MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE, MADANAPALLE

(UGC-AUTONOMOUS)

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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

M.TECH. ELECTRICAL POWER SYSTEMS

COURSE STRUCTURE
AND
DETAILED SYLLABI (R16)

M.TECH. REGULAR TWO YEAR P. G. DEGREE PROGRAMME

(Applicable for the batches admitted from 2016-17)

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

COURSE STRUCTURE

I YEAR - I Semester

Sl. No.	Course code	Course	Credits
1.	16EPS101	Modern Control Theory	4
2.	16EPS102	Power System Dynamics and Stability	4
3.	16EPS103	Modern Power System Analysis	4
4.	16EPS104	EHVAC Transmission	4
5.	16EPS105	Analysis of Power Electronic Converters	4
6.		**Elective-I**	4
	16EPS401	Artificial Intelligence Techniques	
	16EPS402	Energy Auditing, Conservation and Management	
	16EPS403	Power System Transients	
7.	16EPS201	Electrical Machines and Power Systems Practicals	2
		Total	**26**

I YEAR - II Semester

Sl. No.	Course code	Course	Credits
1.	16EPS106	Machine Modeling Analysis	4
2.	16EPS107	HVDC & FACTS	4
3.	16EPS108	Operation and Control of Power System	4
4.	16EPS109	Advanced Power System Protection	4
5.	16EPS110	Integration of Renewable Energy Sources	4
6.		**Elective-II**	4
	16EPS404	Power System Deregulation	
	16EPS405	Power System Planning and Reliability	
	16EPS406	Distributed Generation and Micro Grid	
7.	16EPS202	Power System Simulation Practicals	2
		Total	**26**

II YEAR - (I & II Semesters)

Sl. No.	Course code	Course	Credits
1.	16EPS501	Seminar	2
2.	16EPS602	Project Work	16

SYLLABUS

I YEAR - I Semester

MODERN CONTROL THEORY

(16EPS101)

L	T	P	C
4	0	0	4

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:

- To educate on system modeling and analysis in state space domain
- To educate on design of observers and system testing conditions
- To illustrate the controller design and effect of system parameters changes
- To educate on nonlinear system studies
- 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.

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.

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.

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.

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.

Course Outcomes:

After Completion of this course students will be able to

- analyze the system behavior in state space model
- investigate the controllability and observability of LTI system
- design a controller for linear systems
- analyze system stability condition in presence of nonlinearities
- 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.

REFERENCES:

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.
6. Automatic control in power generation, distribution and protection, proceedings of the IFAC symposium, Pretoria, 1980, ISBN: 0-08-026709-2

I YEAR - I Semester

POWER SYSTEM DYNAMICS AND STABILITY
(16EPS102)

L	T	P	C
4	0	0	4

Course Description:

This course is designed to provide knowledge in power system stability and dynamics. Course covers swing equation, dynamic stability and analysis, transient stability, equal area criterion and voltage stability

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.

UNIT-I: THE ELEMENTARY MATHEMATICAL MODEL

Development of swing equation – linearization of swing equation – 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.

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

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.

Course Outcomes:

After completion of this course students will be able to

- describe the classical model of single and multi machine system
- examine the dynamic stability of single machine system
- analyze the dynamic stability of multi machine system
- evaluate the transient stability of electrical system
- assess the voltage stability and angle stability

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.

I YEAR - I Semester

MODERN POWER SYSTEM ANALYSIS
(16EPS103)

L	T	P	C
4	0	0	4

Course Description:

This course is deals with the modern power system analysis. Course covers optimal power flow analysis, Short circuit analysis, transient analysis, power system security and state estimation of the power system.

Course Objectives:

- To impart in-depth knowledge on different methods of power flow solutions.
- To understand the concept of faults analysis.
- To gain knowledge on transient stability analysis and the associated solution techniques
- To get insight of contingency analysis problem and the solution methods.
- To know the need of state estimation in power system

UNIT-I: OPTIMAL POWER FLOW ANALYSIS

Review of power flow analysis – optimal power flow analysis considering equality and inequality constraints – economic dispatch with and without limits – Gradient method – Newton Raphson method – power loss in a line – calculation of loss coefficients using sensitivity factors.

UNIT-II: SHORT CIRCUIT ANALYSIS

Review of symmetrical and unsymmetrical faults – formation of bus impedance matrix with mutual coupling (single phase basis and three phase basis) – fault analysis using Z bus and sequence components – derivation of equations for bus voltages, fault current and line current.

UNIT-III: TRANSIENT STABILITY ANALYSIS

Introduction, Numerical Integration Methods: Euler and Fourth Order Runge-Kutta methods, Algorithm for simulation of SMIB and multi-machine system with classical synchronous machine model; Factors influencing transient stability, Numerical stability and implicit Integration methods.

UNIT-IV: POWER SYSTEM SECURITY

System state classification – security analysis – importance of contingency analysis – contingency evaluation – concept of security monitoring – techniques of contingency evaluation.

UNIT-V: STATE ESTIMATION OF POWER SYSTEM

Introduction to state estimation – least squares estimation – statistic state estimation – tracking – external system equivalencing – treatment of bad data – network observability and Pseudo-measurements.

Course Outcomes:
After completion of this course students will be able to

- analyze the economic dispatch problems using different methods
- construct the z bus matrix and analyze the fault current
- analyze the transient stability of SMIB and multi machine system
- investigate the security of power system under different contingency conditions
- assess the power system state estimation with different methods

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. Computer Aided Power System operation and Analysis, R.N.Dhar, Tata Mc-Graw Hill New Delhi.
2. J J Grainger and W D Stevension, “Power System Analysis”, McGraw-Hill, Inc., 1994.
3. D P Kothori and I J Nagrath, “Modern Power System Analysis”, Tata McGraw Hill Education Private Limited, 2011.
4. M A Pai,” Computer Techniques in Power System Analysis”, Tata McGraw Publishing Company Limited, 2006.

I YEAR - I Semester

EHVAC TRANSMISSION
(16EPS104)

L	T	P	C
4	0	0	4

Course Description:

This course deals the topics of EHVAC transmission line trends, calculation of line parameters, ground parameters and electrostatic cum magnetic fields of EHVAC lines. This course covers the concept of Corona in EHV lines and its effects. It also covers Power Frequency Voltage control and over voltages in EHV lines as well as design factors of EHV lines.

Course Objectives:

- To provide the in-depth knowledge of EHV AC lines and their evaluation of line & 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 and to comprehend the concept of designing of EHV AC lines based on steady state and transient limits.

UNIT-I: EHVAC LINE TRENDS AND CALCULATION OF LINE & GROUND PARAMETERS

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 – bundled conductors: properties, inductance and capacitance of E.H.V. lines – positive, negative and zero sequence impedance – line parameters for modes of propagation.

UNIT-II: ELECTROSTATIC & MAGNETIC FIELD OF EHVAC LINES

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 – electrostatic induction in un-energized lines – measurements of field and voltage gradients for three phase single and double circuit lines.

UNIT-III: POWER FREQUENCY VOLTAGE CONTROL IN EHV LINES

Introduction – 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 EFFECTS

Corona in E.H.V. lines – Corona loss formulae – attenuation of traveling waves due to Corona – audible noise – measurements of audible noise – radio interference due to Corona – limits for RI fields – frequency spectrum of RI fields – measurements of RI and RIV.

UNIT-V: DESIGN OF EHVAC LINES

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

Course Outcomes:

After Completion of this course students will be able to

- describe transmission line trends, preliminaries and evaluate line parameters
- evaluate the electrostatic and magnetic fields of ehv ac lines
- explain the power frequency voltage control in ehv lines
- investigate the corona and its effects in ehv lines
- design EHV lines based on steady state and transient limits

TEXT BOOKS:

1. Extra High Voltage AC Transmission Engineering – Rokosh Das Begamudre, Wiley Eastern Ltd, New Delhi – Fourth Edition -2014.
2. EHV Transmission line reference Books – Edison Electric Institution (GEC 1968).

REFERENCES:

1. S. Rao. EHVAC, HVDC Transmission and Distribution Engineering, Khanna Publishers, 2008.
2. Transmission Line Reference Book 345 kV and Above, Electrical Power Research Institute (EPRI) 1982.
3. Alston, L.L.: High Voltage Technology. Oxford University Press, 1968. (Harwell Post-Graduate Series).
4. High voltage Engineering -Farouk A.M. Rizk, Giao N. Trinh, , CRC press

MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE
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I YEAR - I Semester

ANALYSIS OF POWER ELECTRONIC CONVERTERS (16EPS105)

L	T	P	C
4	0	0	4

Course Description:

This course is deals with analysis of power electronics converters. Course AC Voltage Controllers, AC-AC converters, DC-DC converters, PWM inverters and Multilevel inverters.

Course Objectives:

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

UNIT I: AC VOLTAGE CONTROLLERS

Single Phase AC Voltage Controllers with R-L load – ac voltage controller's with PWM control – effects of source and load inductances–synchronous tap changers – applications – three phase AC voltage controllers – analysis of controllers with star and delta connected R and R-L loads – effects of source and load inductances – applications.

UNIT II: AC - DC CONVERTERS

Half controlled and fully controlled converters with R-L and R-L-E loads for single phase and three phase system – evaluation of input power factor and harmonic factor – continuous and discontinuous load current – power factor improvements – extinction angle control – symmetrical angle control – dual converters.

UNIT III: DC - DC CONVERTERS

Principles of step-down and step-up converters – analysis of buck, boost, buck-boost and Cuk converters – time ratio and current limit control – resonant and quasi – resonant converters.

UNIT IV: PWM INVERTERS

Review of single phase inverters – sinusoidal PWM – modified PWM – phase displacement control – advanced modulation techniques – review of three phase inverters – voltage control of three-phase inverters – sinusoidal PWM – third harmonic PWM – space vector modulation – current source inverters – variable dc link inverter.

UNIT V: MULTILEVEL INVERTERS

Introduction – multilevel concept – types of multilevel inverters – principle, operation, features and applications: diode-clamped multilevel inverter, flying-capacitors multilevel inverter, cascaded type multilevel inverter – switching device currents – DC-Link capacitor voltage balancing – comparisons of multilevel inverters.

Course Outcomes:
After Completion of this course students will be able to

- analyze the operation of single and three phase AC voltage controllers
- evaluate the operation and design of AC-DC converters
- analyze the operation of different DC-DC converters
- describe the voltage control of DC-AC converters
- analyze the operation and features of multilevel inverters

TEXT BOOKS:

1. Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Prentice Hall India, New Delhi, 1995.
2. Ned Mohan, Underland and Robbins, “Power Electronics: Converters, Application and design” John Wiley and sons. Inc, Newyork, 1995.
3. Cyril W.Lander, “power electronics”, Third Edition McGraw Hill, 1993

REFERENCES:

1. P.C Sen.," Modern Power Electronics ", Wheeler publishing Co, First Edition, New Delhi, 1998.
2. P.S. Bimbra, “Power Electronics”, Khanna Publishers, Eleventh Edition, 2003.

I YEAR - I Semester

ARTIFICIAL INTELLIGENCE TECHNIQUES (16EPS401)

L	T	P	C
4	0	0	4

Course Description:

This course will focus on the basic foundations and techniques in neural networks, single & multilayer feed forward neural networks, Self-Organizing Maps (SOM) and Adaptive Resonance Theory (ART), genetic algorithms, fuzzy logic systems components.

Course Objectives:

- 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 design fuzzy logic controller and genetic algorithm for electrical engineering problems.

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*:* FEED FORWARD NEURAL NETWORKS

Introduction – perceptron models – training algorithms – perceptron convergence theorem – generalized delta rule, derivation of back propagation (BP) – training – architecture of Hopfield network – ANN applications to load forecasting and load flow studies.

UNIT-III: SELF-ORGANIZING MAPS (SOM) AND ADAPTIVE RESONANCE THEORY (ART)

Introduction – competitive learning – vector quantization – self-organized learning networks – stability – plasticity dilemma – feed forward competition – architecture of ART1 applications – architecture of ART2 applications

UNIT-IV: GENETIC ALGORITHMS

Introduction – genetic modeling: encoding – fitness function – genetic operators – cross over – mutation and reproduction – generational cycle – convergence of genetic algorithm – genetic algorithm application in economic load dispatch.

UNIT-V: FUZZY LOGIC SYSTEMS

Introduction to classical sets and fuzzy sets – properties – operations and relations – membership functions – fuzzification – development of rule base and decision making system –defuzzification methods – fuzzy application to speed control of DC motor.

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.
- explains the concepts of genetic algorithm and its applications to power systems.
- design the fuzzy logic controller for various applications.

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. Neural 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.

REFERENCES:

1. Neural Networks by James A Freeman and Davis Skapura, Pearson Education, 2002.
2. Neural Networks by 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 – Wesley longman publishing, 1999.

I YEAR - I Semester

ENERGY AUDITING, CONSERVATION AND MANAGEMENT (16EPS402)

L	T	P	C
4	0	0	4

Course Description:
This course is designed to provide knowledge in energy auditing, conservation & management course covers energy audit, energy management, energy efficient motors, lighting, power factor correction and economic analysis etc.

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

UNIT-I: BASIC PRINCIPLES OF ENERGY AUDIT AND ENERGY MANAGEMENT
Energy audit – definitions, types of audit, energy index and cost index – representation of energy audit – energy conservation schemes – energy audit of industries – energy saving potential – energy audit of process industry – building energy audit – principles of energy management – organizing energy management program.

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 – power factor 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.

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.

Course Outcomes:

After Completion of this course students will be able to

- explain the basic principles of energy auditing and energy management
- analyze the energy efficient motors
- explain different methods to improve power factor
- asses the lighting and energy systems
- analyze economics of energy savings

TEXT BOOKS:

1. Energy management hand book by W.C. Turner, john Wiley and sons
2. Energy management by W.R. Murphy & G. Mckay Butter worth, Heinemann publications.

REFERENCES:

1. Energy management by Paulo' Callaghan, Mc-graw Hill Book company-1st edition, 1998
2. Energy efficient electric motors by John C. Andreas, Marcel Dekker Inc Ltd-2/e, 1995
3. Energy management and good lighting practice: fuel efficiency- booklet12-EEO

I YEAR - I Semester

POWER SYSTEM TRANSIENTS
(16EPS403)

L	T	P	C
4	0	0	4

Course Description:
This course is designed to provide knowledge of power system transients. Course covers travelling waves, analysis of wave, lighting, switching and temporary over-voltages. This course also describes the protection against surges and insulation coordination.

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.

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.

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.

Course Outcomes:
After completion of this course students will be able to
- explain the concept of travelling waves in transmission line.
- analyze the self and mutual surge impedance of multi-conductor system.
- investigate the various causes of over voltages
- identify the suitable protection system against surges
- describe the issues related to insulation coordination

TEXT BOOKS:
1. Allan Greenwood, "Electrical Transients in Power System", Wiley & Sons Inc. New York, 1991.
2. Naidu M S and Kamaraju V, "High Voltage Engineering", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2004.

REFERENCES:
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. Klaus Ragaller, "Surges in High Voltage Networks", Plenum Press, New York, 1980.
4. Rakosh Das Begamudre, "Extra High Voltage AC Transmission Engineering", (Second edition) Newage International (P) Ltd., New Delhi, 1990.

I YEAR - I Semester

ELECTRICAL MACHINES AND POWER SYSTEMS PRACTICALS (16EPS201)

L	T	P	C
4	0	0	4

Course Description:

This course is developed to obtain a practical knowledge and hands-on-experience on electrical machines and power system networks.

Course Objectives:

- To analyze 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

List of Experiments:

1. Determination of sub transient reactance of a salient pole synchronous machine
2. Determination of sequence impedances of a cylindrical rotor synchronous machine
3. Power angle characteristics of a salient pole synchronous machine
4. Fault Analysis-I
   i) LG Fault
   ii) LL Fault
5. Fault Analysis-II
   i) LLG Fault
   ii) LLLG Fault
6. Calculation of string efficiency
7. Design of buck converter for power system applications
8. Study of Ferranti effect and voltage distribution HV long transmission line using transmission line model
9. Characteristics of microprocessor based over voltage relay
10. Characteristics of IDMT over current relay
11. Characteristics of static negative sequence relay
12. Characteristics of electromagnetic-over voltage relay
13. Characteristics of percentage biased differential relay

Course Outcomes:

After Completion of this course students will be able to

- analyze the characteristics of synchronous machine
- investigate the various fault in the power systems
- estimate the string efficiency
- describe the Ferranti effect in long transmission line
- analyze characteristics of various types of relays

I YEAR - II Semester

MACHINE MODELING ANALYSIS

(16EPS106)

L	T	P	C
4	0	0	4

Course Description:

This course introduces generalized electric machines theory, modeling of all varieties of Electrical machines such as dc machines, synchronous machines, poly phase and single phase induction machines. It also gives steady state and dynamic analysis of electrical machines.

Course Objectives:

- To analyze the concepts of machine modeling and Kron's primitive machine
- To analyze the mathematical modeling of AC and DC machines
- To understand the linear transformations in AC and DC machines
- To evaluate the modeling of synchronous machine and single phase induction machine

UNIT-I: BASIC CONCEPTS OF MODELING

Basic two-pole machine representation: commutator machines, three-phase induction machine, three-phase synchronous machine with and without damper bars – 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 and shunt motor – linearization techniques for small perturbations.

UNIT-III: LINEAR TRANSFORMATIONS IN MACHINES

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.

UNIT-IV: MODELING OF POLY PHASE INDUCTION MACHINE

Mathematical model of poly phase induction machine – steady state analysis – 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 – 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 – synchronous machine inductances – phase coordinate model – space phasor (d-q) model – steady state operation – mathematical model of PM synchronous motor.

Course Outcomes:
After Completion of this course students will be able to

- explain the representations of machine modeling
- analyze the mathematical modeling of dc machines
- describe the linear transformation in ac and dc machines
- analyze the mathematical modeling of poly phase induction machines
- evaluate the mathematical modeling of single phase induction machine and pm synchronous machine

TEXT BOOKS:

1. Generalized Theory of Electrical Machines – P.S. Bimbra - Khanna publications-5th edition-1995
2. Electric Motor Drives Pearson Modeling, Analysis& control - R. Krishnan- Publications-1st edition -2002

REFERENCES:

1. The Unified Theory of Electrical Machines by C.V.jones, Butterworth- London, 1967
2. Electrical Drives- I. Boldea & S.A. Nasar-The Oxford Press Ltd.
3. Electrical Machine Dynamics- D.P. Sengupta & J.B. Lynn- The Macmillan Press
4. Electromechanical Dynamics- Woodson & Melcher -John Wiley
5. Analysis of Electrical Machinery – P.C.Krause – McGraw Hill

MADANAPALLE INSTITUTE OF TECHNOLOGY & SCIENCE
(UGC - AUTONOMOUS)

I YEAR - II Semester

HVDC & FACTS
(16EPS107)

L	T	P	C
4	0	0	4

Course Description:

The course is designed to gain an in-depth understanding of the various types of HVDC technologies, their typical applications and FACTS controllable devices whose functions are to enhance the security, capacity and flexibility of power transmission systems.

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 analyze the operation of shunt and series compensators.
- To impart knowledge on application of shunt and series compensators to improve AC power transmission.

UNIT-I: DC POWER TRANSMISSION TECHNOLOGY
Introduction-comparison of AC and DC transmission-application of DC transmission- Types of DC links-description of DC transmission system-planning for HVDC transmission-modern trends in DC transmission, Different configuration of HVDC scheme-relative merits.

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: SHUNT COMPENSATION TECHNIQUE
Objectives of shunt compensation – Methods of controllable VAR generation – Static Var Compensator – its characteristics – TCR – TSC – FC –TCR configurations – STATCOM – basic operating principle – control approaches and characteristics

UNIT-V: SERIES COMPENSATION TECHNIQUE

Objectives of series compensator – variable impedance type of series compensators – TCSC – TSSC – operating principles and control schemes – SSSC – Power Angle characteristics – Control range and VAR rating – Capability to provide reactive power compensation – external control – Introduction to Unified Power Flow Controller – Basic operating principles – Conventional control capabilities – Independent control of real and reactive power

Course Outcomes:

After Completion of this course students will be able to

- compare the HVDC Transmission and EHVAC transmission
- analyze converter configurations used in HVDC and list the performance metrics
- identify the suitable methods to review and reduce the harmonics in HVDC system
- examine compensation techniques for AC transmission systems
- elucidate the control of real and reactive power in transmission systems

TEXT BOOKS:

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

REFERENCES:

1. Arrilaga, J., `High Voltage Direct current transmission', Peter Pereginver Ltd. London, UK.,1983
2. Padiyar, K.R., `HVDC Transmission system', Wiley Eastern Limited., New Delhi, 1992
3. Flexible AC Transmission Systems (FACTS) Young Huasong & Alian T. hons, The Institution of Electrical Engineers, IEE Power and Energy Series 30.

I YEAR - II Semester

OPERATION AND CONTROL OF POWER SYSTEM
(16EPS108)

L	T	P	C
4	0	0	4

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:
- To know the general concepts of economic operation and unit commitment
- To impart the concepts of hydro thermal scheduling.
- To analyze automatic generation control and AGC implementation
- To gain the knowledge on inter change of power and energy
- 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.

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.

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.

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.

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.

Course Outcomes:
After Completion of this course students will be able to

- explain the economic operation, load forecasting and optimal unit commitment methods.
- analyze the hydrothermal systems through various techniques.
- assess static and dynamic responses of two-area system.
- examine the interchange of power and energy.
- 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

REFERENCES:
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.

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I YEAR - II Semester

ADVANCED POWER SYSTEM PROTECTION (16EPS109)

L	T	P	C
4	0	0	4

Course Description:
This course is to understanding the concepts of power system protections, construction of static relay, different types of comparators, overcurrent, differential, distance, microprocessor based relays and multi input comparators.

Course Objectives:
- To understand the operation of static relays
- To analyze the amplitude and phase comparators
- To explain the concepts of various static relays
- To examine multi-input comparators and power swings
- To realize the operation of microprocessor based protective relays

UNIT-I: INTRODUCTION TO STATIC RELAYS
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: STATIC COMPARATORS
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: TYPES OF STATIC RELAYS
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.

Course Outcomes:
After Completion of this course students will be able to

- explain the concepts of static relays
- analyze the amplitude and phase comparators
- examine the operation of various static relays
- assess multi-input comparators and power swings
- investigate the microprocessor based protective relays

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

REFERENCES:

1. Transmission network Protection by Y.G. Paithankar ,Taylor and Francis,2009.
2. Power system protection and switch gear by Bhuvanesh Oza, TMH, 2010.
3. Electrical Power Systems – by C.L.Wadhwa, New Age international (P) Limited, Publishers, 3rd edition
4. Electrical power System Protection by C. Christopoulos and A. Wright, 2nd Edition, Springer International Edition.
5. Fundamentals of Power System Protection by Y. G. Paithankar and S. R. Bhide, 2nd Edition, PHI

I YEAR - II Semester

INTEGRATION OF RENEWABLE ENERGY SOURCES (16EPS110)

L	T	P	C
4	0	0	4

Course Description:
This course is to understanding the concepts of integration of different renewable energy sources like solar energy, wind energy and other energy sources

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.

UNIT I: ENERGY SCENARIO
Classification of energy sources – Energy resources: Conventional and non-conventional – Worldwide Potentials of these sources with focus on India–Energy security – Energy and its environmental impacts – Global environmental concern – Kyoto Protocol – Concept of Clean Development Mechanism (CDM)– Factors favoring and against renewable energy sources.

UNIT II: SOLAR ENERGY
Solar thermal Systems – Types of collectors — Solar Photo Voltaic (PV) technology – Solar cells – Cell technologies –Characteristics of PV systems –Array design – Building integrated PV system and its components – Sizing and economics – Peak power operation – Standalone and grid interactive systems-Applications of Solar Energy.

UNIT III: WIND ENERGY
Wind Energy – Wind speed and power relation – Power extracted from wind – wind speed vs power output characteristics - Wind power systems – System components – Types of Turbines – Horizontal axis turbines-vertical axis turbines-Choice of generators – Turbine rating – System design features – Stand alone and grid connected operation. Wind energy conversion systems, Induction generator, synchronous generator.

UNIT IV: OTHER ENERGY SYSTEMS
Biomass – Various resources — Conversion of Bio-mass in other forms of energy — 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 energy- wave energy – Geothermal and Ocean-Thermal Energy Conversion (OTEC).

UNIT V: ENERGY STORAGE AND HYBRID SYSTEM CONFIGURATIONS FOR ENERGY STORAGE

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

Course Outcomes:

After Completion of this course students will be able to

- Describe the concept of energy scenario
- Explain the solar energy system
- Explain the wind energy system
- Describe the other energy sources like biomass, hydel, tidal energy etc.
- Explain the concept of energy storage systems

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.

REFERENCES:

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.

I YEAR - II Semester

POWER SYSTEM DEREGULATION
(16EPS404)

L	T	P	C
4	0	0	4

Course Description:

This course deals with the need of deregulation, electricity market structure, bilateral marketing, transmission costing, congestion management methods, power systems security and regulatory issues.

Course Objectives:

- To provide knowledge on operation of deregulated electricity systems
- To become familiar with the concepts of electricity market structure
- To analyze the operation of various electricity markets
- To understand the transmission costing and congestion management methods
- To assess ancillary services and system security in deregulation

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 (FTR).

Course Outcomes:

After Completion of this course students will be able to

- explain the operation of deregulated electricity market systems
- analyse cost-effective methods to supply quality power
- assess price based unit commitment problems
- investigate transmission costing and congestion management methods
- examine ancillary services and system security in deregulation

TEXT BOOKS:

1. Operation of restructured power systems - K. Bhattacharya, M.H.J. Bollen and J.E. Daalder
2. Power System Economics: Designing markets for electricity - S. Stoft
3. Power generation, operation and control, -J. Wood and B. F. Wollenberg

REFERENCES:

1. Market operations in electric power systems - M. Shahidehpour, H. Yamin and Z. Li
2. Fundamentals of power system economics - S. Kirschen and G. Strbac
3. Optimization principles: Practical Applications to the Operation and Markets of the Electric Power Industry - N. S. Rau
4. Competition and Choice in Electricity - Sally Hunt and Graham Shuttleworth
5. Electrical Power Distribution System Engineering – TuranGonen, second edition

I YEAR - II Semester

POWER SYSTEM PLANNING AND RELIABILITY (16EPS405)

L	T	P	C
4	0	0	4

Course Description:

This course is designed to provide knowledge in power system planning and reliability. Course covers load forecasting, reliability concepts, generation, transmission and composite system reliability.

Course Objectives:

- To gain knowledge about power system planning
- To understand the basic concepts of reliability
- To analyze the generation system reliability
- To evaluate the transmission system reliability
- To investigate the composite system reliability

UNIT-I: POWER SYSTEM PLANNING

Objectives of planning – long and short term planning. load forecasting – characteristics of loads – methodology of forecasting – energy forecasting – peak demand forecasting – total forecasting – annual and monthly peak demand forecasting.

UNIT-II: RELIABILITY CONCEPTS

Exponential distributions – meantime to failure – series and parallel system – MARKOV process – recursive technique.

UNIT-III: GENERATING SYSTEM RELIABILITY ANALYSIS

Generation system model – capacity outage probability tables – recursive relation for capacitive model building – sequential addition method – unit removal – evaluation of loss of load and energy indices

UNIT-IV: TRANSMISSION SYSTEM RELIABILITY ANALYSIS

System and load point reliability indices – weather effects on transmission lines – weighted average rate and MARKOV model – common mode failures.

UNIT-V: COMPOSITE SYSTEM RELIABILITY ANALYSIS

Introduction – radial configurations – conditional probability approach – network configurations – state selection - system and load point indices

Course Outcomes:

After Completion of this course students will be able to

- examine the power system planning methodology
- explain the reliability concepts
- construct capacity outage probability table
- analyze transmission system reliability indices
- assess system and load point reliability

TEXT BOOKS:

1. Roy Billinton and Ronald N. Allan, Reliability Evaluation of Power Systems, Plenum Press, New York and London, 2nd Edition, 1996.
2. Sullivan, R.L., „Power System Planning", Heber Hill, 1987.

REFERENCES:

1. J. Endrenyi , Reliability Modeling in Electric Power Systems, John Wiley & Sons, 1st Edition, 1978.

I YEAR - II Semester

DISTRIBUTED GENERATION AND MICRO GRID (16EPS406)

L	T	P	C
4	0	0	4

Course Description:

This course deals with distributed generation and micro grid. Course covering the distributed generation and its installation, impact of grid integration, micro grid, dc micro grid, power quality issues, control and operation of micro grid.

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.

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 and stability.

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 micro grid, grid connected and islanded mode, Active and reactive power control, anti-islanding schemes: passive, active and communication based techniques.

UNIT-V: PROTECTION ISSUES FOR MICRO-GRIDS

Introduction – typical micro-grid protection – different islanding scenarios – micro-grid distribution system protection – protection of micro-sources – NEC requirements for distribution transformer protection – neutral grounding requirements – choice of grounding system.

Course Outcomes:

After Completion of this course students will be able to

- explain about conventional and non-conventional energy sources
- analyze the impact of grid integration
- describe the structure and configuration of a micro-grid
- analyze the operation, control and protection of dc micro grid
- explain the Power quality issues in micro-grids

TEXT BOOKS:

1. N. Jenkins, J.B. Ekanayake and G. Strbac,, "Distributed generation" Volume 1, IET, Renewable energy series, 2013
2. S. Chowdhury, S.P. Chowdhury and P. Crossley, “Microgrids and Active Distribution Networks”, IET, London, 2009.

REFERENCES:

1. AmirnaserYezdani, and Reza Iravani, “Voltage Source Converters in Power Systems: Modeling, Control and Applications”, IEEE John Wiley Publications, 2009.
2. G. Masters, Renewable and Efficient Electric Power Systems
3. A.J. Pansini, “Guide to Electrical Power Distribution Systems”, The Fairmont Press Inc., 2005.
4. N Jenkins, R Allen, P Crossley, D Kirschen, G Strbac, Embedded generation, IEE, 2000.
5. DorinNeacsu, “Power Switching Converters: Medium and High Power”, CRC Press, Taylor & Francis, 2006.
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.

I YEAR - II Semester

POWER SYSTEM SIMULATION PRACTICALS (16EPS202)

L	T	P	C
0	0	3	2

Course Description:

This course is designed for students to understand the power flow analysis, power system operations and control by using computer simulations.

Course Objectives:

- To calculate the transmission line parameters
- To calculate the power flow and line losses in the power system
- To assess the stability of power system
- To analyse the power system with different fault conditions

List of Experiments:

1. Computation of parameters and modeling of transmission lines
2. Y – bus and Z - bus formation
3. Load flow solution using Gauss – Seidel method
4. Load flow solution using Newton Raphson method
5. Load flow solution using FDLF method
6. Load flow analysis of power system with FACTS controllers
7. Stability analysis using point by point method
8. Analysis of Ferranti effect in long transmission lines.
9. Short circuit analysis – symmetrical faults
10. Short circuit analysis – unsymmetrical faults
11. Economic dispatch in power systems
12. Load frequency dynamics of Single area power systems
13. Load frequency dynamics of two area power systems

Course Outcomes:

After Completion of this course students will be able to

- Evaluate the transmission line parameters
- Analyse the power flow and line losses in the power system
- Assess the stability of power system
- Investigate the power system under different fault conditions
- Examine the frequency dynamics of power system