SEMESTER I

PMA 15105 APPLIED MATHEMATICS FOR ELECTRICAL ENGINEERS 3 2 0 4

COURSE OBJECTIVES

- To develop the ability to apply the concepts of matrix theory and linear programming in electricalengineering problems.
- To familiarize the students in calculus of variations and solve problems using fourier transformsassociated with engineering applications
- To understand the basic concepts of one dimensional random variables and apply in electrical engineering problems
- To formulate and construct a mathematical model for a linear programming problem in real lifesituation
- To introduce fourier series analysis which is central to many applications in engineering apart from itsuse in solving boundary value problems

UNIT I MATRIX THEORY 9+3

The Cholesky decomposition – Generalized Eigenvectors, Canonical basis – QR factorization – Least square method – Singular value decomposition.

UNIT II CALCULUS OF VARIATIONS 9+3

Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functional's dependant on functions of several independent variables – Variational problems with moving boundaries – problems with constraints – Direct methods: Ritz and Kantorovich methods.

UNIT III ONE DIMENSIONAL RANDOM VARIABLES 9+3

Random variables – Probability function – moments – moment generating functions and theirproperties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions – Function of a Random Variable.

UNIT IV LINEAR PROGRAMMING 9+3

Formulation – Graphical solution – Simplex method – Two phase method – Transportation and Assignment Models.

UNIT V FOURIER SERIES 9+3

Fourier Trigonometric series: Periodic function as power signals – Convergence of series – Even and odd function: cosine and sine series – Non-periodic function: Extension to other intervals – Power signals: Exponential Fourier series – Parseval's theorem and power spectrum – Eigen value problems and orthogonal functions – Regular Sturm-Liouville systems – Generalized Fourier series.

TOTAL (L: 45 +T: 15): 60 PERIODS

COURSE OUTCOMES

At the end of this course, the students will be able to

- gain a well found knowledge in matrix to calculate the electrical properties of a circuit, with voltage ,amperage ,resistance, etc.
- solve a variational problem using the Euler equation.
- gain knowledge in standard distributions which can describe the real life phenomena.
- understand and apply linear, integer programming to solve operational problem with constraints.
- apply fourier series, their different possible forms and the frequently needed practical harmonicanalysis.

REFERENCES:

1. Richard Bronson, “Matrix Operation”, Schaum‟s outline series, 2^{nd} Edition, McGraw Hill, (2011).
2. Gupta, A.S., “Calculus of Variations with Applications”, Prentice Hall of India Pvt. Ltd., New Delhi, (1997).
3. Oliver C. Ibe, “Fundamentals of Applied Probability and Random Processes”, Academic Press, (An imprint of Elsevier), (2010).
4. Taha, H.A., “Operations Research, An introduction”, 10th Edition, Pearson education, New Delhi, (2010).
5. Andrews L.C. and Phillips R.L., “Mathematical Techniques for Engineers and Scientists”, Prentice Hall of India Pvt.Ltd., New Delhi, (2005).
6. Elsgolts, L., “Differential Equations and the Calculus of Variations”, MIR Publishers, Moscow, (1973).
7. O'Neil, P.V., “ Advanced Engineering Mathematics”, Thomson Asia Pvt. Ltd., Singapore, (2003).
8. Johnson R. A. and Gupta C. B., “Miller & Freund‟s Probability and Statistics for Engineers”, Pearson Education, Asia, 7^{th} Edition, (2007).

WEB LINKS:

1. **http://www.sosmath.com/matrix/matrix.html**
2. **http://tutorial.math.lamar.edu/Classes/CalcI/CalcI.aspx**
3. **http://nptel.ac.in/courses/122104017/28**

CO-PO MAPPING:

Mapping of Course Outcome (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes PSO’s (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO’s	Programme Outcomes PO’s												PSO’s	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3	-	1	-	-	2	-	-	3	2	1
CO2	3	3	3	3	-	1	-	-	2	-	-	3	2	1
CO3	3	3	3	3	-	1	-	-	2	-	-	3	2	1
CO4	3	3	3	3	-	1	-	-	2	-	-	3	2	1
CO5	3	3	3	3	-	1	-	-	2	-	-	3	2	1

Approved BOARD OF STUDIES Mathematics
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PPS 15101 ADVANCED POWER SYSTEMS ANALYSIS 3 2 0 4

COURSE OBJECTIVES

- To acquire the mathematical representation of power system components and solution techniques.
- To make the students to equip with the knowledge on the power flow analysis using various methods.
- To obtain the optimal power flow solutions by using Newton's method, gradient method, LP methods.
- To gain knowledge of the different types of faults and its calculation using computer method and mathematical model.
- To impart knowledge on the concept of Numerical Integration Methods to analyze power system transient stability.

UNIT 1 SOLUTION TECHNIQUES 9+6

Sparse Matrix techniques for large scale power systems: Optimal ordering schemes for preserving sparsity. Flexible packed storage scheme for storing matrix as compact arrays – Factorization by Bifactorization and Gauss elimination methods; Repeat solution using Left and Right factors and L and U matrices.

UNIT 2 POWER FLOW ANALYSIS 9+6

Power flow equation in real and polar forms; Review of Newton's method for solution; Adjustment of P-V buses; Review of Fast Decoupled Power Flow method; Sensitivity factors for P-V bus adjustment; Net Interchange power control in Multi-area power flow analysis: ATC, Assessment of Available Transfer Capability (ATC) using Repeated Power Flow method; Continuation Power Flow method.

UNIT 3 OPTIMAL POWER FLOW 9+6

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

UNIT 4 SHORT CIRCUIT ANALYSIS 9+6

Fault calculations using sequence networks for different types of faults. Bus impedance matrix(ZBUS) construction using Building Algorithm for lines with mutual coupling; Simple numerical problems. Computer method for fault analysis using ZBUS and sequence components. Derivation of equations for bus voltages, fault current and line currents, both in sequence and phase domain using Thevenin's equivalent and ZBUS matrix for different faults.

UNIT 5 TRANSIENT STABILITY ANALYSIS 9+6

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.

TOTAL: 75 PERIODS

COURSE OUTCOMES

Upon the completion of the course, the student will be able to

- develop proper mathematical models for analysis of power system components.
- understand the methodologies of power flow studies for the power system network.
- obtain the optimal solutions for power flow problems.
- perform analysis of short circuit problems prevailing in power systems.
- apply numerical integration methods to analyse power system transient stability.

REFERENCES

1. Grainger, J.D., "Power System Analysis", Tata McGraw Hill Publishing Company, 2008.
2. Kusic, C.L., "Computer Aided Power System Analysis", Tata McGraw Hill Publishing Company, 2001.
3. Pai, M. A., "Computer Techniques in Power System Analysis", TMH Publishing Company, 2003.
4. Stagg, G. W. and Elabiad, A. H., "Computer Methods in Power System Analysis", McGraw Hill, 2010.
5. Wood, A.J. and Wollenberg, B.F., "Power Generation, Operation and Control", John Wiley and Sons, 2013.
6. Singh L.P., "Advanced power system analysis and dynamics", 3rd Ed., Wiley eastern, New Delhi, 2012.

WEB LINKS

1. media.johnwiley.com.au/product_data/excerpt/59/.../0471790559-4.pdf
2. dl.lib.mrt.ac.lk/bitstream/handle/123/1748/92960_Post-text.pdf.
3. www.kandrfarms.com/.../power-system-analysis-by-grainger-and-stevens.

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CO5	3	3	3	2	3	1	-	1	-	2	-	2	2	3

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PPS 15102 POWER SYSTEM OPERATION AND CONTROL 3 2 0 4

COURSE OBJECTIVES

- To understand the modelling and analysis various controlling techniques for single machine and multi machine systems.
- To impart the AVR control for single-machine infinite bus system and multi machine power systems.
- To make the students to understand the optimum generation allocation and the economic dispatch for energy management concepts in power system engineering.
- To gain knowledge on the effective implementation of coordinated hydro thermal power systems.
- To achieve knowledge on finding the least-cost dispatch of available generation resources to meet the electrical load.

UNIT 1 LOAD FREQUENCY CONTROL 9+6

Introduction, Modelling of ALFC control loop, biased control, concept of multi-area control, tie line bias control, Mathematical models of various turbine-governor systems, stability analysis of single area and multi area systems, transient stability analysis of multi-machine system.

UNIT 2 AVR CONTROL 9+6

Mathematical model of AVR control loop, modeling of various excitation systems, stability analysis of AVR systems, Lag-Lead compensation, cross coupling between AVR and ALFC control loops. Concept of AVR in multi-machine system, concept of reactive power and voltage dependency,voltage stability analysis of single machine infinite bus system.

UNIT 3 OPTIMAL GENERATION DISPATCH 9+6

Input output characteristics of a power generation units, optimum generation allocation of thermal units with and without losses, derivation of transmission loss formula, Reactive power dispatch, environmental economic dispatch, optimal dispatch of hydro units.

UNIT 4 HYDRO THERMAL COORDINATION 9+6

Advantages of coordination, optimal scheduling of hydrothermal system, short term, long term and stochastic hydro-thermal scheduling, combined working of runoff river plant with steam plant, Multi-reservoir plant, Pumped storage hydro plants.

UNIT 5 UNIT COMMITMENT 9+6

Optimal Unit commitment, Solution to unit commitment by dynamic programming, effect of start-up and shut down time/cost, optimal unit commitment with security.

TOTAL: 75 PERIODS

COURSE OUTCOMES

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

- model and control single and multi machine systems.
- apply AVR control in single-machine infinite bus system and multi machine systems.
- realize power systems pertaining to economic dispatch for energy management concepts.
- implement effectively the coordinated hydro thermal power systems.
- optimize the dispatch of available generation resources to meet the electrical load demand.

REFERENCES

1. Wood, A.J. and Wollenberg, B.F., “Power Generation, Operation and Control”, John Wiley and Sons, 2013.
2. Kothari, D.P., Dhillon J.S. “Power system Optimisation”, 2nd Ed., PHI, 2011.
3. Elgerd O.I., “Electric Energy System Theory- An Introduction”, McGraw-Hill, 2012.
4. P. Kundur, “Power System Stability & Control” Tata McGraw Hill, 2007.

WEB LINKS

1. media.johnwiley.com.au/product_data/excerpt/59/.../0471790559-4.pdf
2. www.newagepublishers.com/samplechapter/001758.pdf
3. www.unge.gq/ftp/biblioteca%20digital/.../Estabilidad%20-%20kundur.pdf.

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CO3	3	2	3	2	3	1	-	1	-	2	-	2	3	3
CO4	3	2	3	2	3	1	-	1	-	2	-	2	3	3
CO5	3	2	3	2	3	1	-	1	-	2	-	2	3	3

PPS 15103 MODERN POWER SYSTEM PROTECTION 3 0 0 3

COURSE OBJECTIVES

- To introduce the characteristics and functions of relays and protection schemes.
- To illustrate the concepts of transformer protection and generator protection in faulty conditions.
- To analyse the usage of relays in distance and carrier protection for single and double end fed lines.
- To familiarize the concepts of busbar protection under various fault conditions using current transformer.
- To describe the various schemes of static comparators and analysis of numerical protection.

UNIT 1 INTRODUCTION 9

Zones of protection – Primary and Backup protection – operating principles and Relay Construction - time – current characteristics-Current setting – Time setting-Over current protective schemes - Reverse power or directional relay - Protection of parallel feeders - Protection of ring feeders - Earth fault and phase fault protection - Combined Earth fault and phase fault protection scheme - Phase fault protective scheme directional earth fault relay - Static over current relays.

UNIT 2 EQUIPMENT PROTECTION 9

Types of transformers – Phasor diagram for a three phase transformer-Equivalent circuit of transformer – Types of faults in transformers- Over current protection Percentage Differential Protection of Transformers - Inrush phenomenon- High resistance Ground Faults in Transformers – Inter turn faults in transformers – Incipient faults in transformers - Phenomenon of over fluxing in transformers – Transformer protection application chart .Generator protection: Electrical circuit of the generator – Various faults and abnormal operating conditions- Stator faults- Rotor faults –Abnormal operating conditions. Induction Motor protection: Electrical Faults-Abnormal Operating Conditions from Supply side.

UNIT 3 DISTANCE AND CARRIER PROTECTION OF TRANSMISSION LINES 9

Introduction to distance relay – Simple impedance relay – Reactance relay – mho relays- Distance protection of a three Phase line - Three stepped distance protection - Trip contact configuration for the three - Stepped distance protection - Three-stepped protection of three-phase line against allten shunt faults - Three-stepped protection of double end fed lines - Various options for a carrier – Coupling and trapping the carrier into the desired line section - Unit type carrier aided directional comparison relaying – Carrier aided distance schemes for acceleration of zone II- Phase Comparison Relaying.

UNIT 4 BUSBAR PROTECTION 9

Introduction – Differential protection of busbars-external and internal fault – Actual behaviors of a protective CT - Circuit model of a saturated CT - External fault with one CT saturation need for high impedance – Minimum internal fault that can be detected by the high impedance Bus bar differential scheme – Stability ratio of high impedance busbar differential scheme - Supervisory relay-protection of three Phase busbars.

UNIT 5 STATIC COMPARATOR AS A RELAY AND NUMERICAL PROTECTION 9

Amplitude Comparator- Phase Comparator- Duality between Amplitude and Phase Comparator Introduction-Synthesis of Various distance Relay using Static Comparator. Numerical Protection: Block diagram of numerical relay - Sampling theorem- Correlation with a reference wave – Least error squared (LES) technique - numerical over Current protection – Numerical transformer differential protection-Numerical distance protection of transmission line.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- know the construction and operation of electromagnetic relays.
- choose the protective circuit based on the knowledge of faults in equipment.
- analyse the usage of relays in distance and carrier protection for single and double end fed lines.
- know the effective usage of CT in protection circuits.
- perform synthesis of numerical protection of transmission line using static comparator.

REFERENCES

1. Ravindar P. Singh, "Digital Power System Protection", PHI, New Delhi, 2007.
2. T.S.M.Rao, "Digital / Numerical Relays", Tata McGraw Hill, 2005.
3. Y.G.Paithankar, S.R.Bhide, "Fundamentals of Power System Protection", Prentice – Hall India, 2004.
4. Y.G. Paithankar and S.R Bhide, "Fundamentals of Power System Protection", Prentice-Hall of India, 2003.
5. L.P.Singh, "Digital protection, Protective Relaying from Electromechanical to Microprocessor", John Wiley & Sons, 1995.

WEB LINKS

1. my.mmosite.com/.../fundamentals_of_power_system_protection_pdf.ht.
2. www.spendbooks.org/1jw7fr_ebooks-digital-numerical-relays.pdf
3. www.egully.com/.../SWITCHGEAR-%26-POWER-SYSTEM-PROTECTION.

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CO3	3	-	3	2	3	1	-	1	-	2	-	2	-	2
CO4	3	-	3	2	3	1	-	1	-	2	-	2	-	2
CO5	3	-	3	2	3	1	-	1	-	2	-	2	-	2

PPS 15104 EHV AC TRANSMISSION ENGINEERING 3 0 0 3

COURSE OBJECTIVES

- To provide knowledge in understanding the different aspects of design and analysis of EHV A.C Transmission systems.
- To make the students understand the analysis of various transmission line parameters.
- To gain knowledge on the impact of voltage gradients in conductors.
- To calculate different types of losses caused by corona effect.
- To acquire knowledge on the effects of electrostatic field in EHV AC transmission system.

UNIT 1 TRANSMISSION ENGINEERING 9

Role of EHV AC transmission – Standard transmission voltages – Power handling capacity and line losses – cost of transmission lines and equipment – Mechanical considerations – Indian Requirement.

UNIT 2 LINE AND GROUND PARAMETERS 9

Resistance, power loss, temperature rise properties of bundled conductors, inductance and capacitance, calculation of sequence inductions and capacitance line parameters for modes of propagations, resistance and inductance of the ground return.

UNIT 3 VOLTAGE GRADIENTS 9

Charge-potential relations for multi-conductor lines – surface voltage gradient on conductors – gradient factors and their use – distribution of voltage gradient on sub conductors of bundle – voltage gradients on conductors in the presence of ground wires on towers.

UNIT 4 CORONA EFFECTS 9

Power losses and audible losses: I^2R loss and corona loss - audible noise generation and characteristics - limits for audible noise - Day-Night equivalent noise level- radio interference: corona pulse generation and properties - limits for radio interference fields.

UNIT 5 ELECTROSTATIC FIELD OF EHV LINES 9

Effect of EHV line on heavy vehicles - calculation of electrostatic field of AC lines- effect of high field on humans, animals, and plants- measurement of electrostatic fields - electrostatic Induction in unenergised circuit of a D/C line - induced voltages in insulated ground wires - electromagnetic interference.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon the completion of the course, the student will be able to

- appreciate the necessity of EHV AC transmission, choice of voltage for transmission line losses and power handling capability.
- analyze the statistical procedures for line designs, scientific and engineering principles in power systems.
- predict the distribution of voltage gradients on conductors.
- calculate the losses encountered due to corona effect.
- study the effects due to the electrostatic field in EHV AC transmission system.

REFERENCES

1. Rakosh Das Bagamudre, "Extra High Voltage AC Transmission Engineering", Wiley Eastern Ltd., New Delhi, 2013.
2. Allan Greenwood, "Electrical Transients in Power Systems", John Wiley and Sons New York, 2012.
3. C.L.Wadhwa, "Electrical Power Systems", New Age International (p) Ltd Publishers, 2015.
4. S.Rao "EHVAC and HVDC Transmission Engg. Practice" Khanna publishers.
5. Arrillaga.J "High Voltage Direct Current Transmission" 2nd Edition (London) peter Peregrines, IEEE, 1998.

WEB LINKS

1. www.faadooengineers.com/.../24501-Extra-HIgh-voltage-AC-Transmission
2. https://www.scribd.com/.../Electrical-Transients-in-Power-Systems
3. www.faadooengineers.com/.../9550-Power-System-book-by-C-L-Wadhwa

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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CO2	3	-	3	-	2	1	-	-	-	-	2	1	1	1
CO3	3	-	3	-	2	1	-	-	-	-	2	1	1	1
CO4	3	-	3	-	2	1	-	-	-	-	2	1	1	1
CO5	3	-	3	-	2	1	-	-	-	-	2	1	1	1

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PPS 15105 POWER SYSTEM SIMULATION LABORATORY-I 0 0 4 2

COURSE OBJECTIVES

- know the power systems analysis in power system simulation software.
- understand the basics of design aspects of EMTP, single machine-infinite bus system and contingencyanalysis.
- use the economic dispatch and unit commitment programming.
- implement relay coordination

LIST OF EXPERIMENTS

1. Power flow analysis by Newton-Raphson method and Fast decoupled method.
2. Transient stability analysis of single machine-infinite bus system using classical machine model.
3. Contingency analysis: Generator shift factors and line outage distribution factors.
4. Economic dispatch using lambda-iteration method.
5. Unit commitment: Priority-list schemes and dynamic programming.
6. Analysis of switching surge using EMTP: Energisation of a long distributed- parameter line.
7. Analysis of switching surge using EMTP: Computation of transient recovery voltage.
8. Simulation and Implementation of Voltage Source Inverter.
9. Digital over current relay setting and relay coordination.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon the completion of the course, the student will be able to

- simulate and implement the power systems analysis in power system simulation software.
- design EMTP, single machine-infinite bus system and contingencyanalysis.
- Utilize the economic dispatch and unit commitment programming.
- implement relay coordination

CO-PO MAPPING:

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CO2	3	-	3	-	3	1	-	-	2	1	-	2	3	3
CO3	3	-	3	-	3	1	-	-	2	1	-	2	3	3

PPS 15106 **TECHNICAL SEMINAR - I** **0 0 2 1**

COURSE OBJECTIVES

- To help students to acquire wide knowledge in the communication and the presentation skills in theirtechnical papers.
- To strengthen their prospects of success in technical presentation.
- To enhance leadership quality.
- To Progress Employability

In this course, every student has to present at least two technical papers on recent advancements in engineering/technology referring journal papers and will be evaluated by the course instructor. During the seminar session, each student is expected to present a topic, for duration of about 15 to 20 minutes which will be followed by a discussion for 5 minutes. Each student is responsible for selecting a suitable topic that has not been presented previously. Every student is expected to participate actively in the ensuing class discussion by asking questions and providing constructive criticism.

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

- communicate effectively.
- prepare quality and focused presentation.
- be the successful student researchers.
- success in employment

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CO3	3	-	-	-	-	2	1	2	3	3	1	3	1	-

SEMESTER II

PPS 15201 DEREGULATION OF POWER SYSTEMS 3 0 0 3

COURSE OBJECTIVES

- To introduce the concepts of deregulation for restructuring of power industry and market models.
- To impart knowledge on fundamental concepts of congestion management.
- To analyze the concepts of locational marginal pricing and financial transmission rights.
- To understand the concept of ancillary services for deregulation power system.
- To familiarize the recent development in Indian power systems.

UNIT 1 INTRODUCTION TO RESTRUCTURING OF POWER INDUSTRY 9

Introduction: Deregulation of power industry, Restructuring process, Issues involved in deregulation, Deregulation of various power systems – Fundamentals of Economics: Consumer behavior, Supplier behavior, Market equilibrium, Short and long run costs, Various costs of production – Market models: Market models based on Contractual arrangements, Comparison of various market models, Electricity vis – a – vis other commodities, Market architecture, Case study.

UNIT 2 TRANSMISSION CONGESTION MANAGEMENT 9

Introduction: Definition of Congestion, reasons for transfer capability limitation, Importance of congestion management, Features of congestion management – Classification of congestion management methods – Calculation of ATC - non – market methods – Market methods – Nodal pricing – Inter zonal and Intra zonal congestion management – Price area congestion management – Capacity alleviation method.

UNIT 3 LOCATIONAL MARGINAL PRICES AND FINANCIAL TRANSMISSION RIGHTS 9

Mathematical preliminaries: -Locational marginal pricing– Lossless DCOPF model for LMP calculation – Loss compensated DCOPF model for LMP calculation – ACOPF model for LMP calculation – Financial Transmission rights – Risk hedging functionality - Simultaneous feasibility test and revenue adequency – FTR issuance process: FTR auction, FTR allocation – Treatment of revenue shortfall – Secondary trading of FTRs – Flow gate rights – FTR and market power - FTR and merchant transmission investment.

UNIT 4 ANCILLARY SERVICE MANAGEMENT AND PRICING OF TRANSMISSION NETWORK 9

Introduction of ancillary services – Types of Ancillary services – Classification of Ancillary services – Load generation balancing related services – Voltage control and reactive power support devices – Black start capability service - ancillary service –Co-optimization of energy and reserve services - International comparison - Transmission pricing – Principles – Classification – Role in transmission pricing methods – Marginal transmission pricing paradigm – Composite pricing paradigm – Merits and demerits of different paradigm.

UNIT 5 REFORMS IN INDIAN POWER SECTOR 9

Introduction – Framework of Indian power sector – Reform initiatives - Availability based tariff – Electricity act 2003 – Open access issues – Power exchange – Reforms in the near future.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- understand the restructuring of power industry and market models based on contractual arrangements.
- know the fundamental concepts of congestion management.
- suggest the marginal transmission pricing network.
- formulate pricing of transmission network with the impact of ancillary services.
- demonstrate the framework of Indian power sector and its future reorganization.

REFERENCES

1. Mohammad Shahidehpour, Muwaffaq Alomoush, Marcel Dekker, “Restructured electrical power systems: operation, trading and volatility”, 2001.
2. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, “Operation of restructured power systems”, Kluwer Academic Publications., 2015.
3. Sally Hunt, “Making competition work in electricity”, John Willey and Sons Inc, 2002.
4. Steven Stoft, “Power system economics: designing markets for electricity”, John Wiley & Sons, 2002.

WEB LINKS

1. www.springer.com/cda/content/.../cda.../9781852336707-c1.pdf.
2. www.powershow.com/.../Deregulation_as_a_Power_Engineering_Course.
3. www.powerworld.com/files/tjo_sum99_market.ppt

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CO1	3	-	3	-	2	1	-	-	-	-	2	1	2	-
CO2	3	-	3	-	2	1	-	-	-	-	2	1	2	-
CO3	3	-	3	-	2	1	-	-	-	-	2	1	2	-
CO4	3	-	3	-	2	1	-	-	-	-	2	1	2	-
CO5	3	-	3	-	2	1	-	-	-	-	2	1	2	-

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PPS15202 **POWER SYSTEM DYNAMICS** **3 2 0 4**

COURSE OBJECTIVES

- To know the basics of mathematical description of a synchronous machine.
- To illustrate the modelling of excitation system and speed governing systems for power generation control.
- To understand the concept of system stability analysis with and without controllers for various power system networks.
- To analyze the transient stability using various approaches.
- To learn instability analysis of power system transmission using digital simulation.

UNIT 1 SYNCHRONOUS MACHINE MODELING 9+6

Synchronous Machine - Physical Description - Mathematical Description of a Synchronous Machine - Basic equations of a synchronous machine - stator circuit equations, stator self, stator mutual and stator to rotor mutual inductances - dq0 Transformation - Per Unit Representation - Equivalent Circuits for direct and quadrature axes - Steady-state Analysis - Steady-state equivalent circuit, Computation of steady-state values Equations of Motion - Swing Equation, H-constant calculation - Representation in system studies - Synchronous Machine Representation in Stability Studies - Simplified model with amortisseurs neglected: - classical model with amortisseur windings neglected.

UNIT 2 MODELING OF EXCITATION AND SPEED GOVERNING SYSTEMS 9+6

Excitation System Modeling - Excitation System Requirements - Types of Excitation System -Rotating Rectifier and Potential-source controlled-rectifier systems: hardware block diagram and IEEE(1992) Type ST1A block diagram. Turbine and Governing System Modeling: Functional Block Diagram of Power Generation and Control - Schematic of a hydroelectric plant - classical transfer function of a hydraulic turbine (no derivation) - special characteristic of hydraulic turbine - electrical analogue of hydraulic turbine Governor for Hydraulic Turbine - Requirement for a transient droop, Block diagram of governor with transient droop compensation - Steam turbine modeling: Single reheat tandem compounded type only and IEEE block diagram for dynamic simulation; generic speed-governing system model for normal speed/load control function.

UNIT 3 SMALL-SIGNAL STABILITY ANALYSIS WITH AND WITHOUT CONTROLLERS 9+6

Classification of Stability - Basic Concepts and Definitions: Rotor angle stability - Fundamental Concepts of Stability of Dynamic Systems: State-space representation - stability of dynamic system - Linearisation, Eigen properties of the state matrix – eigenvalue and stability - Single-Machine Infinitie Bus (SMIB) Configuration: Classical Machine Model stability analysis with numerical example - Effect of field flux variation on system stability: analysis with numerical example -Effects Of Excitation System - analysis of effect of AVR on synchronizing and damping components using a numerical example - Multi-Machine Configuration - Equations in a common reference frame - Formation of system state matrix for a two-machine system with classical models for synchronous machines, illustration of stability analysis using a numerical example.

UNIT 4 TRANSIENT STABILITY ANALYSIS 9+6

Introduction - Factors influencing transient stability – Review of Numerical Integration Methods - Simulation of Power System Dynamic response: Structure of Power system Model, Synchronous machine representation - Thevenin's and Norton's equivalent circuits, Excitation system representation, Transmission network and load representation, Overall system equations and their solution: Partitioned - explicit and Simultaneous-implicit approaches, treatment of discontinuities, Simplified Transient Stability Simulation using simultaneous-implicit approaches.

UNIT 5 INSTABILITY ANALYSIS 9+6

Small signal angle instability (sub-synchronous frequency oscillations): analysis and counter- measures. Transient Instability: Analysis using digital simulation and energy function method. Transient stability controllers. Introduction to voltage instability, analysis of voltage Instability.

TOTAL: 75 PERIODS

COURSE OUTCOMES

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

- understand the fundamental dynamic behavior of power systems.
- comprehend concepts in modeling and simulate the dynamic phenomena of power systems.
- examine the effectiveness of controllers in power system stability
- interpret results of system stability studies.
- demonstrate the theory and practice of modeling power system components.

REFERENCES

1. P. S. Kundur, “Power System Stability and Control”, McGraw-Hill, 2009.
2. K.R.Padiyar, “Power System Dynamics Stability & Control”, BS Publications, Hyderabad, 2007.
3. P.M Anderson and A.A Fouad, “Power System Control and Stability”, Iowa State University Press, Ames, Iowa, 2008.
4. PeterW.Sauer & M.A.Pai, “Power System Dynamics & Stability”, Pearson Education, 2002.

5. IEEE Committee Report, “Dynamic Models for Steam and Hydro Turbines in Power System Studies,” IEEE Transactions, Vol.PAS-92, pp 1904-1915, November / December 1973.

WEB LINKS

1. www.unge.gq/ftp/biblioteca%20digital/.../Estabilidad%20-%20kundur.p
2. www.solvina.se/wp.../04/Power_System_Stability_Sweden_20132.pdf
3. ebitik.azerblog.com/anbar/3194.pdf

CO-PO MAPPING:

Mapping of Course Outcome (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes PSO’s (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO’s	Programme Outcomes PO’s												PSO’s	
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CO3	3	2	3	-	2	1	-	-	-	-	2	1	2	1
CO4	3	2	3	-	2	1	-	-	-	-	2	1	2	1
CO5	3	2	3	-	2	1	-	-	-	-	2	1	2	1

PPS 15203 POWER SYSTEM TRANSIENTS AND SURGE PROTECTION 3 0 0 3

COURSE OBJECTIVES

- To give introduction about various types of power system transients and devise a mathematical model for calculation of transients.
- To brief the students about the lightning surges and various lightning protection schemes.
- To acquire knowledge about line surges due to switching and its protection.
- To familiarize the students in transient calculation in transmission lines.
- To analyze the recent advancements in insulation co-ordination.

UNIT 1 INTRODUCTION 9

Review of various types of power system transients – Lightning surges, Switching surges: Inductive energy transient and Capacitive energy transient - effect of transients on power systems- relevance of the study and computation of power system transients – Surge voltage and surge current specifications (As per BIS).

UNIT 2 LIGHTNING SURGES 9

Lightning – overview - Lightning Surges-Electrification of thunderclouds – Simpson's theory of thunderclouds - Direct and Indirect Strokes - Stroke to conductor, midspan and tower – Conventional lightning protection schemes for transmission lines and terminal equipments – Advanced Lightning protection technique: Collection Volume method (Dynasphere).

UNIT 3 SWITCHING SURGES 9

Closing and reclosing of lines – load rejection – fault initiation – fault clearing – short line faults – Ferro Resonance – isolator switching surges – temporary over voltages – surges on an integrated systems – switching – harmonics – Protection scheme.

UNIT 4 TRANSIENT CALCULATION 9

Traveling wave concepts – Telegraphic Equation, Wave Propagation, Reflections – Bewley's Lattice diagrams for various cases – Analysis in time and frequency domain – Eigen value approach – Z-transform.

UNIT 5 INSULATION CO ORDINATION 9

Principles of insulation co-ordination – recent advancements in insulation co ordination – BIL, Design of EHV system – Insulation coordination as applied to transformer, substations – Examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- understand various types of power system transients and its effect on power system.
- evolve a mathematical model for transients calculation.
- know various protection schemes for lightning surges.
- analyse transients to find a effective means of protection.
- know the recent advancements in insulation co-ordination.

REFERENCES

1. Allan Greenwood, “Electrical Transients in Power Systems”, Willey Interscience, New York, 2010.
2. Klaus Ragaller, “Surges in High Voltage Networks”, Plenum Press, New York, 2013.
3. C.S.Indulkar, DP Kothari, “Power System Transients” – A Statistical approach, Prentice Hall 2010.
4. Subir Ray, “Electrical Power Systems – Concepts, Theory and Practice”, Prentice Hall of India, New Delhi, 2014.
5. Rakosh das Begamudre, “Extra High Voltage AC Transmission Engineering”, Wiley Eastern Ltd, New Delhi, 2007
6. Chakrabarthy.A, Soni.M.L, Gupta.P.V. and Bhatnagar.U.S., “A Text Book on Power System Engineering“ ,Dhanpat Rai & Co., New Delhi, 2005.

. WEB LINKS

1. https://www.scribd.com/.../Electrical-Transients-in-Power-Systems-2E-Allan G. Wood.
2. vintagevirgo.com/?search=D.+P.+Kothari
3. www.faadooengineers.com/.../24501-Extra-HIgh-voltage-AC-Transmission.

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CO4	3	-	3	2	3	1	-	1	-	2	-	2	-	2
CO5	3	-	3	2	3	1	-	1	-	2	-	2	-	2

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PPS 15204 ARTIFICIAL INTELLIGENCE APPLICATION TO POWER SYSTEMS 3 0 0 3

COURSEOBJECTIVES

- To expose the concepts of feed forward neural networks.
- To teach about the concept of fuzziness involved in various systems.
- To apply the ANN techniques to power system problems.
- To expose the application of FLS in power systems.
- To provide adequate knowledge about Genetic algorithm and its application.

UNIT 1 ARTIFICIAL NEURAL NETWORKS 9

Basics of ANN – Perceptron -Delta learning rule –Back Propagation Algorithm- Multilayer Feed forward network-Memory models-Bi-directional associative memory-Hopfield network

UNIT 2 FUZZY LOGIC SYSTEM 9

Crispness-Vagueness-Fuzziness-Uncertainty-Fuzzy set theory Fuzzy sets-Fuzzy set operations-fuzzy measures-fuzzy relations-fuzzy function. Structure of fuzzy logic controller- fuzzification models-data base-rule base-inference engine defuzzification module.

UNIT 3 APPLICATION OF ANN TO POWER SYSTEM 9

Application of Neural Networks to load forecasting, Contingency Analysis-VAR control, Economic Load Dispatch.

UNIT 4 APPLICATION FLS TO POWER SYSTEM 9

Decision making in Power system Control through fuzzy set theory -Use of fuzzy set models of LP in Power systems scheduling problems-Fuzzy logic based power system stabilizer.

UNIT 5 GENETIC ALGORITHM AND ITS APPLICATIONS 9

Introduction – Simple Genetic Algorithm – Reproduction, Crossover, Mutation, Advanced Operators in Genetic Search – Applications to voltage Control and Stability Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- explore the concepts of neural networks methods.
- learn the concept of fuzziness involved in various systems.
- implement ANN concepts to solve power system problems.

- obtain solutions to power system problems using FLS.
- Implement Fuzzy Logic, Genetic Algorithm and Neural Networks in Power Systems.

REFERENCES

1. Laurene V. Fausett, Fundamentals of Neural Networks: Architectures, Algorithms And Applications, Pearson Education,
2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications” Wiley India.
3. Zimmermann H.J. "Fuzzy set theory and its Applications" Springer international edition, 2011.
4. David E.Goldberg, “Genetic Algorithms in Search, Optimization, and Machine Learning”, Pearson Education, 2009.

WEB LINKS

1. iosrjournals.org/iosr-jce/papers/necon/volume-1/B.pdf
2. www.gbv.de/dms/ilmenau/toc/01600020X.PDF
3. www.ijest-ng.com/ijest-ng-vol2-no3-pp1-7.pdf

CO-PO MAPPING:

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CO3	3	2	3	-	3	1	-	-	-	-	2	1	3	1
CO4	3	2	3	-	3	1	-	-	-	-	2	1	3	1
CO5	3	2	3	-	3	1	-	-	-	-	2	1	3	1

PPS 15205 POWER SYSTEM SIMULATION LABORATORY-II 0 0 4 2

COURSE OBJECTIVES

- To know stability analysis system
- To study load flow and starting analysis
- To study of STATCOM,PMSG, and DFIG for variable speed wind energy conversion system.
- To understand relay coordination

LIST OF EXPERIMENTS

1. Small-signal stability analysis of single machine-infinite bus system using classical machine model.
2. Small-signal stability analysis of multi-machine configuration with classical machine model.
3. Induction motor starting analysis.
4. Load flow analysis of two-bus system with STATCOM.
5. Transient analysis of two-bus system with STATCOM.
6. Available Transfer Capability calculation using an existing load flow program.
7. Study of variable speed wind energy conversion system- DFIG.
8. Study of variable speed wind energy conversion system- PMSG.
9. Computation of harmonic indices generated by a rectifier feeding a R-L load.
10. Co-ordination of over-current and distance relays for radial line protection.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- Implement stability analysis system
- Demonstrate load flow and starting analysis
- design of STATCOM,PMSG, and DFIG for variable speed wind energy conversion system.
- Implement relay coordination

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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CO3	3	-	3	-	3	1	-	-	2	1	-	2	3	3
CO4	3	-	3	-	3	1	-	-	2	1	-	2	3	3

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PPS 15206 TECHNICAL SEMINAR - II **0 0 2 1**

COURSE OBJECTIVES

- To enhance the communication skills
- To improve presentational skills for betterment of their carrier.
- To enhance leadership quality.
- To Progress Employability.

In this course, every student has to present at least two technical papers on recent advancements in engineering/technology referring journal papers and will be evaluated by the course instructor. During the seminar session, each student is expected to present a topic, for duration of about 15 to 20 minutes which will be followed by a discussion for 5 minutes. Each student is responsible for selecting a suitable topic that has not been presented previously. Every student is expected to participate actively in the ensuing class discussion by asking questions and providing constructive criticism.

TOTAL: 30 PERIODS

COURSE OUTCOMES

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

- acquire knowledge in communication
- technical presentation skills
- expose leadership quality
- success in employment.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

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CO3	3	-	-	-	-	2	1	2	3	3	1	3	3	3
CO4	3	-	-	-	-	2	1	2	3	3	1	3	3	3

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LIST OF ELECTIVES

PPE 15E01 ANALYSIS OF INVERTERS 3 0 0 3

COURSE OBJECTIVES

- To provide the electrical circuit concepts behind the different working modes of single phase inverters.
- To brief the different working modes of three phase inverters and various switching techniques.
- To make the students to gain knowledge on design and development of current source inverters.
- To analyse and comprehend the various operating modes of different configurations of power converters.
- To familiarize the concepts of various resonant inverter techniques and its application.

UNIT 1 SINGLE PHASE INVERTERS 12

Introduction to self commutated switches : MOSFET and IGBT - Principle of operation of half and full bridge inverters – Performance parameters – Voltage control of single phase inverters using various PWM techniques – various harmonic elimination techniques – forced commutated Thyristor inverters.

UNIT 2 THREE PHASE VOLTAGE SOURCE INVERTERS 9

180 degree and 120 degree conduction mode inverters with star and delta connected loads – voltage control of three phase inverters: single, multi pulse, sinusoidal, space vector modulation techniques.

UNIT 3 CURRENT SOURCE INVERTERS 9

Operation of six-step thyristor inverter – inverter operation modes – load – commutated inverters – Auto sequential current source inverter (ASCI) – current pulsations – comparison of current source inverter and voltage source inverters.

UNIT 4 MULTILEVEL INVERTERS 9

Multilevel concept – diode clamped – flying capacitor – cascade type multilevel inverters - Comparison of multilevel inverters - application of multilevel inverters.

UNIT 5 RESONANT INVERTERS 6

Series and parallel resonant inverters - voltage control of resonant inverters – Class E resonant inverter – resonant DC – link inverters- advancements in inverter technology for industrial applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- understand the various circuit concepts of single phase inverters.
- analyse the working of three phase inverters with modulation techniques.
- design and develop current source inverters.
- derive the design criteria and analyse the various operating modes of different configurations of power converters.
- design inverters for various power applications.

REFERENCES

1. Rashid M.H., “Power Electronics Circuits, Devices and Applications ", Prentice Hall India, New Delhi, 2011.
2. Bimal K.Bose., “Modern Power Electronics and AC Drives”, Pearson Education, 2009.
3. Ned Mohan,Undeland and Robbin, “Power Electronics: converters, Application and design” John Wiley and sons.Inc,Newyork, 2009.
4. P.C. Sen, “Modern Power Electronics”, S. Chand Limited, New Delhi, 2008.
5. P.S.Bimbra, “Power Electronics”, Khanna Publishers, 2005.
6. Dubey. G.K., "Thyristorised power controllers", New age International, New Delhi, 2002.

WEB LINKS

1. https://cld.pt/.../download/.../Power%20Electronics%20Handbook%203r.
2. https://myarchive4u.wordpress.com/.../power-electronics-circuitsdevices-.
3. 7see.blogspot.com/2015/06/power-electronics-by-ps-bimbra-free.html

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CO4	3	3	3	-	-	1	-	1	-	2	-	2	1	3
CO5	3	3	3	-	-	1	-	1	-	2	-	2	1	3

PPS 15E01 POWER SYSTEM RELIABILITY 3 0 0 3

COURSE OBJECTIVES

- To understand the reliability concepts and planning criteria.
- To analyze the reliability models and its applications.
- To obtain the reliability of power system through various approaches.
- To evaluate the reliability of single machine under various loading conditions.
- To evaluate the reliability of multi machine using various approaches.

UNIT 1 BASIC RELIABILITY CONCEPT 9

The General reliability function - The exponential distribution – Mean time to failure – series and parallel systems – Markov process – continuous Markov processes – Recursive Techniques.

UNIT 2 RELIABILITY MODELS AND ITS APPLICATION 9

Equipment Failure Mechanism-Availability of Equipment's-Oil Circuit Recloser Maintenance Issues - Distribution Pole Maintenance-Procedure for Grounding Testing-Insulator Maintenance- Customer Service outages.

UNIT 3 RELIABILITY APPROACHES 9

Loss of energy probability method – frequency and duration approach – conclusion spinning capacity evaluation – Load forecast uncertainty – de-rated capacity levels.

UNIT 4 SINGLE SYSTEM RELIABILITY EVALUATION 9

Average interruption rate method – The frequency and duration method – stormy and normal weather effects – The Markov process approach – system studies – Service quality criterion – The conditional probability approach – simple system application, Two plant single load system, Two plant – two load system – networked system approach

UNIT 5 MULTIPLE SYSTEM RELIABILITY EVALUATION 9

The probability array for two systems – The loss of load approach – Load forecast uncertainty – Reliability evaluation in more than two systems – interconnection benefits – The system modes of failure – The loss of load approach – The frequency and duration approach – spare value assessment – Multiple Bridge equivalents.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- plan and design a model for reliable power system network .
- analyse the reliability models.
- obtain the reliability of power system through various approaches.
- evaluate single reliable systems under various loading conditions.
- evaluate the reliability of multi machine systems.

REFERENCES

1. Gonen, Turan, “Electric Power Distribution System Engineering”, Crc, 2009.
2. Ali Chowdhury, Don Koval,”Power Distribution system Reliability: Practical Methods and Applications”, 2009.
3. William H. Smith, P.E, “Electric Power System Reliability”, Power smiths International, Inc., 2007.
4. Roy Billinton and R.N. Allan, “Reliability Evaluation of Power Systems”, Pitman, London, 1990 Edition.

WEB LINKS

1. edsonjosen.dominiotemporario.com/.../Livro_Electric_Power_Distribution.
2. www.csun.edu/~bjc20362/Billinton-Allan-Excerpt.pdf
3. www.cargobooks.org/2gmiuk_ebooks-electric-machinery-fundamentals.

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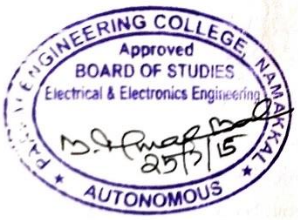
CO4	3	-	-	-	2	3	2	2	3	-	2	1	-	2
CO5	3	-	-	-	2	3	2	2	3	-	2	1	-	2



PPS 15E02 INSULATION AND TESTING ENGINEERING 3 0 0 3

COURSE OBJECTIVES

- To acquire knowledge about the properties of organic and inorganic insulating materials.
- To study the breakdown mechanisms for various dielectric materials.
- To understand the various methods of generation and measurement of high voltage.
- To impart knowledge on electrical equipment testing techniques.
- To gain the knowledge on non destructive testing on electrical apparatus.

UNIT 1 INSULATING MATERIALS 9

Requirements for insulating materials - electrical properties - molecular properties of dielectrics - dependence of permittivity on temperature, pressure, humidity and voltage - permittivity of mixtures - practical importance of permittivity - behavior of dielectrics under alternating fields - complex dielectric constants - bipolar relaxation and dielectric loss dielectric strength - Natural inorganic insulating materials - synthetic inorganic insulating materials - natural organic insulating materials - synthetic organic insulating materials.

UNIT 2 BREAKDOWN MECHANISMS IN SOLID, LIQUID AND GASEOUS DIELECTRICS 9

Intrinsic breakdown of solid dielectrics – electromechanical breakdown - Streamer breakdown thermal breakdown - electrochemical breakdown - tracking and treeing. Breakdown due to internal discharges. Liquid dielectrics - capitation breakdown - suspended particle theory. Behavior of gaseousdielectrics - ionization processes - effect of electrodes on gaseous discharge - Townsend's theory - Streamer theory - breakdown in electronegative gases - Townsend's criterion for break down – breakdown in non-uniform fields - breakdown in vacuum insulation.

UNIT 3 HIGH VOLTAGES GENERATION AND MEASUREMENT 9

Generation and measurement of high direct voltage, alternating voltages, impulse voltages and impulse currents – Tripping and control of Impulse voltage Generator – Digital Storage Oscilloscope for impulse voltage and current measurements.

UNIT 4 ELECTRICAL EQUIPMENT TESTING TECHNIQUES 9

Necessity for high voltage testing - classification of testing methods - self restoration systems - standards and specifications - testing of power transformers - voltage transformers - current transformers - bushings - insulators - surge diverters - cables - circuit breakers and isolators – Artificial pollution testing on insulators – IEC and Indian standards.

UNIT 5 NON-DESTRUCTIVE TESTING 9

Loss in a Dielectric - Measurement of Resistivity - Measurement of Dielectric Constant and Loss Factor - High Voltage Schering Bridge - Measurement of Large Capacitance - Schering Bridge Method for Grounded Test Specimen - Schering Bridge for Measurement of High Loss Factor - Transformer Ratio Arm Bridge - Partial Discharges: equivalent circuit- Bridge Circuit - Recurrent Surge Generator.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon the completion of the course, the student will be able to

- know the electrical properties of insulating materials
- acquire the knowledge on the different breakdown mechanisms of dielectrics.
- understand the various methods of generation and measurement of high voltage.
- acquire the knowledge of various methods of electrical equipments.
- know the use of electric bridges for non-destructive testing.

REFERENCES

1. SK Bhattacharya, "Electrical and Electronic Engineering Materials" 1st edition Khanna Publishers, New Delhi, 2006.
2. A.J. Dekker "Electrical Engineering Materials", PHI, 2006.
3. Naidu,M.S. and Kamaraju,V., "High Voltage Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2009.
4. C.L.Wadhwa., "High Voltage Engineering", New Age International (P) Ltd, Publishers,2007.
5. Kuffel E., Zaengl W.S. and Kuffel J., "High Voltage Engineering Fundamentals", Elsvier India Pvt. Ltd, 2005.
6. Ushakov V.Y., "Insulation of High Voltage Equipment", Springer, 2004.

WEB LINKS

1. www.aikidokunheim.com/download/.../electrical-engineering-materials-a-j-dekker.pdf.
2. https://www.scribd.com/.../High-Voltage-Engineering-Von-M-S-Naidu.
3. https://ofazesap.files.wordpress.com/.../high-voltage-and-electrical-insulation.

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CO's	Programme Outcomes PO's												PSO's	
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CO1	3	-	2	1	-	1	-	1	-	2	-	2	1	2
CO2	3	-	2	1	-	1	-	1	-	2	-	2	1	2
CO3	3	-	2	1	-	1	-	1	-	2	-	2	1	2
CO4	3	-	2	1	-	1	-	1	-	2	-	2	1	2
CO5	3	-	2	1	-	1	-	1	-	2	-	2	1	2

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PPS 15E03 FLEXIBLE AC TRANSMISSION SYSTEMS 3 2 0 4

COURSE OBJECTIVES

- To emphasis the need of FACTS controllers.
- To learn the characteristics, applications and modelling of SVC controllers.
- To understand the characteristics, applications and modelling of TCSC controllers.
- To know about the emerging trends of FACTS controller.
- To analyze the interaction of different FACTS controllers and perform control coordination.

UNIT 1 INTRODUCTION 9+6

Reactive power control in electrical power transmission lines –Uncompensated transmission line - series compensation – Basic concepts of Static Var Compensator (SVC)–Thyristor Switched Series capacitor (TCSC) – Unified power flow controller (UPFC).

UNIT 2 STATIC VAR COMPENSATOR (SVC) AND APPLICATIONS 9+6

Voltage control by SVC – Advantages of slope in dynamic characteristics – Influence of SVC on system voltage – Design of SVC voltage regulator –Modelling of svc for power flow and transient stability – Applications: Enhancement of transient stability – Steady state power transfer – Enhancement of power system damping – Prevention of voltage instability.

UNIT 3 THYRISTOR CONTROLLED SERIES CAPACITOR (TCSC) AND APPLICATIONS 9+6

Operation of the TCSC – Different modes of operation – Modelling of TCSC – Variable reactance model – Modelling for Power Flow and stability studies. Applications: Improvement of the system stability limit – Enhancement of system damping-SSR Mitigation.

UNIT 4 VOLTAGE SOURCE CONVERTER BASED FACTS CONTROLLERS 9+6

Static Synchronous Compensator (STATCOM) – Principle of operation – V-I Characteristics. Applications: Steady state power transfer-Enhancement of transient stability - Prevention of voltage instability. SSSC-operation of SSSC and the control of power flow –Modelling of SSSC in load flow and transient stability studies. Applications: SSR Mitigation-UPFC and IPFC

UNIT 5 CO-ORDINATION OF FACTS CONTROLLERS 9+6

Controller interactions – SVC – SVC interaction – Co-ordination of multiple controllers using linear control techniques – Control coordination using genetic algorithms.

TOTAL: 75 PERIODS

COURSE OUTCOMES

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

- understand the need for FACTS controllers.
- learn the characteristics, applications and modeling of SVC controllers.
- learn the characteristics, applications and modeling of TCSC controllers.
- update knowledge on the merging trends of FACTS controllers.
- analyze the interaction of different FACTS controller and perform control coordination.

REFERENCES

1. R.MohanMathur, Rajiv K.Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc., 2002.
2. Narain G. Hingorani, "Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers Distributors, Delhi- 110 006, 2000.
3. K.R.Padiyar,"FACTS Controllers in Power Transmission and Distribution", New Age International (P) Limited, Publishers, New Delhi, 2008.
4. A.T.John, "Flexible A.C. Transmission Systems", Institution of Electrical and Electronic Engineers, IEEE, 1999.
5. Xiao – Ping Zang, Christian Rehtanz and Bikash Pal, "Flexible AC Transmission System: Modelling and Control" Springer, 2012.

WEB LINKS

1. ir.nmu.org.ua/bitstream/.../60e92e97ebde9c734f5675bffb604a89.pdf
2. www.chettinadtech.ac.in/g_articlen/10.../10-10-12-08-46-17-bresnav.pdf
3. www.botonbook.com/doc/understanding-facts.pdf

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	2	-	-	3	2	-	-	-	-	1	2	3	3
CO2	3	2	-	-	3	2	-	-	-	-	1	2	3	3
CO3	3	2	-	-	3	3	-	-	-	-	1	2	3	3
CO4	3	2	-	-	3	2	-	-	--	-	1	2	3	3
CO5	3	2	-	-	3	3	-	-	-	-	1	2	3	3

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PPS 15E04 LINEAR AND NON-LINEAR SYSTEM THEORY 3 2 0 4

COURSE OBJECTIVES

- To introduce the modeling and representing systems in state variable form.
- To acquire knowledge on solving linear and non-linear state equations.
- To illustrate and analyse the role of controllability and observability.
- To familiarize the nonlinearity of systems by describing function.
- To educate on stability analysis of systems using Lyapunov's theory and other techniques.

UNIT 1 STATE VARIABLE REPRESENTATION 9+6

Introduction-Concept of State equation for Dynamic Systems -Time invariance and linearity- Non uniqueness of state model-State Diagrams - Physical System and State Assignment.

UNIT 2 SOLUTION OF STATE EQUATIONS 9+6

Existence and uniqueness of solutions to Continuous-time state equations-Solution of Nonlinear and Linear Time Varying State equations-Evaluation of matrix exponential.

UNIT 3 FEEDBACK CONTROLLERS AND OBSERVERS 9+6

Controllability and Observability-Test for Continuous time Systems- Time varying and Time invariant case-Output Controllability-Controllable and Observable Companion Forms-SISO and MIMO Systems-Pole Placement by State Feedback for both SISO and MIMO Systems-Full Order andReduced Order Observers.

UNIT 4 ANALYSIS OF NON LINEAR SYSTEMS 9+6

Classification of nonlinearity-physical nonlinearities-Linearization of nonlinear systems-phase plane analysis-describing function analysis of nonlinear systems-Application of describing functions

UNIT 5 STABILTY 9+6

Introduction-Equilibrium Points-Stability in the sense of Lyapunov-BIBO Stability-Stability of LTI Systems-Equilibrium Stability of Nonlinear Continuous Time Autonomous Systems-The Direct Method of Lyapunov and the Linear Continuous-Time Autonomous Systems-Finding Lyapunov Functions for Nonlinear Continuous Time Autonomous Systems-Krasovskii and Variable-Gradiant Method.

TOTAL: 75 PERIODS

COURSE OUTCOMES

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

- apply the mathematical fundamentals for deriving the state model.
- obtain solutions of state equations to derive the system matrix.
- analyse and design the linear and nonlinear systems.
- analyse non-linear system using describing functions.
- determine the complexity and stability of control systems.

REFERENCES

1. M.Gopal, "Modern Control System theory", New Age International Publishers, 2014.
2. Nagrath I.J., and Gopal, M., "Control Systems Engineering" New Age International Limited, 2013.
3. K. Ogatta, "Modern Control Engineering", Pearson Education Asia, 2010.

WEB LINKS

1. https://www.scribd.com/.../Control-Systems-Engineering-Nagrath-I-J-and Gopal.M.
2. een.iust.ac.ir/.../Linear%20Control%20System/Ogata%20Modern_Control_Engineering.
3. http://www.clemson.edu/ces/crb/ece801/notes/chap10t.pdf

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
CO1	3	3	3	3	-	1	-	-	2	-	-	3	2	3
CO2	3	3	3	3	-	1	-	-	2	-	-	3	2	3
CO3	3	3	3	3	-	1	-	-	2	-	-	3	2	3
CO4	3	3	3	3	-	1	-	-	2	-	-	3	2	3
CO5	3	3	3	3	-	1	-	-	2	-	-	3	2	3

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PPS 15E05 INDUSTRIAL POWER SYSTEM ANALYSIS AND DESIGN 3 2 0 4

COURSE OBJECTIVES

- To brief about the various motor starting techniques and computer aided analysis.
- To study about power factor correction methods.
- To analyze the harmonic sources and design the harmonic filters.
- To understand the flicker analysis and conduct a case study.
- To know about ground grid analysis.

UNIT 1 MOTOR STARTING STUDIES 9+6

Introduction-Evaluation Criteria-Starting Methods-System Data-Voltage Drop Calculations-Calculation of Acceleration time-Motor Starting with Limited-Capacity Generators Computer-Aided Analysis-Conclusions.

UNIT 2 POWER FACTOR CORRECTION STUDIES 9+6

Introduction-System Description and Modeling-Acceptance Criteria-Frequency Scan Analysis-Voltage Magnification Analysis-Sustained Over voltages-Switching Surge Analysis-Back-to-Back Switching-Summary and Conclusions.

UNIT 3 HARMONIC ANALYSIS 9+6

Harmonic Sources-System Response to Harmonics-System Model for Computer-Aided Analysis-Acceptance Criteria-Harmonic Filters-Harmonic Evaluation-Case Study- Summary and Conclusions.

UNIT 4 FLICKER ANALYSIS 9+6

Sources of Flicker-Flicker Analysis-Flicker Criteria-Data for Flicker analysis- Case Study- Arc Furnace Load-Minimizing the Flicker Effects-Summary.

UNIT 5 GROUND GRID ANALYSIS 9+6

Introduction-Acceptance Criteria-Ground Grid Calculations-Computer-Aided Analysis - Improving the Performance of the Grounding Grids-Conclusions.

TOTAL: 75 PERIODS

COURSE OUTCOMES

Upon the completion of the course, the student will be able to

- know about the various motor starting techniques and computer aided analysis.
- demonstrate the power factor correction techniques.
- determine the level of harmonics and its effect.
- analysis the flickers and methods of minimizing its effects.
- perform ground grid calculations and analyze the performance of ground grids.

REFERENCES

1. Ramasamy Natarajan,” Computer-Aided Power System Analysis”, Marcel Dekker Inc., 2002.
2. J. Duncan Glover, Mulukutla S.Sarma, Thomas Overbye, “Power System Analysis and Design”, 2011.
3. Patrick H Garrett,” High performance Instrumentation and Automation”, CRC Press, Taylor & Francis Group, 2005.
4. Turan Gonen “Electrical Power Transmission System Engineering: Analysis and Design”, Mcgraw Hill publishers, 2008.
5. Ramasamy Natarajan, “Computer-Aided Power System Analysis”, Marcel Dekker Inc., 2012.
6. P. Kundur, “Power System Stability and Control”, McGraw-Hill, 2008.

WEB LINKS

1. www.unge.gq/ftp/biblioteca%20digital/.../Estabilidad%20-%20kundur.p.
2. www.infibeam.com/.../high-performance-instrumentation-automation-patrick H Garrett.
3. www.gbv.de/dms/ilmenau/toc/593623495.PDF.

CO-PO MAPPING:

Mapping of Course Outcome (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes PSO’s (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO’s	Programme Outcomes PO’s												PSO’s	
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CO1	3	2	3	-	2	1	-	-	-	-	2	3	2	2
CO2	3	2	3	-	2	1	-	-	-	-	2	3	2	2
CO3	3	2	3	-	2	1	-	-	-	-	2	3	2	2
CO4	3	2	3	-	2	1	-	-	-	-	2	3	2	2
CO5	3	2	3	-	2	1	-	-	-	-	2	3	2	2

PPS 15E06 **POWER SYSTEM ECONOMICS** **3 0 0 3**

COURSE OBJECTIVES

- To brief about the various generation constraints and its load characteristics.
- To understand the methods of solving the economic dispatch problems.
- To analyse the basic electric energy market computational tools.
- To know the methods of plant location and equipment selection.
- To analyze the solutions of optimal power flow.

UNIT 1 INTRODUCTION 8

Introduction – Characteristics of Stream units, Hydro units, Cogeneration plants – Load curves – Load duration curves – Number and size of generator units – Cost of Electrical energy – Cost of service, Fixed charges, Interest applications, Investment, Taxes, Depreciation charges and Annual operating cost.

UNIT 2 ECONOMIC DISPATCH 9

Economic Dispatch problem – Thermal system dispatching with Network losses considered – Lambda Iteration method – Gradient Method – Newton's Method – Piecewise linear cost functions – Dynamic programming – Base point and participation factor – Transmission system effects – Power flow problem and its solution – Transmission Losses – Problems.

UNIT 3 UNIT COMMITMENT 8

Introduction – Constraints in unit commitment – Reserves – Unit commitment solution methods – Priority List method, Dynamic programming solution, FDP method, Lagrange Relaxation solution, Linear programming – Load Forecasting.

UNIT 4 POWER ECONOMICS 8

Selection of plant: Plant capacity, Capacity Probability analysis, Plant location, equipment selection, Equipment cost – Station performance and operation characteristics – Specific economic energy problems: Steam plant, Hydraulic plant Interconnections – Energy rates.

UNIT 5 OPTIMAL POWER FLOW AND SECURITY 12

Introduction – Solution of optimal power flow: Gradient method, Newton's method, Linear Sensitivity analysis, Linear programming methods (with real power variables & AC power flow variables) – Security constrained optimal power flow – Correction of generator dispatch by sensitivitymethod – Compensation factor – Voltage security assessment – Transient security assessment – Methods and Calculations – Comparisons.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- understand the basic economical factors related to power system.
- solve the economic dispatch problems using Newton's method and Lambda Iteration method.
- gain knowledge about unit commitment solution methods.
- make a choice on the plant location and optimal equipment selection.
- provide optimal power flow using Gradient method, Newton's method.

REFERENCES

1. Allen J.Wood, Bruce F. Wollenberg, " Power Generation, Operation and Control", John Wiley & Sons, 2012
2. Bernhardt, Skrotzki.G.A., William A. Vopat, "Power Station Engineering and Economy" Tata McGraw Hill Publishing Company Limited, New Delhi, 2005.
3. Wadwa.C.L, "Generation, Distribution and Utilization of Electrical Energy", (Revised Edition), New Age International, New Delhi, 2006.
4. George L.Kusic,"Computer Aided Power System Analysis", Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
5. Allen J.Wood, Bruce F.Wollenberg, "Power generation, Operation for security", John Wiley and Sons, 1989.

WEB LINKS

1. http://file258.casebooks.org/m77gn_power-generation-operation-and-control.pdf
2. www.debtbooks.org/doa8j_ebooks-power-station-engieering-and-economy.
3. https://fyzedefo.files.wordpress.com/.../computer-aided-power-systems-analysis.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
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CO1	3	-	-	-	2	3	2	2	3	-	2	1	-	1
CO2	3	-	-	-	2	3	2	2	3	-	2	1	-	1
CO3	3	-	-	-	2	3	2	2	3	-	2	1	-	1
CO4	3	-	-	-	2	3	2	2	3	-	2	1	-	1
CO5	3	-	-	-	2	3	2	2	3	-	2	1	-	1

PPS 15E07 POWER QUALITY ANALYSIS 3 0 0 3

COURSE OBJECTIVES

- To understand the power quality issues.
- To learn about the concept of power quality monitoring.
- To familiarize the concept of short interruptions & long interruptions .
- To analyse the various power quality issue and mitigation.
- To understand the active compensation techniques used for power factor correction.

UNIT 1 INTRODUCTION 9

Introduction – Characterization of Electric Power Quality: Transients, short duration and long duration voltage variations, Voltage imbalance, waveform distortion, Voltage fluctuations, Power frequency variation, Power acceptability curves – power quality problems: poor load power factor, Nonlinear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

UNIT 2 POWER QUALITY MONITORING 9

Introduction – Power quality monitoring : Need for power quality monitoring, Evolution of power quality monitoring, Deregulation effect on power quality monitoring – Power factor improvement – Brief introduction to power quality measurement equipments and power conditioning equipments – Planning, Conducting and Analyzing power quality survey – Active Filters for Harmonic Reduction.

UNIT 3 SHORT INTERRUPTIONS & LONG INTERRUPTIONS 9

Introduction – Origin of short interruptions : Voltage magnitude events due to re-closing, Voltage during the interruption – Monitoring of short interruptions –Influence on induction motors, Synchronous motors, Adjustable speed drives, Electronic equipments – Single phase tripping : Voltage during fault and post fault period, Current during fault period. Definition – Failure, Outage, Interruption – Origin of interruptions – Causes of long interruptions – Principles of regulating the voltage – Voltage regulating devices, Applications: Utility side, End-User side.

UNIT 4 ANALYSIS AND CONVENTIONAL MITIGATION METHODS 9

Analysis of power outages, Analysis of unbalance: Symmetrical components of phasor quantities, Instantaneous symmetrical components, Instantaneous real and reactive powers, Analysis of distortion: On–line extraction of fundamental sequence components from measured samples – Harmonic indices – Analysis of voltage sag: Detorit Edison sag score, Voltage sag energy, Voltage Sag Lost Energy Index (VSLEI)- Analysis of voltage flicker, Reduced duration and customer impact of outages, Classical load balancing problem: Open loop balancing, Closed loop balancing, current balancing, Harmonic reduction, Voltage sag reduction.

UNIT 5 LOAD COMPENSATION USING DSTATCOM 9

Compensating single – phase loads – Ideal three phase shunt compensator structure – generating reference currents using instantaneous PQ theory – Instantaneous symmetrical components theory – Generating reference currents when the source is unbalanced – Realization and control of DSTATCOM – DSTATCOM in Voltage control mode

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- understand the various power quality issues.
- know the various methods of monitoring the power quality issues.
- distinguish short and long interruptions.
- analyse the various power quality issue and mitigation.
- demonstrate the conventional compensation techniques used for power factor correction.

REFERENCES

1. Arindam Ghosh "Power Quality Enhancement Using Custom Power Devices", Kluwer Academic Publishers, 2002.
2. Power System Harmonics, Second Edition J. Arrillaga, N.R. Watson. 2003 John Wiley
3. G.T.Heydt, "Electric Power Quality", Stars in a Circle Publications, 1994(2nd edition).
4. Roger C. Dugan, Mark F. Mc Granaghan and H.Wayne Beaty, "Electrical Power Systems Quality", McGraw-Hill, New York,2012
5. Handbook of Power Quality, editor: Angelo Baggini, John Wiley & Sons, 2008.

WEB LINKS

1. www.materialdownload.in/article/Power-Quality-Enhancement-Using-Custom-Power-Devices
2. read.pudn.com/downloads156/.. /Power%20System%20Harmonics.pdf
3. accessengineeringlibrary.com/ ../electrical-power-systems-quality-third-edition.

CO-PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes PO's												PSO's	
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CO1	3	-	3	-	2	2	-	-	-	-	2	1	2	1
CO2	3	-	3	-	2	2	-	-	-	-	2	1	2	1
CO3	3	-	3	-	2	2	-	-	-	-	2	1	2	1
CO4	3	-	3	-	2	2	-	-	-	-	2	1	2	1
CO5	3	-	3	-	2	2	-	-	-	-	2	1	2	1

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PPS 15E08 POWER SYSTEM SECURITY 3 0 0 3

COURSE OBJECTIVES

- To impart knowledge on various power system security techniques.
- To know the various power system state estimation methods.
- To learn the security assessment in the different networks.
- To acquire knowledge on the various power system security enhancement methods.
- To update knowledge on the recent power system security techniques.

UNIT 1 INTRODUCTION 9

Factors affecting power system security, decomposition and multilevel approach, state estimation, system monitoring, security assessment and security enhancement.

UNIT 2 POWER SYSTEM STATE ESTIMATION 9

Maximum likelihood weighted least-square estimation, state estimation, detection and identification of bad measurements, estimation of quantities not being measure, network observability and pseudo measurements.

UNIT 3 SECURITY NETWORK 9

Detection of network problems, network equivalent for external system, network sensitivity methods, calculation of network sensitivity factors, fast contingency algorithms, contingency ranking, dynamic security indices.

UNIT 4 SECURITY ENHANCEMENT 9

Correcting the generator dispatch by sensitivity methods, compensated factors, security constrained optimization, preventive, emergency and restorative control through NLP and LP methods.

UNIT 5 RECENT TECHNIQUES 9

Voltage security assessment - Transient Security assessment – methods - Comparison.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of the course, the student will be able to

- understand the fundamentals of security system.
- know various techniques for power system security.
- estimate and design the security assessment network.
- understand the security enhancement methods.
- update knowledge on the recent power system security techniques.

REFERENCES

1. Wood, Allen J./ Wollenberg, Bruce F./ Sheble, Gerald “Power Generation, Operation, andControl” , published by John Wiley and Sons Inc., 2013.
2. Wood, A.J. and Woolenberg, John Wiley and sons, “Power generation operation forsecurity”, 2013.
3. Abdullah Khan, M, “Real time control of power system for security”, vol.2, Proceedings ofsummer school, College of Engineering, Madras.
4. Handsching.E, “Real time control of Electric Power Systems”, Elsevier publishing Co.,Amsterdam.
5. George Anders, Alfredo Vaccaro, “Innovations in Power Systems Reliability”, springerpublishing co.

WEB LINKS

1. cusp.umn.edu/Napa.../Wollenberg%20NAPA%20Feb%202013.pdf
2. www.iaeng.org/publication/.../WCECS2012_pp1025-1031.pdf
3. www.mit.edu/~mitter/publications/C11_hierarchical_system_EPS.pdf

CO-PO MAPPING:

Mapping of Course Outcome (CO’s) with Programme Outcomes (PO’s) and Programme Specific Outcomes PSO’s (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

	Programme Outcomes PO’s												PSO’s	
CO’s	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
CO1	3	-	3	-	2	2	-	-	-	-	2	1	2	1
CO2	3	-	-	-	2	3	2	2	3	-	2	1	-	2
CO3	3	-	-	-	2	3	2	2	3	-	2	1	-	2
CO4	3	-	-	-	2	3	2	2	3	-	2	1	-	2
CO5	3	-	-	-	2	3	2	2	3	-	2	1	-	2

9. Computation of harmonic indices generated by a rectifier feeding a R-L load
10. Design of active filter for mitigating harmonics.

TOTAL: 45 PERIODS

Lab Requirements

Sl.No.	Description of Equipment	Quantity Required
1.	Personal Computers (Intel Core i3, 250 GB, 1 GB RAM)	25
2.	Laser Printer	1
3.	Dot matrix Printer	2
4.	Server (Intel Core i3, 4 GB RAM) (High Speed Processor)	1
5.	Software: 1. Any Power system simulation package like ETAP / MIPOWER 2. Any Power system simulation package for dynamic studies like EUROSTAG (or) own source code can be developed	5 Licenses 5 Licenses
6.	Compilers: C, C++, Matlab	25 users

PS7311 PROJECT WORK (PHASE I)

L	T	P	C
0	0	12	6

PS7411 PROJECT WORK (PHASE II)

L	T	P	C
0	0	24	12

6. "Renewable Energy Resources" John Twidell and Tony Weir, Tyalor and Francis Publications, Second edition

PS7004 SOLAR AND ENERGY STORAGE SYSTEMS

L	T	P	C
3	0	0	3

OBJECTIVES

- To Study about solar modules and PV system design and their applications
- To Deal with grid connected PV systems
- To Discuss about different energy storage systems

UNIT I INTRODUCTION 9

Characteristics of sunlight – semiconductors and P-N junctions –behavior of solar cells – cell properties – PV cell interconnection

UNIT II STAND ALONE PV SYSTEM 9

Solar modules – storage systems – power conditioning and regulation - protection – stand alone PV systems design – sizing

UNIT III GRID CONNECTED PV SYSTEMS 9

PV systems in buildings – design issues for central power stations – safety – Economic aspect – Efficiency and performance - International PV programs

UNIT IV ENERGY STORAGE SYSTEMS 9

Impact of intermittent generation – Battery energy storage – solar thermal energy storage – pumped hydroelectric energy storage

UNIT V APPLICATIONS 9

Water pumping – battery chargers – solar car – direct-drive applications –Space – Telecommunications.

REFERENCES:

1. Eduardo Lorenzo G. Araujo, Solar electricity engineering of photovoltaic systems, Progensa,1994.
2. Stuart R.Wenham, Martin A.Green, Muriel E. Watt and Richard Corkish, Applied Photovoltaics, 2007,Earthscan, UK.
3. Frank S. Barnes & Jonah G. Levine, Large Energy storage Systems Handbook , CRC Press, 2011.
4. Solar & Wind Energy Technologies – McNeils, Frenkel, Desai, Wiley Eastern, 1990
5. Solar Energy – S.P. Sukhatme, Tata McGraw Hill,1987.

PS7005 HIGH VOLTAGE DIRECT CURRENT TRANSMISSION **L T P C**

3 0 0 3

OBJECTIVES

- To impart knowledge on operation, modelling and control of HVDC link.
- To perform steady state analysis of AC/DC system.
- To expose various HVDC simulators.

UNIT I DC POWER TRANSMISSION TECHNOLOGY **6**

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 **–** DC breakers – Cables, VSC based HVDC.

UNIT II ANALYSIS OF HVDC CONVERTERS AND HVDC SYSTEM CONTROL 12

Pulse number, choice of converter configuration **–** Simplified analysis of Graetz circuit - Converter bridge characteristics – characteristics of a twelve pulse converter- detailed analysis of converters- General principles of DC link control **–** Converter control characteristics **–** System control hierarchy - Firing angle control **–** Current and extinction angle control **–** Generation of harmonics and filtering - power control **–** Higher level controllers.

UNIT III MULTITERMINAL DC SYSTEMS **9**

Introduction **–** Potential applications of MTDC systems - Types of MTDC systems - Control and protection of MTDC systems - Study of MTDC systems.

UNIT IV POWER FLOW ANALYSIS IN AC/DC SYSTEMS **9**

Per unit system for DC Quantities - Modelling of DC links - Solution of DC load flow - Solution of AC-DC power flow – Unified, Sequential and Substitution of power injection method.

UNIT V SIMULATION OF HVDC SYSTEMS **9**

Introduction – DC LINK Modelling , Converter Modeling and State Space Analysis , Philosophy and tools **–** HVDC system simulation, Online and OFFline simulators –– Dynamic interactions between DC and AC systems.

TOTAL: 45 PERIODS

REFERENCES

1. P. Kundur, "Power System Stability and Control", McGraw-Hill, 1993
2. K.R.Padiyar, , "HVDC Power Transmission Systems", New Age International (P) Ltd., New Delhi, 2002.
3. J.Arrillaga, , "High Voltage Direct Current Transmission", Peter Pregrinus, London, 1983.
4. Erich Uhlmann, " Power Transmission by Direct Current", BS Publications, 2004.
5. V.K.Sood,HVDC and FACTS controllers – Applications of Static Converters in Power System, APRIL 2004 , Kluwer Academic Publishers.

PS7006 INDUSTRIAL POWER SYSTEM ANALYSIS AND DESIGN **L T P C**
3 0 0 3

OBJECTIVES

- To analyze the motor starting and power factor correction.
- To perform computer-aided harmonic and flicker analysis and to design filters.
- To expose various grid grounding methodologies

UNIT I MOTOR STARTING STUDIES **9**

Introduction-Evaluation Criteria-Starting Methods-System Data-Voltage Drop Calculations-Calculation of Acceleration time-Motor Starting with Limited-Capacity Generators-Computer-Aided Analysis-Conclusions.

UNIT II POWER FACTOR CORRECTION STUDIES **9**

Introduction-System Description and Modeling-Acceptance Criteria-Frequency Scan Analysis-Voltage Magnification Analysis-Sustained Overvoltages-Switching Surge Analysis-Back-to-Back Switching-Summary and Conclusions.

UNIT III HARMONIC ANALYSIS **9**

Harmonic Sources-System Response to Harmonics-System Model for Computer-Aided Analysis-Acceptance Criteria-Harmonic Filters-Harmonic Evaluation-Case Study-Summary and Conclusions.

UNIT IV FLICKER ANALYSIS **9**

Sources of Flicker-Flicker Analysis-Flicker Criteria-Data for Flicker analysis- Case Study-Arc Furnace Load-Minimizing the Flicker Effects-Summary.

UNIT V GROUND GRID ANALYSIS **9**

Introduction-Acceptance Criteria-Ground Grid Calculations-Computer-Aided Analysis - Improving the Performance of the Grounding Grids-Conclusions.

TOTAL : 45 PERIODS

REFERENCES

1. Ramasamy Natarajan, ”Computer-Aided Power System Analysis”, Marcel Dekker Inc., 2002.

PS7007 WIND ENERGY CONVERSION SYSTEMS L T P C

3 0 0 3

OBJECTIVES

- To learn the design and control principles of Wind turbine
- To understand the concepts of fixed speed and variable speed, wind energy conversion systems
- To analyze the grid integration issues.

UNIT I INTRODUCTION 9

Components of WECS-WECS schemes-Power obtained from wind-simple momentum theory-Power coefficient- Sabinin's theory-Aerodynamics of Wind turbine

UNIT II WIND TURBINES 9

HAWT-VAWT-Power developed-Thrust-Efficiency-Rotor selection-Rotor design considerations-Tip speed ratio-No. of Blades-Blade profile-Power Regulation-yaw control-Pitch angle control-stall control-Schemes for maximum power extraction.

UNIT III FIXED SPEED SYSTEMS 9

Generating Systems- Constant speed constant frequency systems -Choice of Generators-Deciding factors-Synchronous Generator-Squirrel Cage Induction Generator- Model of Wind Speed- Model wind turbine rotor - Drive Train model- Generator model for Steady state and Transient stability analysis.

UNIT IV VARIABLE SPEED SYSTEMS 9

Need of variable speed systems-Power-wind speed characteristics-Variable speed constant frequency systems synchronous generator- DFIG- PMSG -Variable speed generators modeling - Variable speed variable frequency schemes.

UNIT V GRID CONNECTED SYSTEMS 9

Wind interconnection requirements, low-voltage ride through (LVRT), ramp rate limitations, and supply of ancillary services for frequency and voltage control, current practices and industry trends wind interconnection impact on steady-state and dynamic performance of the power system including modeling issue.

TOTAL: 45 PERIODS

REFERENCES

1. L.L.Freris "Wind Energy conversion Systems", Prentice Hall, 1990
2. S.N.Bhadra, D.Kastha,S.Banerjee,"Wind Electrical Sytems",Oxford University Press,2010.
3. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
4. E.W.Golding "The generation of Electricity by wind power", Redwood burn Ltd., Trowbridge,1976.
5. N. Jenkins," Wind Energy Technology" John Wiley & Sons,1997
6. S.Heir "Grid Integration of WECS", Wiley 1998.

PS7008 **SMART GRID** **L T P C**

3 0 0 3

OBJECTIVES

- To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
- To familiarize the power quality management issues in Smart Grid.
- To familiarize the high performance computing for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID 9

Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation ,Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/VAr control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE 9

Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU), Intelligent Electronic Devices(IED) & their application for monitoring & protection.

UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID 9

Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

REFERENCES*:*

1. Vehbi C. Güngör, DilanSahin, TaskinKocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke, Smart Grid Technologies: Communication Technologies and Standards IEEE Transactions On Industrial Informatics, Vol. 7, No. 4, November 2011.

2. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang "Smart Grid – The New and Improved Power Grid: A Survey" , IEEE Transaction on Smart Grids,
3. Stuart Borlase "Smart Grid :Infrastructure, Technology and Solutions",CRC Press 2012.
4. Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley.

PS7009 ADVANCED POWER SYSTEM DYNAMICS LT P C

3 0 0 3

OBJECTIVES

- To perform transient stability analysis using unified algorithm.
- To impart knowledge on sub-synchronous resonance and oscillations
- To analyze voltage stability problem in power system.
- To familiarize the methods of transient stability enhancement.

UNIT I TRANSIENT STABILITY ANALYSIS 9

Review of numerical integration methods: Euler and Fourth Order Runge-Kutta methods, Numerical stability and implicit methods, Interfacing of Synchronous machine (variable voltage) model to the transient stability algorithm (TSA) with partitioned **–** explicit and implicit approaches – Interfacing SVC with TSA-methods to enhance transient stability.

UNIT II UNIFIED ALGORITHM FOR DYNAMIC ANALYSIS OF POWER SYSTEMS 9

Need for unified algorithm- numerical integration algorithmic steps-truncation error- variable step size – handling the discontinuities- numerical stability- application of the algorithm for transient. Mid-term and long-term stability simulations

UNIT III SUBSYSNCHRONOUS RESONANCE (SSR) AND OSCILLATIONS 9

Subsysnchronous Resonance (SSR) – Types of SSR - Characteristics of series **–** Compensated transmission systems –Modeling of turbine-generator-transmission network- Self-excitation due to induction generator effect **–** Torsional interaction resulting in SSR **–**Methods of analyzing SSR **–** Numerical examples illustrating instability of subsynchronous oscillations **–**time-domain simulation of subsynchronous resonance **–** EMTP with detailed synchronous machine model- Turbine Generator Torsional Characteristics: Shaft system model **–** Examples of torsional characteristics **–** Torsional Interaction with Power System Controls: Interaction with generator excitation controls **–** Interaction with speed governors **–** Interaction with nearby DC converters.

UNIT IV TRANSMISSION, GENERATION AND LOAD ASPECTS OF VOLTAGE STABILITY ANALYSIS 9

Review of transmission aspects – Generation Aspects: Review of synchronous machine theory – Voltage and frequency controllers – Limiting devices affecting voltage stability – Voltage-reactive power characteristics of synchronous generators – Capability curves – Effect of machine limitation on deliverable power – Load Aspects – Voltage dependence of loads – Load restoration dynamics – Induction motors – Load tap changers – Thermostatic load recovery – General aggregate load models.

UNIT V ENHANCEMENT OF TRANSIENT STABILITY AND COUNTER MEASURES FOR SUB SYNCHRONOUS RESONANCE [1] 9

Principle behind transient stability enhancement methods: high-speed fault clearing, reduction of transmission system reactance, regulated shunt compensation, dynamic braking, reactor switching, independent pole-operation of circuit-breakers, single-pole switching, fast-valving, high-speed excitation systems; NGH damper scheme.

TOTAL : 45 PERIODS

REFERENCES*:*

1. R.Ramnujam," Power System Dynamics Analysis and Simulation, PHI Learning Private Limited, New Delhi, 2009
2. T.V. Cutsem and C.Vournas, "Voltage Stability of Electric Power Systems", Kluwer publishers,1998.
3. P. Kundur, Power System Stability and Control, McGraw-Hill, 1993.
4. H.W. Dommel and N.Sato, "Fast Transient Stability Solutions," IEEE Trans., Vol. PAS-91, pp, 1643-1650, July/August 1972.
5. Roderick J . Frowd and J. C. Giri, "Transient stability and Long term dynamics unified", IEEE Trans., Vol 101, No. 10, October 1982.
6. M.Stubbe, A.Bihain,J.Deuse, J.C.Baader, "A New Unified software program for the study of the dynamic behaviour of electrical power system," IEEE Transaction, Power Systems, Vol.4.No.1,Feb:1989 Pg.129 to 138.

PX7301 POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS L T P C
3 0 0 3

OBJECTIVES :

- To Provide knowledge about the stand alone and grid connected renewable energy systems.
- To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
- To analyse and comprehend the various operating modes of wind electrical generators and solar energy systems.
- To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems.
- To develop maximum power point tracking algorithms.

UNIT I INTRODUCTION 9

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources ocean, Biomass, Hydrogen energy systems : operating principles and characteristics of: Solar PV, Fuel cells, wind electrical systems-control strategy, operating area.

UNIT II ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION 9

Review of reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

UNIT III POWER CONVERTERS 9

Solar: Block diagram of solar photo voltaic system : line commutated converters (inversion-mode) - Boost and buck-boost converters- selection Of inverter, battery sizing, array sizing.

Wind: three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT IV ANALYSIS OF WIND AND PV SYSTEMS 9

Stand alone operation of fixed and variable speed wind energy conversion systems and solar system-Grid connection Issues -Grid integrated PMSG and SCIG Based WECS-Grid Integrated solar system

UNIT V HYBRID RENEWABLE ENERGY SYSTEMS 9

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV-Maximum Power Point Tracking (MPPT).

TOTAL : 45 PERIODS

REFERENCES*:*

1. S.N.Bhadra, D. Kastha, & S. Banerjee "Wind Electricaal Systems", Oxford University Press, 2009
2. Rashid .M. H "power electronics Hand book", Academic press, 2001.
3. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
4. Rai. G.D," Solar energy utilization", Khanna publishes, 1993.
5. Gray, L. Johnson, "Wind energy system", prentice hall linc, 1995.
6. Non-conventional Energy sources B.H.Khan Tata McGraw-hill Publishing Company, New Delhi.

ET7014 APPLICATION OF MEMS TECHNOLOGY **L T P C**
3 0 0 3

Pre-requisites: Basic Instrumentation ,Material Science,Programming

OBJECTIVES

- To teach the students properties of materials ,microstructure and fabrication methods.
- To teach the design and modeling of Electrostatic sensors and actuators.
- To teach the characterizing thermal sensors and actuators through design and modeling
- To teach the fundamentals of piezoelectric sensors and actuators
- To give exposure to different MEMS and NEMS devices.

UNIT I MEMS:MICRO-FABRICATION, MATERIALS AND ELECTRO-MECHANICAL CONEPTS 9

Overview of micro fabrication – Silicon and other material based fabrication processes – Concepts: Conductivity of semiconductors-Crystal planes and orientation-stress and strain-flexural beam bending analysis-torsional deflections-Intrinsic stress- resonant frequency and quality factor.

UNIT II ELECTROSTATIC SENSORS AND ACTUATION 9

Principle, material, design and fabrication of parallel plate capacitors as electrostatic sensors and actuators-Applications

UNIT III THERMAL SENSING AND ACTUATION 9

Principle, material, design and fabrication of thermal couples, thermal bimorph sensors, thermal resistor sensors-Applications.

UNIT IV PIEZOELECTRIC SENSING AND ACTUATION 9

Piezoelectric effect-cantilever piezo electric actuator model-properties of piezoelectric materials-Applications.

UNIT V CASE STUDIES 9

Piezoresistive sensors, Magnetic actuation, Micro fluidics applications, Medical applications, Optical MEMS.-NEMS Devices

TOTAL : 45 PERIODS

REFERENCES

1. Chang Liu, “Foundations of MEMS”, Pearson International Edition, 2006.
2. Marc Madou , “Fundamentals of microfabrication”,CRC Press, 1997.
3. Boston , “Micromachined Transducers Sourcebook”,WCB McGraw Hill, 1998.
4. M.H.Bao “Micromechanical transducers :Pressure sensors, accelerometers and gyroscopes”, Elsevier, Newyork, 2000.
5. P. RaiChoudry“ MEMS and MOEMS Technology and Applications”, PHI, 2012.
6. Stephen D. Senturia, “ Microsystem Design”, Springer International Edition, 2011.

PS7010 POWER SYSTEM PLANNING AND RELIABILITY **L T P C**
3 0 0 3

OBJECTIVES

- To introduces the objectives of Load forecasting.
- To study the fundamentals of Generation system, transmission system and Distribution system reliability analysis
- To illustrate the basic concepts of Expansion planning

UNIT I LOAD FORECASTING 9

Objectives of forecasting - Load growth patterns and their importance in planning - Load forecasting Based on discounted multiple regression technique-Weather sensitive load forecasting-Determination of annual forecasting-Use of AI in load forecasting.

UNIT II GENERATION SYSTEM RELIABILITY ANALYSI 9

Probabilistic generation and load models- Determination of LOLP and expected value of demand not served –Determination of reliability of iso and interconnected generation systems.

UNIT III TRANSMISSION SYSTEM RELIABILITY ANALYSIS 9

Deterministic contingency analysis-probabilistic load flow-Fuzzy load flow probabilistic transmission system reliability analysis-Determination of reliability indices like LOLP and expected value of demand not served.

UNIT IV EXPANSION PLANNING 9

Basic concepts on expansion planning-procedure followed for integrate transmission system planning, current practice in India-Capacitor placer problem in transmission system and radial distributions system.

UNIT V DISTRIBUTION SYSTEM PLANNING OVERVIEW 9

Introduction, sub transmission lines and distribution substations-Design primary and secondary systems-distribution system protection and coordination of protective devices.

TOTAL: 45 PERIODS

REFERENCES*:*

1. Reliability Evaluation of Power System - Roy Billinton & Ronald N. Allan, Springer Publication
2. Power System Planning - R.L. Sullivan, Tata McGraw Hill Publishing Company Ltd.
3. Modern Power System Planning – X. Wang & J.R. McDonald, McGraw Hill Book Company
4. Electrical Power Distribution Engineering - T. Gönen, McGraw Hill Book Company
5. Generation of Electrical Energy – B.R. Gupta, S. Chand Publications