K. S. R. M. COLLEGE OF ENGINEERING (AUTONOMOUS)

Course Structure and Syllabus for

M. Tech. Power Systems (PS)

for 2014 -15

I SEMESTER

S. No.	Course Code	SUBJECT	SC	L	T	P	IM	EM	CR
1	14521101	Modern Control Theory	PJ	3	1	0	40	60	4
2	14521102	Power System Control & Stability	PJ	3	1	0	40	60	4
3	14521103	EHVAC Transmission	PJ	3	1	0	40	60	4
4	14521104	Reactive Power Compensation & Management	PJ	3	1	0	40	60	4
5	14521105	Power System Deregulation	PJ	3	1	0	40	60	4
6	14521106 14521107 12521108	**Elective – I** i) Optimization Techniques ii) Power Conversion Techniques iii) Gas Insulated Systems	PJ	3	1	0	40	60	4
7	14521109	Power Systems Lab	PJ	-	-	3	50	50	2
		Contact Periods/Week		18	6	3	290	410	26

II SEMESTER

S. No.	Course Code	SUBJECT	SC	L	T	P	IM	EM	CR
1	14521201	Operation and Control of Power Systems	PJ	3	1	0	40	60	4
2	14521202	Advanced Power System Protection	PJ	3	1	0	40	60	4
3	14521203	Power Quality	PJ	3	1	0	40	60	4
4	14521204	Power System Reliability	PJ	3	1	0	40	60	4
5	14521205	Energy Conversion Systems	PJ	3	1	0	40	60	4
6	**Elective – II** 14521206 14521207 12521208	Electric Smart Grid AI Techniques in Electrical Power Engineering Digital Control Systems	PJ	3	1	0	40	60	4
7	14521209	Power Systems Simulation Lab	PJ	-	-	3	50	50	2
		Contact Periods/Week		18	6	3	290	410	26

III SEMESTER

S. No.	Course Code	Subject	SC	IM	Credits
1	14522101	Seminar	PJ	100	2

IV SEMESTER

S. No.	Course Code	Subject	SC	IM	EM	Credits
1	14522201	Project Work	PJ	50	50	16

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M. Tech. I SEMESTER (PS) **Th 4 C 4**

(14521101) MODERN CONTROL THEORY

UNIT –I

State Variable Analysis: The concept of state – State Equations for Dynamic systems – Time invariance and Linearity – Non-uniqueness of state model – State diagrams for Continuous Time state models –Linear Continuous time model for physical systems - Existence and Uniqueness of Solutions to Continuous – Time State Equations – Solutions – Linear Time Invariant Continuous – Time State Equations – Eigen values, Eigen Vectors, State transition matrix and it's properties.

UNIT – II

Controllability and Observability: General concept of Controllability - General concept of Observability Controllability tests for Continuous – Time Invariant systems - Observability tests for Continuous - Time Invariant systems - Controllability and Observability of state model in Jordan Canonical form - Controllability and Observability Canonical forms of State model

State Feedback Controllers and Observers: State Feedback Controller design through Pole Assignment – state observers: Full order and Reduced order.

Unit – III

Non Linear Systems: Introduction – Non Linear Systems – Introduction to Linearization of nonlinear systems, properties of non linear systems – Types of Non – Linearities – Saturation – Dead – Zone – Backlash – Jump Phenomenon etc - Singular Points – Describing function – describing function analysis of nonlinear systems- Stability analysis of Non – Linear systems through describing functions.

Introduction to phase – plane analysis, Method of Isoclines for Constructing Trajectories, singular points, phase – plane analysis of nonlinear control systems.

UNIT - IV

Stability Analysis: Stability in the sense of Lyapunov, Lyapunov's stability and Lyapunov's instability theorems – Stability Analysis of the Linear Continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

UNIT – V

Introduction to Optimal Control: Formulation of optimal control problems – calculus of variations – fundamental concepts, functional, variation of functional – fundamental theorem of Calculus of variations – boundary conditions – constrained minimization – formulation using Hamiltonian method – Linear quadratic regulator.

Text Books

1. Modern Control System Theory by M. Gopal – New Age International – 1984
2. Modern Control Engineering by Ogata. K – Prentice Hall – 1997
3. Optimal Control Theory by Donald Kirk

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(14521102) POWER SYSTEM CONTROL & STABILITY

UNIT-I

Power system stability considerations – definitions-classification of stability-rotor angle and voltage stability-synchronous machine representation –classical model- load modeling concepts-modeling of excitation systems-modeling of prime movers.

UNIT-II

Transient stability-swing equation--solution of swing equation- Numerical methods -Euler method-Runge-Kutte method-critical clearing angle and clearing time-effect of excitation system and governors-Multimachine stability –extended equal area criterion-transient energy function approach.

UNIT-III

Small signal stability – state space representation – Eigen values- modal matrices- small signal stability of single machine infinite bus system – Generator represented by the classical model- effect of field circuit dynamics- effect of excitation system-small signal stability of multi machine system -power system stabilizers.

UNIT-IV

Excitation Systems – Excitation system response – non-continuously regulated systems – continuously regulated systems – excitation system compensation – state space description of the excitation system – simplified linear model – effect of excitation on generator power limits. Types of excitation system – Type 1 and Type 2 system – rotating rectifier system, Type 3 system: Static with terminal potential and current supplies, Type 4 system – continuous acting – Block diagram representation – state space modeling equations of these types.

UNIT-V

Introduction to Voltage Stability – What is voltage stability – Factors affecting voltage instability and collapse – Comparison of angle and voltage stability – Analysis of voltage instability and collapse – Integrated analysis of voltage and angle stability – Control of voltage instability.

Text Books

1. P. Kundur, "Power System Stability and Control", McGraw-Hill International Editions.
2. P. M. Anderson and A. A. Fouad, "Power System Control and Stability", Galgotia Publications, New Delhi, 2003.
3. K. R. Padiyar, "Power System Dynamics (Stability & Control)", 2nd Edition, B. S. Publications – 2002.
4. S. S. Vadhera, " Power System Analysis & Stability", Khanna Publishers, 3rd edition – 2004.

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(14521103) EHVAC TRANSMISSION

Unit I

E.H.V.A.C. Transmission line trends and preliminary aspect standard transmission voltages – Estimation at line and ground parameters

Bundle conductor systems inductance and capacitance of E.H.V. lines – positive, negative and zero sequence impedance – Line Parameters for Modes of Propagation.

Unit II

Electrostatic field and voltage gradients – calculations of electrostatic field of AC lines – effect of high electrostatic field on biological organisms and human beings surface voltage gradients and maximum gradients of actual transmission lines – voltage gradients on sub conductor

Unit III

Electrostatic induction in unenergised lines – measurements of field and voltage gradients for three phase single and double circuit lines – unenegised lines.

Unit IV

Power Frequency Voltage control and over voltages in EHV lines: No load voltage – charging currents at power frequency - voltage control – shunt and series compensation – static VAR compensation.

Corona in E.H.V. lines – Corona loss formulae attention of traveling waves due to Corona – Audio noise due to Corona, its generation, characteristic and limits

Unit V

Measurements of audio noise radio interference due to Corona RF properties of radio noise – frequency spectrum of RI fields – Measurements of RI and RIV.

Design of EHV lines based on steady state and transient limits. EHV cables and their characteristics.

Text Books

1. Extra High Voltage AC Transmission Engineering – Rokosh Das Begamudre, Wiley Eastern Ltd., New Delhi – 1987.
2. EHV Transmission line reference Books–Edison Electric Institution (GEC 1968).

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M. Tech. I SEMESTER (PS) **Th 4 C 4**

(14521104) REACTIVE POWER COMPENSATION AND MANAGEMENT

UNIT I

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

UNIT II

Steady – state reactive power compensation in transmission system**:** Uncompensated line – types of compensation – Passive shunt and series and dynamic shunt compensation – examples

Transient state reactive power compensation in transmission systems**:** Characteristic time periods – passive shunt compensation – static compensations- series capacitor compensation –compensation using synchronous condensers – examples.

UNIT-III

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

Demand side management: Load patterns – basic methods load shaping – power tariffs- KVAR based tariffs penalties for voltage flickers and Harmonic voltage levels.

UNIT-IV

Reactive power Management: System losses –loss reduction methods – examples – Reactive power planning – objectives – Economics Planning capacitor placement – retrofitting of capacitor banks. KVAR requirements for domestic appliances – Purpose of using capacitors – selection of capacitors – deciding factors – types of available capacitor, characteristics and Limitations

UNIT-V

Reactive power management in electric traction systems and are furnaces: Typical layout of traction systems – reactive power control requirements – distribution transformers- Electric arc furnaces – basic operations- furnaces transformer –filter requirements – remedial measures –power factor of an arc furnace

Text Books

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

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M. Tech. I SEMESTER (PS) **Th 4 C 4**

(14521105) POWER SYSTEM DEREGULATION

UNIT I

Deregulation of Electric Utilities: Introduction – Traditional central utility model, reform motivations, separation of ownership and operation, competition and direct access in the electricity market, independent system operator (ISO), retail electric providers, different experiences.

UNIT II

Competitive Wholesale Electricity Markets & Transmission Open Access: Introduction, ISO, wholesale electricity market characteristics, market model, challenges, trading arrangements, the pool and bilateral trades, multi lateral trades.

UNIT III

Transmission Cost Allocation Methods: Introduction - Postage Stamp Rate Method - Contract Path Method - MW-Mile Method – Unused Transmission Capacity Method - MVA-Mile method – Comparison of cost allocation methods.

UNIT IV

Market Power & Ancillary Services Management: Introduction - Different types of market Power – Mitigation of Market Power – Examples - Introduction – Reactive Power as an Ancillary Service – a Review – Synchronous Generators as Ancillary Service Providers.

UNIT V

Available Transfer Capability (ATC) : Transfer Capability Issues – ATC – TTC – TRM – CBM Calculations – Calculation of ATC based on power flow - Introduction – Electricity Price Volatility Electricity Price Indexes – Challenges to Electricity Pricing – Construction of Forward Price Curves – Short-time Price Forecasting.

Text Books:

1. Power System Restructuring and Deregulation, Loi Lei Lai, John Wiley & Sons Ltd., England, 2001.

Reference Books

1. Operation of Restructured Power System, Kankar Bhattacharya, Math H.J. Boller and Jaap E. Daalder Kulwer Academic Publishers, 2001.
2. Restructured Electrical Power Systems, Mohammad Shahidehpour and Muwaffaq alomoush, Marcel Dekker, Inc., 2001.

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M. Tech. I SEMESTER (PS) **Th 4 C 4**

ELECTIVE – I
(14521106) OPTIMIZATION TECHNIQUES

Unit – I

Linear programming –formulation-Graphical and simplex methods-Big-M method- Two phase method-Dual simplex method-Primal Dual problems.

Unit - II

Unconstrained one dimensional optimization techniques -Necessary and sufficient conditions –Unrestricted search methods-Fibonacci and golden section method- Quadratic Interpolation methods, cubic interpolation and direct root methods.

Unit – III

Unconstrained n dimensional optimization techniques – direct search methods – Random search –pattern search and Rosen brooch's hill claiming method- Descent methods-Steepest descent, conjugate gradient, quasi -Newton method.

Unit – IV

Constrained optimization Techniques- Necessary and sufficient conditions – Equality and inequality constraints-Kuhn-Tucker conditions-Gradient projection method-cutting plane method- penalty function method.

Unit - V

Dynamic programming- principle of optimality- recursive equation approach-application to shortest route, cargo-loading, allocation and production schedule problems.

Text Books

1. Rao, S. S., "Optimization :Theory and Application" Wiley Eastern Press, 2nd edition 1984.
2. Taha, H.A., "Operations Research –An Introduction", Prentice Hall of India, 2003.
3. Fox, R.L., "Optimization methods for Engineering Design", Addition Welsey, 1971.

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M. Tech. I SEMESTER (PS) **Th 4 C 4**

ELECTIVE – I
(14521107) POWER CONVERSION TECHNIQUES

Unit I

Single-Phase AC to DC converters- half controlled and fully controlled configurations- Three-Phase AC to DC converters- half controlled and fully controlled converters. Operation of 12-pulse converter.

Unit II

Inverters, Operating Principle, Types of Inverters, Voltage source and Current source inverters, multi-stepped inverters.

Unit III

AC to AC voltage regulators, continuous and discontinuous configurations, single phase and three phase circuits, introduction to DC to DC voltage regulators –Step down and Step up configuration.

Unit IV

Reactive power and harmonic considerations and analysis in the converters and inverters, harmonic reduction techniques, selected harmonic elimination, reactive power control.

Unit V

Output voltage control methods in inverters, Sinusoidal PWM, Bus clamping PWM, space vector based PWM.

Text Books

1. Ned Mohan, Undeland and Robbin, “Power Electronics: converters, Application and design” John Wiley and sons. Inc, New York, 3rd edition, 2002.
2. Rashid M.H., “Power Electronics Circuits, Devices and Applications”, Prentice Hall India, New Delhi, 3rd edition, 2004.
3. P.C Sen., Modern Power Electronics”, Wheeler publishing Co, First Edition, New Delhi, 1998.

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M. Tech. I SEMESTER (PS) **Th 4 C 4**

ELECTIVE – I
(14521108) GAS INSULATED SYSTEMS (GIS)

UNIT–I

Introduction to GIS - Characteristics of GIS- Introduction to SF6 - Physical properties-Chemical properties - Electrical properties-Specification of SF6 gas for GIS application - Handling of SF6 gas before use - Safe handling of Sf6 gas in electrical equipment - Equipment for handling the SF6 Gas - SF6 and environment.

UNIT–II

Layout of GIS Stations: Advancement of GIS station - Comparison with Air Insulated Substation - Economics of GIS - User Requirements for GIS - Main Features for GIS - Planning and Installation components of a GIS station.

UNIT–III

Design and Construction of GIS Station: Introduction - Rating of GIS components - Design Features - Estimation of different types of Electrical Stresses -Design Aspects of GIS components - Insulation Design for Components - Insulation Design for GIS - Thermal Considerations in the Design of GIS - Effect of very Fast Transient Over-voltages (VFTO) on the GIS design - Insulation Coordination systems - Gas handling and Monitoring System Design.

UNIT-IV

Fast Transient Phenomena in GIS: Introduction- disconnector switching in Relation to Very fast Transients-Origin of VFTO- Propagation and Mechanism of VFTO-VFTO Characteristics- Effects of VFTO-Testing of GIS for VFTO.

UNIT–V

Special Problems in GIS and GIS Diagnostics: Introduction - particles their effects and their control- Insulating Spacers and their Reliability - SF6 Gas Decomposition - Characteristics of imperfections in insulation - Insulation Diagnostic methods - PD Measurement and UHF Method.

Text Book

1. M. S. Naidu, “Gas Insulated Substations”- IK International Publishing House Pvt. Ltd.

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(14521109) POWER SYSTEMS LAB

List of Experiments

1. Determination of Sequence Impedances of Cylindrical Rotor Synchronous Machine.
2. Determination of Sequence Impedances of Three Phase Transformers.
3. Fault Analysis – I
   a) LG Fault
   b) LL Fault
4. Fault Analysis – II
   a) LLG Fault
   b) LLLG Fault
5. Power Angle Characteristics of Salient Pole Synchronous Machine.
6. Characteristics of IDMT Over Current Relay (Electromagnetic Type).
7. Characteristics of Negative Sequence Relay (Static Type).
8. Characteristics of Over Voltage/ Under Voltage Relay (Static Type).
9. Characteristics of Percentage Biased Differential Relay (Electromagnetic Type).
10. Simulation of 220KV Transmission Line.

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(14521201) OPERATION AND CONTROL OF POWER SYSTEM

UNIT I

Economic operation- Load forecasting - Unit commitment – Economic dispatch problem of thermal units – Gradient method- Newton's method –Base point and participation factor method. Hydrothermal co-ordination: Short-term hydrothermal scheduling problem

UNIT II

Unit Commitment and Solution Methods: Optimal Unit Commitment, Constraints in unit commitment, Spinning reserve, Thermal Unit Constraints, Other constraints, Hydro constraints, Must Run, Fuel constraints, Unit commitment Solution methods: Priority-List methods, Dynamic Programming solution. Backward DP Approach, Forward DP Approach, Restricted Search Ranges, Strategies- Reliability considerations.

UNIT III

Automatic generation control: Review of LFC and Economic Dispatch control (EDC) using the three modes of control viz. Flat frequency – tie-line control and tie-line bias control.

AGC implementation – AGC features - static and dynamic responses of uncontrolled & controlled two-area system.

UNIT IV

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

UNIT V

Power system security-Contingency analysis – linear sensitivity factors – AC power flow methods – contingency selection – concentric relaxation – bounding-security constrained optimal power flow-Interior point algorithm-Bus incremental costs.

Text Books

1. Allen J.Wood and Wollenberg B.F., 'Power Generation Operation and control', John Wiley & Sons, Second Edition.
2. Nagrath, I.J. and Kothari D.P., 'Modern Power System Analysis', TMH, New Delhi, 1980.
3. D.P.Kothari & J.S.Dhillon, Power System Optimization , PHI,2004.

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M. Tech. II SEMESTER (PS) **Th 4 C 4**

(14521202) POWER QUALITY

UNIT-I

Introduction: Power quality – voltage quality, concerns about power quality, the power quality Evaluation procedure, Terms and Definitions, Transients, Long-duration voltage variations, short-voltage variations, voltage imbalance, wave form distortion, voltage fluctuation.

UNIT-II

Voltage Sags and Interruptions: Sources of sags and interruptions, Estimating voltage sag performance, fundamental principles of protection, solutions at the end-use level, Motor-starting sags, utility system fault-clearing issues.

UNIT-III

Transient over Voltages: Sources of over voltages, principles of over voltage protection, devices for over voltage protection, principles of regulating the voltage, Devices for voltage regulation, utility voltage regulator Application, capacitors for voltage regulation flicker.

UNIT-IV

Fundamentals of Harmonics: Harmonic Distortion, Voltage versus current distortion, Harmonics versus Transients, Harmonic indices, Harmonic sources from commercial loads, Harmonic sources from Industrial loads Effects of Harmonics, Harmonic distortion evaluations, Principles of Controlling Harmonics, Devices for Controlling Harmonic Distortion

UNIT-V

Power Quality Bench Marking: Benchmarking process, RMS Voltage variation Indices, Harmonics indices-Power Quality Contracts, Monitoring considerations, power quality measurement equipment, Power quality Monitoring standards

TEXT BOOKS

1. Electrical Power Systems Quality, Roger C. Dugan, Mark F. Mc Granaghan, Surya Santoso, H. Wayne Beaty, 2nd Edition, TMH Education Pvt. Ptd.
2. Power quality by C. Sankaran, CRC Press.
3. Electrical systems quality Assessment by J. Arrillaga, N.R. Watson, S. Chen, John Wiley & Sons.
4. Understanding Power quality problems by Math H. J. Bollen IEEE Press.

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(14521203) ADVANCED POWER SYSTEM PROTECTION

Unit I

General philosophy of protection-Characteristic function of protective relays- basic relay elements and relay terminology-basic construction of static relays- non-critical switching circuits.

Unit II

Protective relays –protection of generators – Transformer protection – magnetizing inrush current – Application and connection of transformer differential relays – transformer over current protection.

Unit III

Bus protection, Techniques applicable for line protection –long EHV line protection Backup remote local and Breaker failure

Unit IV

Placement of reactors in power system- Transformer tap changing –Protection of boosters-capacitors in an interconnected power system.

Unit V

Digital signal processing –digital filtering in protection relays- numeric protection –testing Digital filtering in protection relays – digital data transmission– relay hardware – relay algorithms. Concepts of modern coordinated control system.

Text Books

1. Lewis Blackburn, J., "Protective Relaying – Principles and Applications", Marcel Dekkar, INC, New York, 2006.
2. The Electricity Training Association, ":Power System Protection Vol1-4", The IEE, U.K., 1995.
3. Stanley, H. Horowitz (ED), "Protective relaying for power systems II", IEEE Press, 1992.

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M. Tech. II SEMESTER (PS) **Th 4 C 4**

(14521204) POWER SYSTEM RELIABILITY

UNIT I

Basic Probability Theory and Distribution-Basic probability theory-rules for combining probabilities of events, Bernoulli's trials, Probability Density and Distribution Functions, Binomial and Poisson's Distribution- Expected Value and Standard Deviation.

Network Modeling and Reliability Analysis -Analysis of Series, Parallel, Series – Parallel Networks, Complex Networks – Decomposition Method, Cut set and Tie set methods.

Reliability Functions – f(t), R(t), F(t), h(t) and their relationships – Exponential Distribution – Expected Value and Standard Deviation of Exponential Distribution - Reliability Analysis of Series –Parallel Networks using Exponential Distribution – Bath Tub Curve, Reliability Measures - MTTF, MTTR, MTBF

UNIT II

Markov Modeling – Markov Chains – Concept of STPM, Evaluations of Limiting State Probabilities – Markov Processes on Components Repairable System – Time Dependent Probability Evaluation using Laplace Transform Approach – Evaluation of Limiting State Probabilities using STPM – Two Component Reliability Models.

Frequency and Duration Concept – Evaluation of Frequency of Encountering State, Mean Cycle Time for One and Two Component Repairable Models – Evaluation of Cumulative Probability and Cumulative Frequency of Encountering of Merged States.

UNIT III

Generating System Reliability Analysis – I - Generation system model – Capacity Outage Probability Tables – Recursive Relation for Capacitive Model Building – Sequential Addition Method – Unit Removal – Evaluation of Loss of Load and Energy Indices – Examples.

Generating System Reliability Analysis – II – Frequency & Duration Methods – Evaluation of Equivalent Transitional Rates of Identical and Non-identical Units – Evaluation of Cumulative Probability and Frequency of Non--identical generating Units – Two Level Daily Load Representation – Merging Generation and Load Models - Examples

UNIT IV

Bulk Power System Reliability Evaluation - Basic configuration – conditional probability approach – system and load point reliability indices –weather effects on transmission lines – Weighted average rate and Markov model – Common mode failures.

Inter Connected System Reliability Analysis - Probability array method – Two inter connected systems with independent loads – effects of limited and unlimited tie capacity - imperfect tie – Two connected Systems with correlated loads –Expression for cumulative probability and cumulative frequency.

UNIT V

Distribution System Reliability Analysis- I (Radial Configuration) - Basic Techniques, Radial Networks, Evaluation of Basic Reliability Indices, Performance Indices, Load Point and System Reliability Indices, Customer Oriented, Load and Energy Oriented Indices – Examples.

Distribution System Reliability Analysis- II (Parallel Configuration) - Basic techniques – inclusion of bus bar failures, scheduled maintenance – temporary and transient failures – weather effects – common mode failures –Evaluation of various indices – Examples

Text Books

1. Reliability Evaluation of Engineering System – R. Billinton, R. N. Allan, Plenum Press, New York, Reprinted in India by B. S. Publications, 2006
2. Reliability Evaluation of Power Systems – R. Billinton, R. N. Allan, Plenum Press, New York, Reprinted in India by B. S. Publications, 2006.
3. Reliability Modeling in Electric Power Systems by J. Endrenyi, John Wiley and Sons, 1978. (First Edition).

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M. Tech. II SEMESTER (PS) **Th 4 C 4**

(14521205) ENERGY CONVERSION SYSTEMS

UNIT I

Photo voltaic power generation, spectral distribution of energy in solar radiation, solar cell configurations, voltage developed by solar cell, photo current and load current, practical solar cell performance, commercial photo voltaic systems, test specifications for PV systems, applications of super conducting materials in electrical equipment systems.

UNIT II

MHD Power generation**:** Principles of MHD power generation, ideal MHD generator performance, practical MHD generator, MHD technology.

Wind Energy conversion**:** Power from wind, properties of air and wind, types of wind Turbines, operating characteristics.

UNIT III

Tides and tidal power stations, modes of operation, tidal project examples, turbines and generators for tidal power generation. Wave energy conversion: properties of waves and power content, vertex motion of Waves, device applications. Types of ocean thermal energy conversion systems, Application of OTEC systems examples.

UNIT IV

Miscellaneous energy conversion systems: biomass conversion, geothermal energy, thermo electric energy conversion, principles of EMF generation, description of fuel cells**.** Types of fuel cells, H_2-O_2 Fuel cells, Application of fuel cells – Batteries, Description of batteries, Battery application for large power.

UNIT V

Environmental effects of energy conversion systems, pollution from coal and preventive measures steam stations and pollution, pollution free energy systems.

TEXT BOOKS

1. "Energy conversion systems" by Rakosh das Begamudre, New age international publishers, New Delhi - 2000.
2. "Renewable Energy Resources" by John Twidell and Tony Weir, CRC Press (Taylor & Francis).

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M. Tech. II SEMESTER (PS) **Th 4 C 4**

ELECTIVE II

(14521206) ELECTRIC SMART GRID

UNIT–I

Introduction: Introduction to smart grid- Electricity network-Local energy networks- Electric transportation- Low carbon central generation-Attributes of the smart grid- Alternate views of a smart grid. Smart Grid to Evolve a Perfect Power System: Introduction- Overview of the perfect power system configurations- Device level power system- Building integrated power systems- Distributed power systems- Fully integrated power system-Nodes of innovation.

UNIT–II

DC Distribution and Smart Grid AC Vs DC Sources: Benefits of and drives of DC power delivery systems-Powering equipment and appliances with DC-Data centers and information technology loads-Future neighborhood- Potential future work and research. Intelligrid Architecture for the Smart Grid: Introduction- Launching intelligrid- Intelligrid today- Smart grid vision based on the intelligrid architecture-Barriers and enabling technologies.

UNIT–III

Dynamic Energy Systems Concept: Smart energy efficient end use devices-Smart distributed energy resources-Advanced whole building control systems- Integrated communications architecture-Energy management-Role of technology in demand response- Current limitations to dynamic energy management-Distributed energy resources. Overview of dynamic energy management-Key characteristics of smart devices- Key characteristics of advanced whole building control systems-Key characteristics of dynamic energy management system.

UNIT–IV

Energy Port as Part of The Smart Grid: Concept of energy -Port, generic features of the energy port. Policies and Programs to Encourage End – Use Energy Efficiency**:** Policies and programs in action -multinational - national-state-city and corporate levels. Market Implementation: Framework-factors influencing customer acceptance and response - program planning- monitoring and evaluation.

UNIT–V

Efficient Electric End – Use Technology Alternatives- Existing technologies – lighting - Space conditioning - Indoor air quality - Domestic water heating - hyper efficient appliances - Ductless residential heat pumps and air conditioners - Variable refrigerant flow air conditioning-Heat pump water heating - Hyper efficient residential appliances - Data center energy efficiency- LED street and area lighting - Industrial motors and drives - Equipment retrofit and replacement - Process heating - Cogeneration, Thermal energy storage - Industrial energy management programs - Manufacturing process-Electro-technologies, Residential, Commercial and industrial sectors.

Text Books

1. Clark W Gellings, "The Smart Grid, Enabling Energy Efficiency and Demand Side Response"- CRC Press, 2009.
2. Janaka Ekanayake, Kithsiri Liyanage, Jianzhong. Wu, Akihiko Yokoyama, Nick Jenkins, "Smart Grid: Technology and Applications"- Wiley, 2012.
3. James Momoh, "Smart Grid :Fundamentals of Design and Analysis"- Wiley, IEEE Press, 2012.

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M. Tech. II SEMESTER (PS) **Th 4 C 4**

ELECTIVE II

(14521207) AI TECHNIQUES IN ELECTRICAL POWER ENGINEERING

UNIT I

Introduction To Artificial Intelligence: Introduction and motivation – Approaches to AI – Architectures of AI – Symbolic Reasoning System – Rule based Systems – Knowledge Representation – Expert Systems.

UNIT II

Artificial Neural Networks: Basics of ANN - Comparison between Artificial and Biological Neural Networks – Basic Building Blocks of ANN – Artificial Neural Network Terminologies – McCulloch Pitts Neuron Model – Learning Rules – ADALINE and MADALINE Models – Perceptron Networks – Back Propagation Neural Networks – Associative Memories.

UNIT III

Ann Applications to Electrical Systems: ANN approach to Electrical Load Forecasting Problem – System Identification – Control Systems – Pattern Recognition.

UNIT IV

Fuzzy Logic: Classical Sets – Fuzzy Sets – Fuzzy Properties and Operations – Fuzzy Logic System – Fuzzification – Defuzzification – Membership Functions – Fuzzy Rule base – Fuzzy Logic Controller Design.

UNIT V

Fuzzy Logic Applications To Electrical Systems: Fuzzy Logic Implementation for Induction Motor Control – Power System Control – Automatic Generation Control – Switched Reluctance Motor Control – Modeling and Control of DC Drive – Fuzzy Excitation Control Systems in Power System Stability Analysis - Transient Stability Analysis – Automatic Voltage Regulator - Fuzzy Logic Controller in an 18 Bus Bar System.

Text Books

1. S. N. Sivanandam, S. Sumathi and S. N. Deepa, "Introduction to Neural Networks using MATLAB", McGraw Hill Edition, 2006.

2. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, Third Edition, WILEY India Edition, 2012.

Reference Books

1. S. N. Sivanandam, S. Sumathi and S. N. Deepa, “Introduction to Fuzzy Logic using MATLAB”, Springer International Edition, 2013.
2. Yung C. Shin and Chengying Xu, “Intelligent System – Modeling, Optimization & Control”, CRC Press, 2009.

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M. Tech. II SEMESTER (PS) **Th 4 C 4**

ELECTIVE II

(14521208) DIGITAL CONTROL SYSTEMS

UNIT I

Introduction: Digital Control Systems, quantization and quantization error, Z-transform, Z-transforms of elementary functions, properties of Z-transform, Inverse Z-transform, Z-transform method for solving difference equations.

UNIT-II

Z-plane Analysis of Discrete time Control Systems: Introduction, Impulse sampling and data hold, pulse transfer function, realization of digital controllers and digital filters

UNIT-III

Design of Digital control systems by Conventional methods: Introduction, Mapping between s-plane and z-plane, transient and steady-state response analysis, Design based on frequency response methods, Analytical Design method.

UNIT IV

State Space Analysis: State space representation of digital systems, solving discrete state space equations, pulse transfer function matrix, discretozation of continuous time state space equations, Liapunov stability analysis.

UNIT V

Pole placement and State Observers design: Controllability, Observability, useful transformations of state space analysis and design, Design through pole placement, state observer.

Text Books

1. Katsuhiko Ogatta, “Discrete time Control Systems” Second Edition, Prentice Hall of India (2005)
2. I. J. Nagrath, “State Space methods and digital control systems”, New Age International (2004).

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M. Tech. II SEMESTER (PS) **L 3 C 4**

(14521209) POWER SYSTEMS SIMULATION LAB
LIST OF EXPERIMENTS

1. Formulation of Y_{BUS} & Z_{BUS} using MATLAB
2. Simulation of Power Flow using Gauss-Seidal Method
3. Simulation of Power Flow using Newton-Raphson Method
4. Simulation of Power Flow using Fast-Decoupled Method
5. Pole Placement by State Feedback
6. Simulation of Single Area System
7. Simulation of Two Area System
8. Simulation of Automatic Voltage Regulator (AVR) System
9. Simulation of Armature Controlled & Field Controlled DC Motor
10. Simulation of Swing Equation