPS11T02	Power System Control and Stability	4	0	4	40	60	100
3.	14EPS11T03	Operation and Control of Power System	4	0	4	40	60	100
4.	14EPS11T04	Integration of Renewable Energy Sources	4	0	4	40	60	100
5.	14EPS11T05	Analysis of Power Electronic Converters	4	0	4	40	60	100
6.		Elective-I	4	0	4	40	60	100
	14EPS11E1a	1. Artificial Intelligence Techniques						
	14EPS11E1b	2. Reactive Power Compensation and Management						
	14EPS11E1c	3. Power System Deregulation						
7	14EPS11P01	Electrical Machines and Power Systems Lab	0	3	2	40	60	100
		Contact periods/week	24	3				
		Total	**27**		**26**	**280**	**420**	**700**

I YEAR - II Semester

S. No	Course code	Subject	Theory	Lab.	Credits	I.M	E.M	M.M
1.	14EPS12T06	HVDC & Flexible A.C. Transmission Systems	4	0	4	40	60	100
2.	14EPS12T07	Machine Modeling Analysis	4	0	4	40	60	100
3.	14EPS12T08	EHVAC Transmission	4	0	4	40	60	100
4.	14EPS12T09	Advanced Power System Protection	4	0	4	40	60	100
5	14EPS12T10	Computer Applications in Power Systems	4	0	4	40	60	100
6.		Elective-II	4	0	4	40	60	100
	14EPS12E2a	1. Energy Auditing, Conservation and Management						
	14EPS12E2b	2. Power System Transients						
	14EPS12E2c	3. Distributed Generation and Micro Grid						
7	14EPS12P02	Power System Simulation lab	0	3	2	40	60	100
		Contact periods/week	24	3				
		Total	**27**		**26**	**280**	**420**	**700**

II YEAR (III & IV Semesters)

S. No	Course code	Subject	Credits	I.M	E.M	M.M
1	14EPS22S01	Seminar	2	50		
2	14EPS22D01	Project Work	16	40	60	100

M. Tech I Year - I SEMESTER

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MODERN CONTROL THEORY
(14EPS11T01)

Course Objectives:

- To analyze dynamics of a linear system by solving system model/equation or applying domain transformation
- To analyze the system stability, controllability and observability
- To implement basic principles and techniques in designing the systems
- To formulate and solve deterministic optimal control problems in terms of performance indices
- To apply knowledge of control theory for practical implementations in engineering and network analysis

Course Outcomes:

After Completion of this course students will be able to

- Understand and design state space models for LTI system
- Determine controllability and observability of LTI system
- Analyze system behavior subjected to non-linearity
- Analyze stability of the system using lyapunov method
- Design controller for LTI system
- Understand the concept of optimal controller

Unit-I

State space representation of systems. Solution to Time-Varying state equations. Evaluation of State Transition Matrix (STM) - Simulation of state equation using MATLAB/ SIMULINK program. Similarity transformation and invariance of system properties due to similarity transformations. Minimal realization of SISO, SIMO, MISO transfer functions. Discretization of a continuous time state space model. Conversion of state space model to transfer function model using Fadeeva algorithm.

Unit-II

Introduction to controllability & observability and its tests-Fundamental theorem of feedback control – Jordan Canonical form and Controllable canonical form - Pole assignment by state feedback using different techniques- Observable canonical form - Design of full order & reduced order observer – Test of controllability and observability using MATLAB.

Unit-III

Introduction to non-linear system-describing function-stability analysis using describing function-phase plane analysis.

Unit-IV

Linear Quadratic Regulator (LQR) problem and solution 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.

Unit-V

Introduction-Internal stability of a system-Stability in the sense of Lyapunov, asymptotic stability of linear time variant & invariant continuous systems-Popov’s stability analysis-Solution of Lyapunov type equation.

Text Books:
1. K. Ogata, Modern Control Engineering, Prentice Hall, India 1997
2. T. Kailath, T., Linear Systems, Perntice Hall, Englewood Cliffs, NJ, 1980.
3. N. K. Sinha , Control Systems, New Age International, 3rd edition, 2005.

Reference Books:
1. Panos J Antsaklis, and Anthony N. Michel, Linear Systems, New - age international (P) LTD. Publishers, 2009.
2. John J D‟Azzo 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.

M. Tech I Year - I SEMESTER

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POWER SYSTEM CONTROL & STABILITY (14EPS11T02)

Course Objectives:

- To know the elementary mathematical model and system response to small disturbances
- To gain knowledge about dynamic stability and its analysis
- To impart the concepts of transient stability
- To impart knowledge on voltage stability.

Course Outcomes:

After Completion of this course students will be able to

- Solve mathematical calculations and swing equation and obtain classical model of an infinite bus system
- Analyze state space model of an machine system connected to infinite bus and concepts of dynamic stability by Routh's criteria
- Analyze the effect of small speed changes in multi machine synchronous machines and voltage regulator governor system
- Understand the transient stability analysis under common disturbances including the short circuits and find clearing time and solution for swing equation by step by step method
- Analyze the factors effect voltage stability and analysis of factors and solutions of control of voltage instability

Unit-I: The Elementary Mathematical Model

Development of swing equation, linearization of swing equation A Classical model of one machine connected to an infinite bus – Classical model of multi machine system.

Unit-II: Dynamic Stability

Concept of Dynamic stability – state space model of one machine system connected to infinite bus – effect of excitation on Dynamic stability – examination of dynamic stability by Routh's criterion.

Unit-III: Dynamic Stability Analysis

The unregulated synchronous Machine – Effect of small changes of speed – modes of oscillation of an unregulated Multi machine system – regulated synchronous machine – voltage regulator with one time lag – Governor with one time lag – Problems.

Unit-IV: Transient Stability

Equal area criterion and its application to transient stability studies under common disturbances including short circuits. Critical clearing angle and critical clearing time. Numerical solution of swing equation by step-by-step method.

Unit-V: Voltage Stability

What is voltage stability –Factors affecting voltage instability and collapse – Comparison of Angle and voltage stability – Analysis of voltage instability and collapse – Integrated analysis of voltage and Angle stability – Control of voltage instability.

Text Books:

1. Power System Control and Stability, P.M. Anderson and A.A.Fouad, Galgotia Publications, New Delhi, 2003.
2. Power System Stability and Control, P. Kundur, McGraw Hill Inc., USA, 1994.
3. Power System Dynamics and Stability, M.A.Pai and W.Sauer, Pearson Education Asia, India, 2002.

References:

1. Electric Systems, Dynamics and stability with Artificial Intelligence applications, James A.Momoh, Mohamed.E. EI-Hawary, Marcel Dekker, USA First Edition, 2000.
2. G W Stagg and A H El Abiad, "Computer Methods in Power System Analysis", McGraw Hill, 1968.
3. J J Grainger and W D Stevension, "Power System Analysis", McGraw-Hill, Inc., 1994.
4.D P Kothori and I J Nagrath, "Modern Power System Analysis", Tata McGraw Hill Education Private Limited, 2011.
5.Hadi Saadat, "Power System Analysis" McGraw-Hill, 2004.

M. Tech I Year – I SEMESTER (EPS)

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OPERATION AND CONTROL OF POWER SYSTEM (14EPS11T03)

Course Objectives:

- To know the general concepts of economic operation, unit commitment and solution methods
- To impart the concepts of hydro thermal scheduling and pumped storage hydro plants
- To understand automatic generation control, its implementation and static and dynamic responses of uncontrolled & controlled two-area system.
- To gain the knowledge on inter change of power and energy, power pools and transmission effects.
- To analyze the power system security, load contingency analysis, optimal power flow (OPF) techniques and SCADA in power system

Course Outcomes:

After Completion of this course students will be able to

- Acquaint load forecasting techniques, Economic load dispatch, unit commitment problem and dynamic solution problem.
- Analyze the scheduling of hydro-thermal units, co-ordination and pumped storage hydro plant
- Understand automatic generation control, its implementation and static and dynamic responses of uncontrolled & controlled two-area system.
- Understand the concepts of interchange of power and energy in interconnected modes, power pools and transmission effects
- Investigate the power system security, load contingency analysis, optimal power flow (OPF) techniques and SCADA in power system.

Unit-I:

Economic operation- Load forecasting - Unit commitment – 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

Unit-II:

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.

Unit-III:

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.

Unit-IV:

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

Unit-V:

Power system security-Contingency analysis–linear sensitivity factors – AC power flow methods – contingency selection – concentric relaxation–bounding-security constrained optimal power flow-Interior point algorithm-Bus incremental costs-Introduction to Supervisory Control and Data Acquisition. SCADA functional requirements and Components-General features, Functions and Applications, Benefits.

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

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M. Tech I Year – I SEMESTER (EPS)

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INTEGRATION OF RENEWABLE ENERGY SOURCES (14EPS11T04)

Course Objectives:

- To perform basic engineering calculations of energy and power for renewable energy Systems.
- To understand renewable resource assessment and integration with energy infrastructure.
- To identify environmental impacts of renewable energy systems
- To design and assess the technical and economic feasibility of renewable energy systems.

Course Outcomes:

After Completion of this course students will be able to

- Review the significance of non-conventional energy sources
- Explain the integration of renewable energy sources with energy infrastructure
- Learn the concepts in detail about solar and wind energy systems
- Learn the concepts of other energy systems like biomass, hydro energy, geothermal, tidel wave energy etc.
- Learn about Energy Storage and Hybrid System Configurations for Energy Storage

Unit-I: Energy Scenario

Classification of energy sources – Energy resources: Conventional and non-conventional –Energy needs of India – Energy consumption patterns – Worldwide Potentials of these sources – Energy efficiency – Energy security – Energy and its environmental impacts – Global environmental concern – Kyoto Protocol – Concept of Clean Development Mechanism (CDM) and Prototype Carbon Funds (PCF) – Factors favoring and against renewable energy sources – IRP.

Unit-II: Solar Energy

Solar thermal Systems – Types of collectors – Collection systems – Efficiency calculations – Applications – Photo Voltaic (PV) technology – Present status – Solar cells – Cell technologies – Characteristics of PV systems – Equivalent circuit – Array design – Building integrated PV system and its components – Sizing and economics – Peak power operation – Standalone and grid interactive systems.

Unit-III: Wind Energy

Wind Energy – Wind speed and power relation – Power extracted from wind – Wind distribution and wind speed predictions – Wind power systems – System components – Types of Turbine – Turbine rating – Choice of generators – Turbine rating – System design features – Stand alone and grid connected operation. Wind energy conversion systems, Induction generator, Synchronous generator with full scale power electronic block, variable speed operations, doubly fed induction generation.

Unit-IV: Other Energy Systems

Biomass – Various resources – Energy contents – Technological advancements – Conversion of Bio-mass in other form of energy – solid, liquid and gases – Gasifiers – Biomass fired boilers – Co-firing – Generation from municipal solid waste – Issues in harnessing these sources. Hydro energy – Feasibility of small, mini and micro hydel plants: scheme, layout and economics – Tidal and wave energy – Geothermal and Ocean-Thermal Energy Conversion (OTEC) systems Schemes, feasibility and viability.

Unit-V: Energy Storage and Hybrid System Configurations for Energy Storage

Energy storage –Battery – Types – Equivalent circuit – Performance characteristics – Battery Design-Charging and charge regulators–Battery management-Fly wheel energy relations –Components – Benefits over battery – Fuel cell energy – Storage systems – Ultra capacitors.

Text Books:

1. Rai, G. D., "Non-Conventional Energy Sources", Khanna Publishers, 1993.
2. Rao S. Paruklekar, "Energy Technology – Non Conventional, Renewable and Conventional", Khanna Publishers, 1999.

Reference Books:

1. Openshaw Taylor, E., "Utilisation of Electric Energy in SI Units.", Orient Longman Ltd, 2007.
2. Uppal, S.L., "Electric Power", 13th Edition, Khanna Publishers, 1997.3. Mukund R. Patel, "Wind and Solar Power Systems", CRC Press LLC, 1999.

M. Tech I Year - I SEMESTER

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ANALYSIS OF POWER ELECTRONIC CONVERTERS (14EPS11T05)

Course Objectives:

- To analyze the operation of AC voltage controllers and AC-DC converters.
- To design the single/three phase PWM inverters.
- To learn the characteristics of different Multi level inverters.

Course Outcomes:

After Completion of this course students will be able to

- Analyze the operation, characteristics of single and three phase AC voltage controllers
- Learn the operation, characteristics and analysis and design of single phase controller circuits
- Understand the operation and types of switching technique for single phase dc-ac converters
- Study the operation ,characteristics and analysis of multi-level inverters
- Learn the operation, characteristics and analysis and design of three phase controller circuits
- Understand the operation and types of switching technique for three phase dc-ac converters

Unit-I: AC voltage Controllers

Single Phase AC Voltage Controllers with RL and RLE loads-ac voltage controller's with PWM control-Effects of source and load inductances–synchronous tap changers – Application- numerical problems-Three Phase AC Voltage controllers-Analysis of Controllers with star and delta connected resistive, resistive –inductive loads-Effects of source and load inductances–Application- numerical problems.

Unit –II: Single-Phase AC-DC Converters

Single phase Half controlled and Fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-Power factor improvements-Extinction angle control-symmetrical angle control-PWM single phase sinusoidal PWM-Single phase series converters- numerical problems.

Unit-III: Three-Phase AC-DC Converters

Three Phase ac-dc Converters- Half controlled and fully controlled Converters with RL load– Evaluation of input power factor and harmonic factor-Continuous and Discontinuous load current-three phase dual converters-Power factor improvements-three phase PWM-twelve pulse converters- numerical problems.

Unit –IV: PWM Inverters

Principle of operation-Voltage control of single phase inverters - sinusoidal PWM – modified PWM – phase displacement Control – Trapezoidal, staircase, stepped, harmonic injection and delta modulation – numerical problems-Voltage Control of Three-Phase Inverters- Sinusoidal PWM-Third Harmonic PWM-Space Vector Modulation- Comparison of PWM Techniques-current source inverters-Variable dc link inverter - numerical problems.

Unit V: Multi level 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- Switching Device Currents-

DC-Link Capacitor Voltage Balancing- Features of Multilevel Inverters- Comparisons of Multilevel Converters.

Text Books:

1. Power Electronics-Md.H.Rashid –Pearson Education Third Edition- First Indian Reprint- 2008
2. Power Electronics- Ned Mohan, Tore M.Undelan and William P.Robbins –John Wiley & Sons -2nd Edition.

M. Tech I Year - I SEMESTER
(ELECTIVE-I)

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4	4

ARTIFICIAL INTELLIGENCE TECHNIQUES (14EPS11E1a)

Course Objectives:

- To gain the knowledge of Artificial Neural Networks
- To design the Single Layer and Multilayer Feed Forward Networks for different engineering applications.
- To impart the basics Fuzzy sets and Fuzzy Logic system components
- To gain the basic knowledge on Genetic Algorithms.
- To analyze & design fuzzy logic controller & genetic algorithm for electrical engineering problems.

Course Outcomes:

After Completion of this course students will be able to

- Explain the concepts of Artificial Neural Networks
- Design a single layer and Multilayer neural networks.
- Explain the concepts self-organizing learning networks and adaptive resonance theory.
- Solve economic load dispatch problem using genetic algorithms.
- Design the fuzzy logic controller for various applications using fuzzification and de-fuzzification methods.

Unit – I: Introduction to Neural Networks

Introduction, Humans and Computers, Organization of the Brain, Biological Neuron, Biological and Artificial Neuron Models-architectures-learning process-learning methods.

Unit- II: Single & Multilayer Feed Forward Neural Networks

Introduction, Perceptron Models-Training Algorithms-Perceptron Convergence theorem, Limitations of the Perceptron Model- Generalized Delta Rule, Derivation of Back propagation (BP) -Training, Summary of Back propagation Algorithm, Learning Difficulties and Improvements- Architecture of Hopfield Network-ANN applications to power engineering-load forecasting-load flows.

Unit-III: **Self-Organizing Maps (SOM) and Adaptive Resonance Theory (ART)**

Introduction, Competitive Learning, Vector Quantization, Self-Organized Learning Networks- Kohonen Networks, Training Algorithms, Linear Vector Quantization, Stability- Plasticity Dilemma, Feed forward competition-ART1, ART2.

Unit-IV: Genetic Algorithms

Introduction-encoding-fitness function-reproduction operators, genetic modeling-genetic operators-cross over and mutation-generational cycle-convergence of genetic algorithm-Genetic application-economic load dispatch.

Unit-V: Sets and Fuzzy Sets Fuzzy Logic Systems Components

Introduction to classical sets - properties, Operations and relations-Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions-Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods-Fuzzy application-speed control of dc motor.

Text Books:

1. Principles of – Soft Computing by S. N. Sivanandam and S. N. Deepa, Wiley India Edition.
2. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Pai – PHI Publications.
3. Nureal networks by Satish Kumar , TMH, 2004.
4. Neuro Fuzzy and Soft Computing by J. S. R. Jang, C. T. Sun and E. Mizutani, Pearson Education.

Reference Books:

1. Neural Networks – James A Freeman and Davis Skapura, Pearson Education, 2002.
2. Neural Networks – Simon Hakins , Pearson Education
3. Fuzzy Logic with Engineering Applications by T. J. Ross, 2nd Edition , Wiley India Edition.
4. Neural Networks and Fuzzy Logic System by Bart Kosko, PHI Publications.
5. Genetic Algorithms by D. E. Goldberg, Addison – Wisley, 1999.

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M. Tech I Year - I SEMESTER
(ELECTIVE-I)

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REACTIVE POWER COMPENSATION AND MANAGEMENT
(14EPS11E1b)

Course Objectives:

- To understand the fundamental concepts of compensation
- To impart knowledge on reactive power planning and coordination
- To understand the concepts of Demand side management.
- To interpret the reactive power compensation in arc furnaces.

Course Outcomes:

After Completion of this course students will be able to

- Interpret the fundamental theory of compensation
- Design the steady state reactive power compensation scheme for transmission system
- Design the transient state reactive power compensation scheme for transmission system
- Plan for reactive power coordination in electrical system
- Examine the features of demand side management & user side management
- Infer the distribution side management & reactive power compensation in arc furnaces

Unit – I: Load Compensation

Objectives and specifications – reactive power characteristics – inductive and capacitive approximate biasing – Load compensator as a voltage regulator – phase balancing and power factor correction of unsymmetrical loads- examples.

Unit –II: Reactive power compensation in transmission system:

Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples-Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers – examples

Unit – III: Reactive power coordination:

Objective – Mathematical modeling – Operation planning – transmission benefits – Basic concepts of quality of power supply – disturbances- steady –state variations – effects of under voltages – frequency – Harmonics, radio frequency and electromagnetic interferences

Unit – IV: Demand side management:

Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks

Unit – V: User side reactive power management:

KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace-Reactive power forecasting.

Text Books:

1. Reactive power control in Electric power systems by T.J.E.Miller, John Wiley and sons, 1982.
2. Reactive power Management by D.M.Tagare,Tata McGraw Hill, 2004.

M. Tech I Year - I SEMESTER

(ELECTIVE-I)

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POWER SYSTEM DEREGULATION
(14EPS11E1c)

Course Objectives:

- To provide in-depth understanding of operation of deregulated electricity market systems.
- To impart the knowledge on fundamental concepts of congestion management.
- To analyze the concepts of location marginal pricing and financial transmission rights.
- To enable students to analyze various types of electricity market operational and control issues using new mathematical models.

Course Outcomes:

After Completion of this course students will be able to

- Explain the operation of deregulated electricity market systems
- Analyze cost-effective methods to supply quality power
- Analyze price based unit commitment problems
- Analyze transmission costing and congestion management methods
- Analyze various operational and control issues of electricity market

Unit-I: Need of Deregulation

Need and conditions for deregulation. Introduction of Market structure, Market Architecture, Spot market, forward markets and settlements. Review of Concepts marginal cost of generation, least-cost operation, incremental cost of generation. Power System Operation: Old vs. New methods.

Unit-II: Electricity Market Structure

Electricity sector structures and Ownership /management, the forms of Ownership and management. Different structure model like Monopoly model, Purchasing agency model, wholesale competition model, Retail competition model.

Unit-III: Bilateral Marketing

Framework and methods for the analysis of Bilateral and pool markets, LMP based markets, auction models and price formation, price based Unit commitment, country practices.

Unit-IV: Transmission Costing & Congestion Management Methods

Transmission network and market power. Power wheeling transactions and marginal costing, transmission costing-Congestion management methods- market splitting, counter-trading; Effect of congestion on LMPs- country practices

Unit-V: Power Systems Security & Regulatory Issues

Ancillary Services and System Security in Deregulation. Classifications and definitions, AS management in various markets- country practices-Technical, economic, & regulatory issues involved in the deregulation of the power industry-Fixed transmission rights (FRT).

Text Books:

1. Power System Economics: Designing markets for electricity - S. Stoft
2. Power generation, operation and control, -J. Wood and B. F. Wollenberg
3. Operation of restructured power systems - K. Bhattacharya, M.H.J. Bollen and J.E. Daalder
4. Market operations in electric power systems - M. Shahidehpour, H. Yamin and Z. Li
5. Fundamentals of power system economics - S. Kirschen and G. Strbac
6. Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry - N. S. Rau
7. Competition and Choice in Electricity - Sally Hunt and Graham Shuttleworth
8. Electrical Power Distribution System Engineering – Turan Gonen, second edition

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M. Tech I Year - I SEMESTER

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ELECTRICAL MACHINES AND POWER SYSTEMS LAB (14EPS11P01)

Course Objectives:

- To paraphrase the operational characteristics of synchronous machine
- To categorize losses in induction motor
- To analyze various faults in power system
- To interpret the operating characteristics of various protective relays

Course Outcomes:

After Completion of this course students will be able to

- Analyze the synchronous machine characteristics for power system analysis
- Analyze the no-load loss of a poly-phase induction motor
- Realize the effect of fault during abnormal conditions
- Analyze the performance of salient-pole type synchronous machine
- Plot the characteristics of various protective relays

List of Experiments:

1. Determination of Sub transient Reactance of a Salient Pole Machine
2. Determination of Sequence Impedances of a Cylindrical Rotor Synchronous Machine
3. Fault Analysis-I
   i) LG Fault
   ii) LL Fault
4. Fault Analysis-II
   i) LLG Fault
   ii) LLLG Fault
5. Equivalent circuit of a three-winding transformer
6. Separation of No Load losses of a Three Phase Squirrel Cage Induction Motor
7. Power Angle Characteristics of a Salient Pole Synchronous Machine
8. Capability curve of a Synchronous Generator
9. Conversion of 3-phase to 2-phase through Scott Connection of transformer
10. Characteristics of IDMT Over Current Relay
11. Characteristics of Static Negative Sequence Relay
12. Characteristics of Over Voltage Relay
13. Characteristics of Percentage Biased Differential Relay

II SEMESTER

M. Tech I Year - II SEMESTER

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HVDC & FLEXIBLE A.C. TRANSMISSION SYSTEMS (14EPS12T06)

Course Objectives:

- To understand the configuration and working of HVDC & Ac systems
- This impart the idea about modern trends in HVDC Transmission and its application
- To analyze harmonics and to understand the different protection schemes of HVDC System
- To understand the operating principles of power semiconductor devices.
- To analyse the operation of shunt and series compensators.
- To impart knowledge on application of shunt and series compensators to improve AC power transmission.

Course Outcomes:

After Completion of this course students will be able to

- Elucidate the benefits of high voltage 'HVDC Transmission' in Power systems
- Understand operation of 6-pulse and 12-pulse converter in detail
- Design the suitable filters to filter out harmonics in DC Voltages and AC currents
- Analyze converter control characteristics and their control schemes
- Analyze various series and shunt compensation techniques and their applications
- Work on various Multifunctional FACTS devices

Unit-I: DC Power Transmission Technology

Introduction-comparison of AC and DC transmission-application of DC transmission description of DC transmission system-planning for HVDC transmission-modern trends in DC transmission, Different configuration of HVDC scheme.

Unit-II: Analysis of HVDC Converters

Pulse number-choice of converter configuration-simplified analysis of Graetz circuit converter bridge characteristics – characteristics of a twelve pulse converter, Different faults occurred in converter, Protection against overvoltage, over current.

Unit-III: HVDC System Control

General principles of DC link control-converter control characteristics –system control hierarchy – firing angle control-current and extinction angle control-starting and stopping of DC link – power control-higher level controllers – telecommunication requirements. Harmonics and Filters: Introduction-generation of harmonics-design of AC filters-DC filters-carrier.

Unit-IV: Series Compensation Technique

Basic concepts of reactive power compensation, Types of compensation, Static VAR compensators, Resonance damper, Thyristor controlled series capacitor (TCSC), Static condenser, Phase angle regulator, and other controllers. Sub-Synchronous resonance, Tensional interaction, Modeling and control of Thyristorised controlled series compensators. Static VAR Compensation - Basic concepts, Thyristor controlled reactor (TCR), Thyristors switched reactor (TSR), Thyristor switched capacitor (TSC), saturated reactor (SR), and fixed capacitor (FC).

Unit-V: Shunt Compensation Technique

Variable structure FACTS controllers for Power system transient stability, Non-linear variable structure control, Unified power flow, Unified Power Flow Control - Introduction, Implementation of power flow control using conventional thyristors, concept, Implementation of unified power flow controller. Basics of STATCOM, its applications.

Text Book:

1. “Understanding FACTS Devices” N.G. Hingorani and L. Guygi. IEEE Press Publications 2000.
2. Kimbark, E.W., Direct current transmission-Vol.1’, Wiley Interscience, New York, 1971
3. Arrilaga, J., `High Voltage Direct current transmission’, Peter PereginverLtd. London, UK.,1983
4. Padiyar, K.R., `HVDC Transmission system’, Wiley Eastern Limited., New Delhi, 1992

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M. Tech I Year - II SEMESTER (EPS)

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4	4

MACHINE MODELING AND ANALYSIS
(14EPS12T07)

Course Objectives:

- To analyze the concepts of machine modeling
- To obtain the primitive machine models of Electrical Machines
- To derive the mathematical model of induction motor
- To comprehend the modeling of Synchronous Machine & DC Machine

Course Outcomes:

After Completion of this course students will be able to

- Analyze the basic concepts of machine modelling
- Develop the primitive machine models of Electrical Machines
- Derive the Mathematical models of DC Motors
- Develop d-q model representation of Induction motor for different reference frames
- Derive the mathematical models of PM synchronous motor

Unit-I: Basic concepts of Modeling

Basic Two-pole Machine representation of commutator machines, 3-phase synchronous machine with and without damper bars and 3-phase induction machine, Kron's primitive Machine-voltage, current and Torque equations.

Unit-II: DC Machine Modeling

Mathematical model of separately excited D.C motor – Steady State analysis-Transient State analysis-Sudden application of Inertia Load-Transfer function of Separately excited D.C Motor-Mathematical model of D.C Series motor, Shunt motor-Linearization Techniques for small perturbations.

Unit-III: Modeling of Three Phase Induction Machine - I

Transformation from Three phase to two phase and Vice Versa - Transformation from Rotating axes to stationary axes and vice versa –Park's Transformation and its physical concept –The Inductance matrix-Mathematical model of Induction machine –Steady State analysis.

Unit-IV: Modeling of Three Phase Induction Machine - II

D-Q model of induction machine in Stator reference Frame, Rotor reference Frame and Synchronously rotating reference Frame-Small signal equations of induction machine-d-q flux linkages model derivation- Signal flow graph of the induction machine-Per Unit model-Dynamic simulation of induction machine.

Unit-V: Modeling of Single Phase Induction Machine & Synchronous Machine

Comparison between single phase and poly-phase induction motor - Cross field theory of single phase induction machine, steady state analysis – steady state torque-Synchronous machine inductances –The phase Co-ordinate model-The Space phasor (d-q) model-Steady state operation-Mathematical model of PM Synchronous motor.

Text Books:

1. Generalized Theory of Electrical Machines – P.S.Bimbra-Khanna publications-5th edition- 1995
2. The Unified Theory of Electrical Machines by C.V.jones, Butterworth- London, 1967
3. Electric Motor Drives Pearson Modeling, Analysis& control -R.Krishnan- Publications-1st edition - 2002
4. Electrical Drives- I. Boldea & S.A. Nasar-The Oxford Press Ltd.
5. Electrical Machine Dynamics- D.P. Sengupta & J.B. Lynn- The Macmillan Press
6. Electromechanical Dynamics- Woodson & Melcher -John Wiley

7. Analysis of Electrical Machinery – P.C.Krause – McGraw Hill- 1980

M. Tech I Year - II SEMESTER

Th	C
4	4

EHVAC TRANSMISSION
(14EPS12T08)

Course Objectives:

- To understand the transmission line trends and preliminaries and to calculate line and ground parameters
- To analyze the Electrostatic field and Electromagnetic field in energized and un-energized lines
- To familiarize the effects of corona and their measurements
- To comprehend the concept of designing of EHV AC lines based on steady state and transient limits.

Course Outcomes:

After Completion of this course students will be able to

- Identify the mechanical aspects of transmission lines, standard transmission voltages & ground parameters.
- Calculate inductance and capacitance parameters of EHVAC lines
- Calculate of Electrostatic fields and magnetic fields of AC lines and to analyze the concept of voltage gradient.
- Contrast power frequency voltage control and over voltages in EHV lines.
- Analyze the concepts and measurements of corona and audio noise, radio interference due to corona in EHV AC lines
- Explain the concept of EHV cables and their characteristics.

Unit-I:

E.H.V.A.C. Transmission line trends and preliminary aspects- standard transmission voltages –power handling capacity and line loss- mechanical considerations in line performance- Estimation at line and ground parameters - properties of bundled conductors–bundle conductor systems inductance and capacitance of E.H.V. lines – positive, negative and zero sequence impedance – Line Parameters for Modes of Propagation.

Unit-II:

Electrostatic field and voltage gradients – calculations of electrostatic field of AC lines – effect high electrostatic field on biological organisms and human beings surface voltage gradients and maximum gradients of actual transmission lines – voltage gradients on sub conductor - Electrostatic induction in un-energized lines – measurements of field and voltage gradients for three phase single and double circuit lines un-energized lines.

Unit-III:

Power Frequency Voltage control and over voltages in EHV lines: Problems at power frequency- No load voltage conditions and charging current - voltage control – shunt and series compensation – static VAR compensation – SSR phenomenon in series capacitor compensated lines

Unit-IV:

Corona in E.H.V. lines – Corona loss formulae -Attenuation of traveling waves due to Corona – audio noise due to Corona, its generation, characteristic and limits–Measurements of audio noise -radio interference due to Corona-RF properties of radio noise– Limits for RI fields - frequency spectrum of RI fields – Measurements of RI and RIV.

Unit-V:

Design of EHV lines based on steady state and transient limits: Design factors- Design examples- EHV cables and their characteristics

Text Books:

1. Extra High Voltage AC Transmission Engineering – Rokosh Das Begamudre, Wiley EASTERN LTD., NEW DELHI – 1987.
2. EHV Transmission line reference Books – Edison Electric Institution (GEC 1968).

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M. Tech I Year - II SEMESTER (EPS)

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ADVANCED POWER SYSTEM PROTECTION
(14EPS12T09)

Course Objectives:

- To know construction of static relays
- To understand the operation of amplitude and phase comparators
- To absorb the concepts of Static over current, static differential and static distance relays.
- To understand multi-input comparators and concept of power swings on the distance relays.
- To know the operation of microprocessor based protective relays.

Course Outcomes:

After Completion of this course students will be able to

- Explain the basic construction of static relay and identify the advantages of static relay over electromagnetic relay
- Understand the rectifier bridge comparators, instantaneous comparators and phase comparators operation
- Explain the different static over current relays and to understand the concepts of static differential and distance relays
- Explain multi input comparators and the concept of power swings on distance relays
- Understand the microprocessor based protective relays and their operation

Unit-I:

Static Relays: Advantages of static relays-Basic construction of static relays–Level detectors– Influence of static protective relays on associated equipments-Replica impedance-mixing circuits-general equation for two input phase and amplitude comparators–Duality between amplitude and phase comparator.

Unit-II:

Amplitude comparators: Circulating current type and opposed voltage type rectifier bridge comparators –Direct and Instantaneous comparators

Phase comparators: coincidence circuit type block spike phase comparator, techniques to measure the period of coincidence–Integrating type–Rectifier and vector product type phase comparators.

Unit-III:

Static over current relays: Introduction-Instantaneous over current relay – Time over current relays-basic principles-Definite time and Inverse definite time over current relays.

Static Differential Relays: Analysis of static differential relays–static relay schemes–Duo bias transformer differential protection – Harmonic restraint relay

Static distance Relays: Static impedance –reactance-MHO and angle impedance relay sampling comparator–realization of reactance and MHO relay using a sampling comparator

Unit-IV:

Multi –input comparators: Conic section characteristics–Three input amplitude comparator – Hybrid comparator– switched distance schemes –Polyphone distance schemes-Phase fault scheme –Three phase scheme–combined and ground fault scheme.

Power Swings: Effect of power swings on the performance of Distance relays- Power swing analysis – Principle of out of step tripping and blocking relays –effect of line length and source impedance on distance relays- malfunction of distance relays-power system blackout

Unit-V:

Microprocessor based protective relays: Over current relays – impedance relays – directional relay – reactance relay -Generalized mathematical expression for distance relays - measurement of resistance and reactance – MHO and offset MHO relays –Realization of MHO characteristics – Realization of offset MHO characteristics (Block diagram and flow chart approach only) Basic principle of Digital computer relaying.

Text Books:

1. T.S.Madhava Rao, "Power system Protection static relay", Tata McGraw Hill Publishing company limited , second edition,1989
2. Badri Ram and D.N.Vishwakarma, " Power system Protection and Switchgear ", Tata McGraw Hill Publication company limited First Edition -1995

M. Tech I Year - II SEMESTER

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COMPUTER APPLICATIONS IN POWER SYSTEMS (14EPS12T10)

Course Objectives:

- To impart the basic concepts of optimization techniques
- To analyze the optimal power flow of electrical power systems
- To investigate different faults in electrical power systems

Course Outcomes:

After Completion of this course students will be able to

- Explain the basic concepts behind optimization techniques
- Analyze the load flow studies by different methods
- Analyze the various methods for optimal power flow of electrical power systems
- Explain the concept of the AC and DC load flows
- Investigate different faults in electrical power systems

Unit-I: Optimization Techniques

Introduction, Statement of an optimization problem, design vector, design constraints, constraint surface, objective function, classification of optimization problem- Classical optimization Techniques, Lagrange Multiplier method, formulation of multivariable optimization, Kunh-Tucker conditions.

Unit-II: Load flow studies

Revision of Load flow studies by using Newton Raphson method (polar and rectangular) Contingency evaluation, concept of security monitoring, Techniques of contingency evaluation, Decoupled load flow and fast decoupled load flow.

Unit-III: Optimal Power Flow Analysis

Optimal power flow analysis considering equality and inequality constraints-Economic dispatch with and without limits (Classical method) Gradient method, Newton's method, Newton Raphson method, calculation of loss coefficients, loss coefficients using sensitivity factors, power loss in a line.

Unit-IV: AC & DC Load flows

Three phase load flow problem notation, specified variables, derivation of equations-Introduction, formulation of problem, D.C. System model, converter variables, Derivation of equations, Inverter operation, generalized flow chart for equation Solution.

Unit-V: Fault Analysis

Revision of symmetrical and unsymmetrical faults, formulating the sequence impedance matrix, fault configurations and equations, General computer simulation of faults, introduction to ETAP.

Text Books:

1. Computer Aided Power System operation and Analysis-R.N.Dhar, Tata Mc-Graw Hill New Delhi.
2. Computer Techniques in Power System Analysis- M.A. Pai, Tata Mc-Graw Hill New Delhi.
3. Computer Methods in Power System Analysis- Stagg and El.Abiad, Mc-GrawHill (International Student Edition.)

Reference Books:

1. Computer Analysis of Power Systems-J.Arrilinga, C.P.Arnold. Wiely Eastern Ltd.
2. Optimization Techniques-S.S.Rao, Wiely Eastern Ltd, New Delhi
3. Modern Power System Engineering, Nagrath and Kothari (TataMcGraw Hill)
4. Electrical Energy System Theory–an introduction- Olle Elgerd. TMH Publishing Company, New Delhi
5. Power System Optimization- D. P. Kothari, J. S. Dhillon, PHI
6. Power Generation Operation and Control – Allen Wood, Wiley Publications

M. Tech I Year - II SEMESTER (EPS)

(Elective – II)	**Th**	**C**
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ENERGY AUDITING, CONSERVATION & MANAGEMENT
(14EPS12E2a)

Course Objectives:

- To understand the basic principles of Energy auditing.
- To infer principles of Energy management
- To design Energy efficient Motor & good lighting system
- To develop power factor correction circuit model
- To analyze economics of energy savings.

Course Outcomes:

After Completion of this course students will be able to

- Infer the basic principles of energy audit
- Outline the features of energy management
- Design an energy efficient motor
- Invent new lighting schemes & Power Factor Correction Circuit
- Examine the features of energy instruments & Economics of energy savings

Unit-I Basic principles of Energy audit & Energy Management

Energy audit- definitions, concept , types of audit, energy index, cost index ,pie charts, Sankey diagrams, load profiles, Energy conservation schemes- Energy audit of industries- energy saving potential, energy audit of process industry, thermal power station, building energy audit, Principles of energy management, organizing energy management program, initiating, planning, controlling, promoting, monitoring, reporting. Energy manger, Qualities and functions, language, Questionnaire - check list for top management.

Unit-II Energy efficient Motors

Energy efficient motors, factors affecting efficiency, loss distribution, constructional details, characteristics - variable speed , variable duty cycle systems, RMS hp- voltage variation-voltage unbalance- over motoring- motor energy audit.

Unit-III Power Factor Improvement

Power factor – methods of improvement, location of capacitors, Pf with non linear loads, effect of harmonics on p.f., p.f motor controllers.

Unit-IV Lighting & Energy Instruments:

Good lighting system design and practice, lighting control, lighting energy audit Energy Instruments watt meter, data loggers, thermocouples, pyrometers, lux meters, tongue testers, application of PLC's.

Unit-V Economic aspects and analysis

Economics Analysis-Depreciation Methods , time value of money , rate of return , Calculation of simple payback method- return on investment Present worth method –Present worth method with Increasing Power cost-Net Present Worth method replacement analysis, life cycle costing analysis - Applications of life cycle costing analysis -Energy efficient motors.

Text Books:

1) Energy management by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.
2) Energy management by Paulo' Callaghan, Mc-graw Hill Book company-1st edition, 1998
3) Energy efficient electric motors by John C. Andreas, Marcel Dekker Inc Ltd-2/e, 1995
4) Energy management hand book by W.C. Turner, john Wiley and sons
5) Energy management and good lighting practice: fuel efficiency- booklet12-EEO

M. Tech I Year - II SEMESTER (EPS)
(Elective – II)

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POWER SYSTEMS TRANSIENTS
(14EPS12E2b)

Course Objectives:

- To analyze the electrical transients in power systems
- To impart the concepts of traveling waves and propagation
- To discuss issues related to insulation coordination, grounding and limiting of surge effects
- To develop the techniques related to transition points in transmission lines and cables

Course Outcomes:

After Completion of this course students will be able to

- Analyze the electrical transients in power systems
- Understand concepts on travelling waves on trans mission lines
- Analyze the over voltage effects due to lightning and switching
- Investigate different protection system against surges
- Describe the issues related to insulation coordination, grounding and limiting of surge effects

Unit-I: Introduction to Transients

Introduction – Travelling waves on transmission lines – Wave Equation – surge impedance and wave velocity – Specification of Travelling waves - Reflection and Refraction of waves – Typical cases of line terminations – Equivalent circuit for Travelling wave studies – Forked line – Reactive termination – Analysis of trapezoidal wave.

Unit-II: Travelling Waves on Transmission Line

Successive reflections – Bewley Lattice Diagrams – Attenuation and Distortion – Multi- conductor system – Self and mutual surge impedance – Voltage and currents for two conductor systems.

Unit-III: Lightning, Switching and Temporary Over voltages

Lightning: Physical phenomena of lightning – Interaction between lightning and power system – Factors contributing to line design – Switching: Short line or kilometric fault – Energizing transients - closing and re-closing of lines - line dropping, load rejection - Voltage induced by fault – Very Fast Transient Overvoltage (VFTO).

Unit-IV: Protection of Systems against Surges

Transmission line insulation and performance – Ground wires – Protective angle – Tower footing resistance – Driven rods – Counterpoise – Protector tube – Substation protection – surge diverters – Selection of arrester rating – Location of arresters – Influence of additional lines – Effect of short length of cable – Surge capacitor, surge reactor and surge absorber – Shielding substation with ground wires – Protection of rotating machines.

Unit-V: Insulation Co-Ordination

Principle of insulation co-ordination in Air Insulated substation (AIS) and Gas Insulated Substation (GIS), insulation level, statistical approach, co-ordination between insulation and protection level – overvoltage protective devices – lightning arresters, substation earthing. Principle of digital computation of transients: features and capabilities of EMTP; steady state and time step solution modules: basic solution methods.

Text Books:

1. Gupta.B.R, "Power System Analysis and Design", S.Chand Publications 2004
2. Thapar.B, Gupta.B.R and Khera.L.K, "Power System Transients and High Voltage Principles", Mohindra Capital Publishers
3. Allan Greenwood, "Electrical Transients in Power System", Wiley & Sons Inc. New York, 1991.
4. Klaus Ragaller, "Surges in High Voltage Networks", Plenum Press, New York, 1980.
5. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", (Second edition) Newage International (P) Ltd., New Delhi, 1990.
6. Naidu M S and Kamaraju V, "High Voltage Engineering", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.

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M. Tech I Year - II SEMESTER
(Elective – III)

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4	4

DISTRIBUTED GENERATION AND MICRO GRID (14SPS12E2c)

Course Objectives:

- To illustrate the concept of distributed generation
- To analyze the impact of grid integration
- To study concept of Micro-grid and its configuration

Course Outcomes:

After Completion of this course students will be able to

- Review the distributed generation and installation
- Design the grid integration system with conventional and non-conventional energy sources
- Analyze the stability and power quality issues in micro-grid
- Design the dc micro grid
- Analyze power quality issues and control operation of micro grid

Unit-I: Distributed Generation (DG) and its installation

Conventional power generation: advantages and disadvantages, Energy crises, Non-conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources, 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.

Unit-II: Impact of Grid Integration

Requirements for grid interconnection, limits on operational parameters, voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues.

Unit-III: Micro Grid

Concept and definition of micro-grid, micro-grid drivers and benefits, review of sources of micro-grids, typical structure and configuration of a micro-grid, AC micro-grids, Power Electronics interfaces in AC micro-grids.

Unit-IV: DC Micro Grid

DC micro-grids, Power Electronics interfaces in DC, modes of operation and control of microgri, grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques.

Unit-V: Power quality issues, control and operation of Micro Grid

Power quality issues in micro-grids- Modeling and Stability analysis of Micro-grid, regulatory standards, Micro-grid economics, Introduction to smart micro-grids, Modes of operation and control of micro-grid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, micro-grid communication infrastructure.

Text Books:

1. AmirnaserYezdani, and Reza Iravani, “Voltage Source Converters in Power Systems: Modeling, Control and Applications”, IEEE John Wiley Publications, 2009.
2. DorinNeacsu, “Power Switching Converters: Medium and High Power”, CRC Press, Taylor & Francis, 2006.
3. Chetan Singh Solanki, “Solar Photo Voltaics”, PHI learning Pvt. Ltd., New Delhi, 2009.
4. J.F. Manwell, “Wind Energy Explained, theory design and applications,” J.G. McGowan Wiley publication, 2002.
5. D. D. Hall and R. P. Grover, “Biomass Regenerable Energy”, John Wiley, New York, 1987.
6. John Twidell and Tony Weir, “Renewable Energy Resources” Tyalor and Francis Publications, 2005.

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M. Tech I Year - II SEMESTER (EPS)

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POWER SYSTEM SIMULATION LAB
(14EPS12P02)

Course Objectives:

- To formulate Bus admittance & impedance matrices for a power system network
- To analyze different load flow algorithms
- To investigate the response of a two are power system for tie line deviations

Course Outcomes:

After Completion of this course students will be able to

- Analyze the formation of bus matrices using MATLAB.
- Investigate load flow analyses through different methods using MATLAB
- Realize the transmission line models, economic load dispatch and Ferranti effect using MATLAB
- Realize the stability analysis using SIMULINK
- Investigate the step response of two area system with & without integral controller using SIMULINKS

List of Experiments:

1. Y - Bus Formation Using MATLAB
2. Illustration Transmission line models using MATLAB.
3. Gauss – Seidel Load Flow Analysis using MATLAB
4. Z-bus formation Using MATLAB
5. Fast Decoupled Load Flow Analysis using MATLAB
6. Point by Point Method using MATLAB
7. Ferranti Effect of Long Transmission Lines.
8. Step Response of Two Area System with Integral Control and Estimation of Tie Line Power Deviation using SIMULINK
9. Step Response of Two Area System with Integral Control and Estimation of Tie Line Frequency Deviation using SIMULINK
10. Load Flow Analysis by Newton Raphson Method
11. Transient Stability Analysis
12. Economic Load Dispatch Analysis