Form A-7

PART A

(i) The courses for ME Power & Energy Engineering under Electrical & Electronics engineering courses semester I to IV Post Graduate level was approved and recommended.

PART B

(i) The Scheme of instruction and examination of ME Power & Energy Engineering under Electrical & Electronics engineering courses semester I to IV Post Graduate level was approved and recommended.

PART E

(i) The text books for the courses of ME Power & Energy Engineering semester I to Semester IV for Post Graduate level was approved and recommended.

PART F

(i) The minutes of the meeting were readout by the chairman at the meeting itself.

Date: 10-06-2013
Place: Taleigao Plateau

Signature of Chairman

PART G

The remark of the Dean of the Faculty Engineering

i) The minutes are in order
ii) The minutes may be placed before the Academic Council
iii) The minute is for the approval of the Scheme of instruction and examination of ME Power & Energy Engineering under Electrical & Electronics engineering courses semester I to IV Post Graduate level.

Date: 20/06/2013
Place: GEC - Farmagudi

Signature of the Dean
(Dr R B. Lohani)

GOA UNIVERSITY
Scheme of Teaching and Examination for
Master of Engineering (Power and Energy System Engineering) (Revised)
Two years Full time Course

Semester-I									
Subject Code	**Subject**	**Hours per week**			**Scheme of Examination**				
		L	**T**	**P**	**Theory (Hrs)**	**Credits**			
						Theory	**IA**	**Pract**	**Total**
MPE 1.1	Non Conventional Energy systems	4	-	-	3	4	2	-	6
MPE 1.2	Advanced power Electronics	4	-	-	3	4	2	-	6
MPE 1.3	Computer aided Power system Analysis	4	-	-	3	4	2	-	6
MPE 1.4	Elective-I	4	-	-	3	4	2	-	6
MPE 1.5	Elective -II	4	-	-	3	4	2	-	6
MPE 1.6	Power Engineering lab-I	---	---	8	--	---	2	4	6
	Total	**20**	**-**	**8**	**-**	**20**	**12**	**4**	**36**

Semester-II									
Subject Code	**Subject**	**Hours per week**			**Scheme of Examination**				
		L	**T**	**P**	**Theory (Hrs)**	**Credits**			
						Theory	**IA**	**Pract**	**Total**
MPE 2.1	Solid State AC/DC drives	4	-	-	3	4	2	-	6
MPE 2.2	Restructured Power System	4	-	-	3	4	2	-	6
MPE 2.3	Energy Auditing & Management	4	-	-	3	4	2	-	6
MPE 2.4	Elective-III	4	-	-	3	4	2	-	6
MPE 2.5	Elective -IV	4	-	-	3	4	2	-	6
MPE 2.6	Power Engineering lab-II	---	---	8	-	--	2	4	6
	Total	**20**	**-**	**8**	**-**	**20**	**12**	**4**	**36**

28/06/13

Semester-III										
Subject Code	**Subject**	**Hours per week**			**Scheme of Examination**					
		L	**T**	**P**	**Theory (Hrs)**	**Credits**				
						Theory	**IA**	**Pract**	**Oral**	**Total**
MPE 3.1	Power Electronic Interface for Renewable Energy Systems	4	-	--	3	4	2	-	--	6
MPE 3.2	Elective-V	4	-	--	3	4	2	-	--	6
MPE 3.3	Project	---	---	12	--	----	4	-	4	8
MPE 3.4	Seminar-I	---	---	8	--	----	2	-	2	4
	Total	**8**		**20**	--	**8**	**10**	--	**6**	**24**

Semester-IV									
Subject Code	**Subject**	**Hours per week**			**Scheme of Examination**				
		L	**T**	**P**	**Theory (Hrs)**	**Credits**			
						IA	**Pract**	**Oral***	**Total**
MPE 4.1	Dissertation	---	-----	28	--	8	-	12	20
	Total	**-**	**-**	**28**		**8**	**-**	**12**	**20**

Grand Total of all four semesters	**48**	**-**	**64**	**48**	**42**	**8**	**18**	**116**

All Theory papers of 100 marks

Elective lists

ELECTIVE –I (MPE1.4)

MPE 1.4.1	Energy System Modeling and Analysis
MPE 1.4.2	Switch Mode Power Conversion
MPE 1.4.3	Optimization Techniques
MPE 1.4.4	Digital Protection of Power systems

ELECTIVE-II (MPE 1.5)

MPE 1.5.1	Special Electrical Machines
MPE 1.5.2	Power System Transients and Over Voltages
MPE 1.5.3	DSP application to Power System
MPE 1.5.4	Power System Planning & operation

ELECTIVE-III (MPE 2.4)

MPE 2.4.1	HVDC Transmission Technology
MPE 2.4.2	Wind Energy Conversion Systems
MPE 2.4.3	Distributed generation & Microgrids
MPE 2.4.4	Flexible AC Transmission Systems

ELECTIVE –IV (MPE 2.5)

MPE 2.5.1	Distributed Automation
MPE 2.5.2	Power quality Assessment and Mitigation
MPE 2.5.3	HV Electromagnetic Field Computation & Modelling
MPE 2.5.4	Electrical Machine Modeling and Analysis

ELECTIVE –V (MPE 3.2)

MPE 3.2.1	High Voltage Testing and Measurements
MPE 3.2.2	Finite Element Methods and applications
MPE 3.2.3	AI & its Applications to Power
MPE 3.2.4	Smart Grid

SEMESTER I

MPE 1.1 NON CONVENTIONAL ENERGY SYSTEMS

Introduction: Energy Scenario, worlds Production and reserves of commercial energy sources, India's Production and reserves, energy alternatives, The Solar Option, The Nuclear Option, Fuel Cell, Wind Energy, Tidal Energy, Geothermal Energy

Solar Energy: Solar energy alternatives, solar radiation, availability, measurement and estimation, solar thermal conversion devices and storage applications, Solar Photovoltaic conversion, basics of technology, PV-powered agricultural facility, micro-irrigation systems, remote area applications, portable applications, PV power for domestic use applications, BOS components of solar PV systems, Design & Economic considerations.

Wind Energy: History of wind energy, Wind machine types, classification, and parameters, general concepts of airfoils and aerodynamics, Analysis of wind flow, measurement of wind speed, Power in wind, performance calculations of wind turbine, Electrical systems

Other Energy Sources: Overview of micro mini and small hydro. Site selection and civil works. Penstocks and turbines. Biomass-Biomass as a source of energy, methods of obtaining energy from biomass, biomass gasification, classification of biogas plants, pyrolysis.

Tidal- Basic principle of tidal power, components of tidal power plant, operation methods of utilization of tidal energy, estimation of single basin systems and double cycle systems, Ocean Thermal Electric Conversion (OTEC)-Introduction, open cycle OTEC systems, closed cycle OTEC systems. Storage systems for renewable energy applications

Text Books:

1. G D Rai "Non-Conventional Energy Sources," Khanna Publications
2. R H Taylor, "Alternative Energy Sources", Adam Hilger Limited
3. Jhon Twidell and Tony Weir, Renewable Energy sources, Second Edition, Taylor and Francis

Reference Books:

1. S. P Sukhatme "Solar Energy- Principle of Thermal collector and storage," Third edition, TMH publication
2. Chetan Singh Solanki , "Solar Photo Voltaics" , PHI learning Pvt Ltd., New Delhi,2009
3. S N Bhadra, Chattarjee , "Wind Electrical System" OUP Publications

MPE 1.2 ADVANCED POWER ELECTRONICS

Voltage Source Converters:
Basic concepts of VSI, single phase half bridge, full bridge and three phase bridge inverters, 3-ph- full wave bridge converter, operation and harmonics, Transformer connection for 12 pulse operation, 24 and 48 pulse operation. Operation of 12-pulse converter. Three level voltage source converter. PWM converter. Generalized technique of harmonic elimination and voltage control. Advanced modulation techniques (SPWM, space vector modulation, 3rd harmonic PWM) Comparison of PWM techniques. Converter rating.

Self and Line commutated current source converter:
Basic concepts of CSC, converters with self-commutating devices. Comparison with voltage source converter

Multilevel Inverters:
Multilevel concept, Types of multilevel Inverters, diode clamped multilevel inverter, flying-capacitors multilevel inverters, cascaded multilevel inverter, applications switching device currents, DC link capacitor voltage balancing, features of multilevel inverters, comparison of multilevel converters.

Resonant Converters
Basic resonant circuit concepts, Load resonant converters, series and parallel loaded, Resonant switch converters - ZVS, ZCS, comparison of resonant converters.

Converter dynamics
Review of classical methods of modeling, State space model of various dc to dc converters, State space averaging techniques.

Matrix converters
Frequency converters with and without DC storage Element, Direct AC-AC frequency conversion with matrix topology, Indirect AC-AC conversion without energy storage element, Matrix-Reactance chopper topologies, Hybrid AC-AC frequency converters.

Digital Controller Design
Bode diagram method, PID controller, Root locus method, State-Space method, Full-state feedback, Regulator design by pole placement, Estimator design, Voltage and Current control technique.

Text Books:

1. Power Electronics, Converters, Applications & Design, N. Mohan, T. M. Undeland, W.P Robbins, Wiley India Pvt.Ltd.
2. Power Electronics by M. H. Rashid Prentice Hall of India Pvt. Ltd.
3. Three-phase AC-AC Power Converters Based on Matrix Converter Topology, PawelSzczesniak, Springer.
4. Power Electronics Esssentials and Applications, L Umanand, Wiley India.

Reference Books:

1. Power Electronics Singh and Kanchandani, Tata McGraw Hill publications.
2. Fundamentals of Power Electronics, Robert Erickson, Springer India.

MPE 1.3 COMPUTER AIDED POWER SYSTEM ANALYSIS

Network Modeling & Power flow: Incidence and network matrices- introduction, graphs, incidence matrices formation of network matrix - y_{bus} by singular transformation, π-representation of off-nominal tap transformers. sparsity technique for y_{bus}

Load Flow analysis: Introduction to load flow analysis- bus admittance matrix, Gauss-seidel method, Newton-Raphson method, fast-decoupled method- review of ac/dc load flow solutions, Newton-Raphson load flow study with FACTs (SVC, TCS) power flow analysis using matlab. Three phase Load flow analysis

Short circuit analysis: Short circuit study, algorithms for formation of z_{bus} matrix short- circuit calculations using z_{bus}, z_f^{abc}, y_f^{abc}, z_f^{012}, y_f^{012} matrices for various faults, example of short circuit calculations using z_{bus} for L-L-L andL-G faults

Optimal Power Flow Analysis: Optimal power flow analysis considering equality and inequality constraints. Economic dispatch with and without limits(Classical method) Gradient method, Newton's method, Newton Raphson method, calculation of loss coefficients, loss coefficients using sensitivity factors, power loss in a line, Generation shift distribution factors, Transmission loss coefficients, transmission loss formula as a function of generation and loads, economic dispatch using loss formula which is function of real and reactive power, linear programming method.

Text Books:

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

Reference Books :

1. J. Arrilinga, C. P. Arnold, "Computer Analysis of Power Systems", Wiley Eastern Ltd.
2. Nagrath and Kothari, "Modern Power System Engineering", Tata McGraw Hill
3 John Grainger & Stevenson "Modern Power System Analysis" , Tata McGraw Hill

Electives

MPE 1.4.1 ENERGY SYSTEMS MODELING AND ANALYSIS

I. Modeling overview-levels of analysis, steps in model development, examples of models. Quantitative Techniques: Interpolation-polynomial, Lagrangian. Curve-fitting, regression analysis, solution of transcendental equations. Systems Simulation-information flow diagram.

II. Solution of set of nonlinear algebraic equations, successive substitution, Newton Raphson. Examples of energy systems simulation Optimisation: Objectives/constraints, problem formulation. Unconstrained problems- Necessary & Sufficiency conditions. Constrained Optimisation- Lagrange multipliers, constrained variations, Kuhn-Tucker conditions.

III. Linear Programming - Simplex tableau, pivoting, sensitivity analysis. Dynamic Programming. Search Techniques- Univariate / Multivariate. Case studies of optimization in Energy systems problems.

IV Dealing with uncertainty- probabilistic techniques. Trade-offs between capital & energy using Pinch Analysis. Energy- Economy Models: Scenario Generation, Input Output Model.

V. Numerical solution of Differential equations- Overview, Convergence, Accuracy. Transient analysis- application example.

Reference Books:

1. S. S. Rao, "Optimization Theory and applications", Wiley Eastern.
2. S. S. Sastry, "Introductory methods of numerical analysis", Prentice Hall.
3. P. Meier "Energy Systems Analysis for Developing Countries", Springer Verlag.
4. R.de Neufville, "Applied Systems Analysis", McGraw Hill, International Edition.

MPE 1.4.2 SWITCH MODE POWER CONVERSION

Introduction to Switching Regulator Topologies- Buck switching regulator, Boost switching regulator, Inverting Boost regulator in CCM and DCM mode. Calculation of switching power loss, efficiency, selection of optimum switching frequency.

Push-Pull and Forward Converter Topologies–Basic operation, Flux imbalance effect and its mitigation, power transformer and power transistor design. Basic operation of forward converters, double ended and interleaved forward converter design.

Half and Full Bridge converter design – Basic operation, design of magnetics, filter design.

Flyback converter topologies – DCM and CCM mode of operation, universal input flyback operation, Interleaved and double ended flyback configuration.

Transistorized drive circuits - MOSFET and IGBT Power transistor gate drive requirements, SOA operation, performance characteristics, parallel operation, thermal characteristics.

Switching Losses and snubber design – Transistor losses without a snubber, snubber topologies.

Advanced converter topologies - Basic operation of resonant converters, high frequency electronic ballasts for fluorescent lamps, low voltage regulators for portable electronics, IC regulators.

Text Books

1. Switchmode_Power_Supply_Handbook-Kieth Billings, McGraw Hill
2. Switching Power Supply Design, 3rd Ed. – A. Pressman, K. Billings, T. Morey, McGraw Hill

Reference Books

1. Switch Mode Power Supply Design - P. Chetty, bpb puplishers.
2. Switching Power Supply Design and Optimization, 2nd Edition –Sanjaya Maniktala, McGraw Hill
3. Switch-Mode Power Supplies Spice Simulations and Practical Designs - Christophe Basso, Tata McGraw Hill
4. SMPS AC/DC Reference Design User's Guide – Microchip

MPE 1.4.3 OPTIMIZATION TECHNIQUES

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

Non-linear programming: selected unconstrained and constrained non-linear programming algorithms like quasi Newton, reduced gradient and gradient projection methods
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.

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

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

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

Optimization Techniques applied to Electrical Engineering.

Reference Books:

1. Rao, S. S., "Optimization : Theory and Application", Wiley Eastern Press, 1978.
2. Taha, H. A., "Operations Research- An Introduction", Prentice Hall of India.
3. Fox, R. L., "Optimization methods for Engineering Design", Addition Welsey, 1971.

MPE 1.4.4 DIGITAL PROTECTION OF POWER SYSTEMS

Introduction

Introduction to computer aided relaying, motivation, basic hardware, digital signal processing aspects; Sampling, aliasing, antialiasing filter, Fourier & discrete Fourier transform, recursive DFT, half cycle and full cycle algorithm. Estimation of phasors & frequency; Algorithms for transmission line, transformer & bus bar protection; out-of-step relaying Introduction to adaptive relaying & wide area measurements.

Static Relays

Static Relays- Block diagram- types of static relays- over current, differential and distance relays

Digital Protection Modelling of digital relays- Protection of power system and apparatus using digital protection schemes- New developments in relaying principles.

Digital Protection

Digital protection of Transmission line, Synchronous generator, Power Transformer.

Reference Books

1. J. L Blackburn, "Protective relaying :- Principles and applications", Marcel Dekker, New York 1982.
2. A. G. phadke and J.S Thorpe , "Computer relaying for power systems" , John Wiley and Sons, New York.
3. L. P. Singh, " Digital protection", New age International pvt. Ltd publishers, New Delhi

MPE 1.5.1 SPECIAL ELECTRICAL MACHINES

Synchronous Reluctance Motors: Constructional features: axial and radial air gap Motors. Operating principle, reluctance torque, phasor diagram, motor characteristics, Linear induction machines.

Stepping Motors: Constructional features, principle of operation, modes of excitation torque production in Variable Reluctance (VR) stepping motor, dynamic characteristics, Drive systems and circuit for open loop control, closed loop control of stepping motor.

Switched Reluctance Motors: Constructional features-principle of operation-Torque equation-Power Controllers-Characteristics and control, Microprocessor based controller.

Permanent Magnet Synchronous Motors: Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power controllers, Torque speed characteristics, Self control, Vector control, Current control schemes.

Permanent Magnet Brushless DC Motors: Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics, Controllers-Microprocessor based controller.

Text books

1. Miller, T.J.E. "Brushless permanent magnet and reluctance motor drives ", Clarendon Press, Oxford, 1989.
2. B.K. Bose, "Modern Power Electronics & AC drives", Pearson India

Reference Books

1. R. Krishnan, "Switched Reluctance Electric Motors" – Modeling, Analysis and Design", John Wiley & SOns

MPE 1.5.2 POWER SYSTEM TRANSIENTS AND OVERVOLTAGES

I. Review and importance of the study of transients - causes for transients. RL circuit transient with sine wave excitation - double frequency transients - basic transforms of the RLC circuit transients.

II. Different types of power system transients - effect of transients on power systems – role of the study of transients in system planning. Transients in Electric Power Systems, Internal & external causes of overvoltage's, Lightning strokes, Mathematical model to represent Lightning strokes Footing resistance – Interaction between lightning and power system. Traveling waves in transmission lines, Circuits with distributed constants, wave equations, reflection & refraction of travelling waves, Bewely's lattice diagram – standing waves and natural frequencies - reflection and refraction of travelling waves. Travelling waves at different line terminations.

III. Switching Transients, double frequency transients, abnormal switching transients, transients in switching a three phase reactor, three phase capacitor.

IV. Voltage distribution in transformer winding, voltage surges, transformers, generators and motors. Transient parameter values for transformers, reactors, generators and transmission lines

V. Basic ideas about protection –surge diverters-surge absorbers-protection of lines and stations Modern lighting arrestors. Insulation coordination. Protection of alternators and industrial drive systems.

VI. Generation of high AC and DC –impulse voltages, currents- measurement using sphere gaps – peak voltmeters – potential dividers and CRO.

Reference books:

1. Allen Greenwood, 'Electrical transients in power systems', Wiley Interscience, 1998.
2. Gallaghar, P. J. and Pearmain, A.J., "High voltage measurement, Testing and Design", John Wiley and sons, New York, 1982.
3. Bewley, L.W., 'Traveling waves and transmission systems', Dover publications, New York, 1963
4. R. D. Begamudre, 'Extra High Voltage AC Transmission Engineering', Wiley Eastern Limited, 1986.

MPE 1.5.3 DSP APPLICATIONS TO POWER SYSTEM

Introduction: Fixed and floating-point processors Number formats and operations: Fixed point 16 bit numbers representations of signed integers and fraction, Floating Point Numbers. Review of commonly used DSP processors in power electronics applications, Introductions to TMS320F6000

DSP Architecture, peripherals and programming: Introduction to Digital control using DSP, Overview of TMS320XXXXX Digital signal controller family – Features, Architecture, Interrupt and Reset, Memory map - On-chip memories: Flash, RAM, and Boot ROM – External memory Interface. Clock system- Digital I/O -CPU Timers – Analog to Digital Converter (ADC), Pulse Width Modulator (PWM), High Resolution PWM, Capture Module, Quadrature Encoder Pulse Module. Controller Area Network, Serial Communication Interface, Serial Peripheral Interface, I^2C and Multi-channel Buffered Serial port. Programming: assembler, linker processes, code structure, Code composer studio

Mathematical tools for Real Time DSP implementation: Review of numerical integration: Euler's implicit and explicit method, Heun's Method, Trapezoidal Method. Implementation of low pass filter. Review of reference frame transformation theory. Design of controllers for closed loop applications in power electronics: PI, Type II and Type III controllers

DSP Applications in Power Electronics: Speed control of Induction motor, BLDC motor, Digital control of DC/DC converter, LED Lighting.

DSP Applications in Power Systems: Issues of harmonics and unbalanced currents in power systems, Implementation of Active filters in DSP under balanced and unbalanced condition, harmonic oscillator and 3 phase lock loop, Static VAR Compensator, Hardware in Loop simulations. Design of a DSP controlled Solar PV based Converter/Inverter system:

Reference books:

1. P P Vaidyanathan, "Multirate Systems and Filter Banks", Prentice-Hall, 1993.
2. S J Orfanidis, "Optimum Signal Processing", McGraw-Hill, 1989
3. Proakis, Manolakis, "Introduction to DSP", PHI, 1994/ Pearson, 2002.
4. A V Oppenheim, R W Schafer, "Discrete Time Signal Processing", PHI, 1994.

MPE 1.5.4 POWER SYSTEM PLANNING AND OPERATION

Load Forecasting: Introduction, Factors affecting Load Forecasting, Load Research, Load Growth Characteristics, Classification of Load and Its Characteristics, Load Forecasting Methods - (i) Extrapolation (ii) Co-Relation Techniques, Energy Forecasting, Peak Load Forecasting, Reactive Load Forecasting, Non-Weather sensitive load Forecasting, Weather sensitive load Forecasting, Annual Forecasting, Monthly Forecasting, Total Forecasting.

System Planning: Introduction, Objectives & Factors affecting to System Planning, Short Term Planning, Medium Term Planning, Long Term Planning, Reactive Power Planning.
Objectives & Factors affecting Generation Planning, Generation Sources, Integrated

Economic Operation of Power systems: Optimal operation of generators in Thermal power plants, heat rate curves, cost curve, Incremental fuel and production cost, Input output characteristics, Optimum generation allocation with line losses neglected.

Economic Operation of Power systems: Optimum generation allocation including effect of transmission line losses, los effect, general transmission line loss formula.

Hydrothermal Scheduling: Optimal scheduling of hydrothermal system, Scheduling Problems, short term hydrothermal scheduling problem.

Reference Books :

1. X. Wang & J.R. McDonald "Modern Power System Planning", McGraw Hill Book Company
2. T. Gönen, "Electrical Power Distribution Engineering" , McGraw Hill Book Company
3. B.R. Gupta, "Generation of Electrical Energy", S. Chand Publications
4. A.S. Pabla, "Electrical Power Distribution", Tata McGraw Hill Publishing Company Ltd.
5. Nagrath & Kothari, "Modern Power System Analysis" , TMH Publications New Delhi

MPE 1.6 POWER ENGINEERING LAB I (Minimum ten experiments to be performed)

a) **Design and Hardware Implementation (any three)**

1) DC-DC Converter
2) DC-AC Converter
3) IGBT based single phase PWM Inverter
4) MOSFETs. Practical converter design considerations- Snubber design, gate and base drive circuits.
5) DC to DC converters of various configurations using SCRs, IGBTs, power transistors and power MOSFETs.
6) DC to AC converters of various configurations using SCRs, IGBTs, power transistors and power MOSFETs.
7) AC to AC converters of various configurations using SCRs, IGBTs, power transistors and power MOSFETs.
8) Determination of efficiency of DC/AC inverter

b) **Characteristics of Renewable Sources (Any One)**

1) I-V and P-V Characteristics of solar panel at different Atmospheric Conditions
2) I-V and P-V Characteristics of fuel cell

c) **Design and Simulation (Any four)**

1) Simulation of Three phase semi converter
2) Simulation of Three phase fully controlled converter
3) Simulation of Three phase full bridge inverter. (180 degree and 120 degree mode operation)
4) Simulation of single phase AC Voltage Controller. (R and RL load)
5) Simulation of Three phase AC Voltage Controller. . (R and RL load)
6) Simulation of PWM inverters a) Sinusoidal PWM b) Square PWM

d) **Use of Power system analysis software (any two)**

1. Load flow analysis by using Newton's method on digital computer.
2. Optimal Power flow analysis by Newton's method.
3. AC-DC load flow analysis on digital computer.
4. Analysis of various types of faults on digital computer

Development of virtual instrumentation software interface for power Electronics hardware through suitable VI software

e) Write program in DSP (at least one)

1) Generation of sine wave
2) Sense a non-sinusoidal voltage/current and find out harmonic content in it
3) Generation of Sine-PWM signals
4) Implementation of d-q reference transformations
5) Implementation of Harmonic Oscillator

SEMESTER II

MPE 2.1 SOLID STATE AC/DC DRIVES

Closed Loop Control: Modeling of drive elements – Equivalent circuit, transfer function of self, separately excited DC motors; Linear Transfer function model of power converters; Sensing and feeds back elements - Closed loop speed control – current and speed loops, P, PI and PID controllers – response comparison. Simulation of converter and chopper fed d.c drive.

Digital Control Of D.C Drive: Phase Locked Loop and micro-computer control of DC drives – Program flow chart for constant horse power and load disturbed operations; Speed detection and gate firing.

VSI And CSI Fed Induction Motor Control: AC voltage controller circuit – six step inverter voltage control-closed loop variable frequency PWM inverter with dynamic braking-CSI fed IM variable frequency drives comparison

Rotor Controlled Induction Motor Drives : Static rotor resistance control - injection of voltage in the rotor circuit – modified Kramer drives static scherbius drives - power factor considerations

Field Oriented Control : Field oriented control of induction machines – Theory – DC drive analogy – Direct and Indirect methods – Flux vector estimation - Direct torque control of Induction Machines – Torque expression with stator and rotor fluxes, DTC control strategy.

Synchronous Motor Drives : Wound field cylindrical rotor motor performance equations of operation from a voltage source – Power factor control and V curves – starting and braking, self control – Load commutated Synchronous motor drives - Brush and Brushless excitation .

Text books

1. Bimal K Bose, "Modern Power Electronics and AC Drives", Pearson Education Asia 2002.
2. Gopal K Dubey, "Power Semiconductor controlled Drives", Prentice Hall Inc., New Jersy, 1989.
3. R. Krishnan, "Electric Motor Drives – Modeling, Analysis and Control", Prentice-Hall of India Pvt. Ltd., New Delhi, 2003.

References

1. W. Leonhard, "Control of Electrical Drives", Narosa Publishing House, 1992.
2. Murphy J. M.D and Turnbull, "Thyristor Control of AC Motors", Pergamon Press, Oxford, 1988.
3. S B Dewan, Slemon & Straughen, " Power Semiconductor Drives", John Wiley

MPE 2.2 RESTRUCTURED POWER SYSTEM

Power Sector Economics, Management and Restructuring Power Sector in India

Critical issues / challenges before the Indian power sector, Salient features of Electricity act 2003, various national policies and guidelines under this act.

Power sector economics and regulation

Typical cost components and cost structure of the power sector, Different methods of comparing investment options, Concept of life cycle cost , annual rate of return ,methods of calculations of Internal Rate of Return (IRR) and Net Present Value(NPV) of project, Short term and long term marginal costs, Different financing options for the power sector Different stakeholders in the power sector, Role of regulation and evolution of regulatory commission in India, types and methods of economic regulation, regulatory process in India.

Power sector restructuring and market reform

Different industry structures and ownership and management models for generation, transmission and distribution. Competition in the electricity sector- conditions, barriers, different types, benefits and challenges Latest reforms and amendments. Different market and trading models / arrangements, open access, key market entities- ISO,

Genco, Transco, Disco, Retailco, Power market types, Energy market, Ancillary service market, transmission market, Forward and real time markets, market power.

Transmission Planning and pricing
Transmission planning, Different methods of transmission pricing, Different transmission services, Congestion issues and management, Transmission cost allocation methods, Locational marginal price, and firm transmission right.

Transmission ownership and control, Transco and ISO, Transmission pricing Model in India, Availability based tariff, role of load dispatch centers (LDCs) Salient features of Electricity act 2003, Price based Unit commitment, concept of arbitrage in Electricity markets, game theory methods in Power System, and security constrained unit commitment. Ancillary services for restructuring, Forward ancillary service auction. Power purchase agreements. IT applications in restructured markets, Working of restructured power systems : PJM.

Text Books:
1. "Know Your Power", A citizens Primer On the Electricity Sector, Prayas Energy Group, Pune
2. Sally Hunt, "Making Competition Work in Electricity", 2002, John Wiley Inc.

References:
1. Regulation in infrastructure Services: Progress and the way forward - TERI, 2001
2. Electric Utility Planning and Regulation, Edward Kahn, American Council for Energy Efficient Economy.

MPE 2.3 ENERGY AUDITING & MANAGEMENT

Energy Audit & Management: Definition, Energy audit- need, Types of energy audit, Energy management (audit) approach understanding energy costs, Bench marking, Energy performance, Matching energy use to requirement, Maximizing system efficiencies, Optimizing the input energy requirements, Fuel and energy substitution, Energy audit Instruments energy management, Roles and responsibilities of energy Manager and Accountability, Financial analysis techniques, Financing options, Energy performance contracts and role of ESCOs. Defining monitoring & targeting, Elements of monitoring& targeting, Data and information-analysis, Techniques -energy consumption, Production, Cumulative sum of differences.

Energy Efficiency in Electrical system: Electricity billing, Electrical load management and maximum demand Control, Maximum demand controllers; Power factor improvement, Automatic power factor controllers, efficient operation of transformers, Energy efficient transformers; Induction motors efficiency, motor retrofitting, energy efficient motors, Soft starters, Variable speed drives; Performance evaluation of fans and pumps, Flow control strategies and energy conservation opportunities in fans and pumps, Energy efficiency measures in lighting system, Electronic ballast, Occupancy sensors, Energy efficient lighting controls Factors affecting selection of DG system, Energy performance assessment of diesel conservation avenues. Case study and numerical.

Energy Conservation in Thermal Systems: Types of boilers, Combustion in boilers, Performances evaluation, Feed water treatment, Blow down, Energy conservation opportunities in boiler, Properties of steam, Assessment of steam distribution losses,Steam leakages, Steam trapping, Condensate and flash steam recovery system, Identifying opportunities for energy savings. Classification, General fuel economy measures in furnaces, Excess air, Heat Distribution, Temperature control, Draft control, Waste heat recovery. Insulation-types and application, Economic thickness of insulation, Heat savings and application criteria. Case study and numerical.

Energy Performance Assessment: On site Performance evaluation techniques, Case studies based on: Motors and variable speed drive, Fans and pumps, HVAC system calculations; Lighting System: Installed Load Efficacy Ratio (ILER) method Financial Analysis: simple payback period, NPV, IRR, Case studies of few selected industries, analysis of results and inference.

Reference Books:
1. Energy Management: W. R. Murphy, G. Mckay (Butterworths).
2. Efficient Use of Energy: I.G.C. Dryden (Butterworth Scientific)
3. Industrial Energy Conservation: D.A. Reay (Pergammon Press)
4. Energy Management Handbook – W.C. Turner (John Wiley and Sons, A WileyInter science publication)

MPE 2.4.1 HVDC TRANSMISSION TECHNOLOGY

Introduction: Comparison of AC and DC transmission – Application of DC transmission – Description of DC transmission system - Planning for HVDC transmission – Modern trends in DC transmission – DC breakers – Cables, VSC based HVDC.

Analysis of HVDC converters and HVDC system control: 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.

Multi terminal DC systems: Introduction – Potential applications of MTDC systems - Types of MTDC systems - Control and protection of MTDC systems - Study of MTDC systems.

Power flow analysis in AC/DC systems: Per unit system for DC Quantities - Modeling of DC links - Solution of DC load flow - Solution of AC-DC power flow - Case studies.

Simulation of HVDC systems: Introduction – System simulation: Philosophy and tools – HVDC system simulation – Modeling of HVDC systems for digital dynamic simulation – Dynamic in traction between DC and AC systems.

Reference Books:

1. E. W. Kimbark : Direct current Transmission, Wiely Inter Science –New York.
2. J. Arillaga : H. V. D. C. Transmission Peter Peregrinus ltd., London UK 1983
3. K. R. Padiyar: H. V. Direct current Transmission, Wiely Eastern Ltd., New Delhi – 1992.
4. E. Uhlman: Power Transmission by Direct Current, Springer Verlag, Berlin Helberg – 1985.

MPE 2.4.2 WIND ENERGY CONVERSION SYSTEMS

Introduction

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

Wind Turbines

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.

Fixed Speed Systems

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.

Variable Speed Systems

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.

Grid Connected Systems

Stand alone and Grid Connected WECS system-Grid connection Issues-Machine side & Grid side controllers-WECS in various countries

Reference books

1. Tony Burton, David Sharpe , Nick Jenkins, "Wind energy handbook" , John Wiley and sons
2. L. L. Freris "Wind Energy conversion Systems", Prentice Hall, 1990

3. Thomas Ackermann, "Wind Power in power systems", Wiley IEEE Press ,April 2012
4. S. Heir "Grid Integration of WECS", Wiley 1998.
5. S N Bhadra, Chattarjee " Wind Electrical System", Oxford University Publications

MPE 2.4.3 DISTRIBUTED GENERATION AND MICROGRID

Introduction:
Conventional power generation: advantages and disadvantages, Energy crises, Non-conventional energy (NCE) resources: review of Solar PV, Wind Energy systems, Fuel Cells, micro-turbines, biomass, and tidal sources. Impact of grid integration of NCE sources on existing power system: reliability, stability and power quality issues, Energy storage elements: Batteries, ultra-capacitors, flywheels. Captive power plants

Distributed Generations (DG):
Concept of distributed generations, topologies, selection of sources, regulatory standards/ framework: IEEE 1547, DG installation classes, requirements for grid interconnection, limits on operational parameters,: voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues, security issues in DG implementations

Microgrids:
Concept of microgrid, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids,
communication infrastructure, modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, Power quality issues in microgrids, regulatory standards, Microgrid economics, Introduction to smart microgrids

Reference Books
1. Math H. Bollen, Fainan Hassan, "Integration of distributed generation power system", Wiley IEEE press Jan. 2011.
2. Quing Chang Zhong, Thomas Hornik, "Control of power inverters in renewable energy and smart grid integration" , Wiley IEEE press Jan. 2011.
3. Loi LeiLai, Tze Funchan , "Distributed generation : Induction and permanent magnet generators", Wiley IEEE press.
4. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley IEEE press

MPE 2.4.4 FLEXIBLE AC TRANSMISSION SYSTEMS

Introduction: 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).

Static VAR Compensator (SVC) And Applications : 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.

Thyristor Controlled Series Capacitor (TCSC) And Applications: 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.

Voltage Source Converter Based Facts Controllers: 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 –Modeling of SSSC in load flow and transient stability studies. Applications: SSR Mitigation-

UPFC and IPFC: Operating principle of UPFC, transmission control capabilities, independent control of real and reactive power, Operating principle and characteristics of IPFC

Text books

1. R. Mohan Mathur, Rajiv K.Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc.
2. Narain G. Hingorani, "Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers Distributors, Delhi- 110006
3. A. T. John, "Flexible A.C. Transmission Systems", Institution of Electrical and Electronic Engineers (IEEE), 1999.

Reference books

1. V. K. Sood, "HVDC and FACTS controllers – Applications of Static Converters in Power System", April 2004, Kluwer Academic Publishers.
2. E Acha & others "FACTS Modeling in Power Networks", John Wiley & sons
3. K. R. Padiyar," FACTS Controllers in Power Transmission and Distribution", New Age International (P) Limited, Publishers, New Delhi, 2008

MPE 2.5.1 DISTRIBUTION AUTOMATION

Introduction to Distribution Automation (DA), control system interfaces, control and data requirements, centralized (Vs) decentralized control, DA System (DAS), DA Hardware, DAS software.

DA capabilities, Automation system computer facilities, management processes, Information management, system reliability management, system efficiency management, voltage management, Load management.

DA communication requirements, Communication reliability, Cost effectiveness, Data rate requirements, Two way capability, Ability to communicate during outages and faults, Ease of operation and maintenance, Conforming to the architecture of data flow.

Communication systems used in DA :Distribution line carrier (Power line carrier), Ripple control, Zero crossing technique, telephone, cable TV, Radio, AM broadcast, FM SCA, VHF Radio, UHF Radio, Microwave satellite. fiber optics, Hybrid Communication systems, Communication systems used in field tests.

Technical Benefits: DA benefit categories, Capital deferred savings, Operation and Maintenance savings, Interruption related savings, Customer related savings, Operational savings, improved operation, Function benefits, Potential benefits for functions, function shared benefits, Guide lines for formulation of estimating equations.

Parameters required, economic impact areas, Resources for determining benefits impact on distribution system, integration of benefits into economic evaluation. Economic Evaluation Methods: Development and evaluation of alternate plans, Select study area, Select study period, Project load growth, Develop Alternatives, Calculate operating and maintenance costs, Evaluate alternatives.

Economic comparison of alternate plans, Classification of expenses and capital expenditures, Comparison of revenue requirements of alternative plans, Book Life and Continuing plant analysis, Year by year revenue requirement analysis, short term analysis, end of study adjustment, Break even analysis, Sensitivity analysis computational aids.

Reference books:

1. IEEE Tutorial Course, "Distribution Automation"
2. IEEE Working Group on "Distribution Automation"
3. H Lee Willis, "Electrical Power Distribution", Planning Reference Book, 2 Edition, Marcel Dekker Inc, 2004.
4. K.M. Khedekar, G. M. Dhole, "A Text book of Electric power distribution automation" , Laxmi Publications ltd, New Delhi.

MPE 2.5.2 POWER QUALITY ASSESSMENT & MITIGATION

INTRODUCTION: 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, Non linear and unbalanced loads, DC offset in loads, Notching in load voltage, Disturbance in supply voltage – Power quality standards.

Non-Linear Loads: Single phase static and rotating AC/DC converters, Three phase static AC/DC converters, Battery chargers, Arc furnaces, Fluorescent lighting, pulse modulated devices, Adjustable speed drives.

Measurement and Analysis Methods: Voltage, Current, Power and Energy measurements, power factor measurements and definitions, event recorders, Measurement Error – Analysis: Analysis in the periodic steady state, Time domain methods, Frequency domain methods: Laplace's, Fourier and Hartley transform – The Walsh Transform – Wavelet Transform.

Analysis and Conventional Mitigation Methods: 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.

Power Quality Improvement: Utility-Customer interface –Harmonic filters: passive, Active and hybrid filters – Custom power devices: Network reconfiguring Devices, Load compensation using DSTATCOM, Voltage regulation using DSTATCOM, protecting sensitive loads using DVR, UPQC – control strategies: P-Q theory, Synchronous detection method – Custom power park – Status of application of custom power devices.

Power Quality and EMC Standards: Industry standards and general guidelines. Global quality standards: IEEE standards framework for quality

Reference Books:

1. Recent Technical Papers Published in IEEE on 'Power Quality'.
2. C. Sankaran "Power Quality", YesDee Publishing
3. Bollen M. J., R. Duncan "Understanding Power quality problems", Standard Publishers and Distributors.
4. Angelo Baggini, "Handbook of power quality", John Wiley publication.

MPE 2.5.3 HV ELECTROMAGNETIC FIELD COMPUTATION AND MODELLING

Introduction

Review of basic field theory – electric and magnetic fields – Maxwell's equations – Laplace, Poisson and Helmoltz equations – principle of energy conversion – force/torque calculation – Electro thermal formulation.

Solution of Field Equations I

Limitations of the conventional design procedure, need for the field analysis based design, problem definition , solution by analytical methods-direct integration method – variable separable method – method of images, solution by numerical methods- Finite Difference Method.

Solution of Field Equations II

Finite element method (FEM) – Differential/ integral functions – Variational method – Energy minimization – Discretisation – Shape functions –Stiffness matrix –1D and 2D planar and axial symmetry problem.

Field Computation For Basic Configurations

Computation of electric and magnetic field intensities– Capacitance and Inductance – Force, Torque, Energy for basic configurations.

Design Applications
Insulators- Bushings – Cylindrical magnetic actuators – Transformers – Rotating machines.

Reference books
1. K.J.Binns, P.J.Lawrenson, C.W Trowbridge, "The analytical and numerical solution of Electric and magnetic fields", John Wiley & Sons, 1993.
2. Nathan Ida, Joao P.A.Bastos, "Electromagnetics and calculation of fields", Springer-Verlag, 1992.
3. Nicola Biyanchi, "Electrical Machine analysis using Finite Elements", Taylor and Francis Group, CRC Publishers, 2005.
4. S. J Salon, "Finite Element Analysis of Electrical Machines." Kluwer Academic Publishers, London, 1995, distributed by TBH Publishers & Distributors, Chennai, India
6. Silvester and Ferrari, "Finite Elements for Electrical Engineers" Cambridge University press, 1983.

MPE 2.5.4 ELECTRICAL MACHINE MODELING AND ANALYSIS

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

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

Reference frame theory: Real time model of a two phase induction machine- Transformation to obtain constant matrices-three phase to two phase transformation-Power equivalence.

Dynamic modelling of three phase Induction Machine: Generalized model in arbitrary reference frame-Electromagnetic torque-Derivation of commonly used Induction machine models- Stator reference frame model-Rotor reference frame model-Synchronously rotating reference frame model-Equations in flux linkages-per unit model

Small Signal Modelling of Three Phase Induction Machine: Small signal equations of Induction machine-derivation-d-q flux linkage model derivative control principle of Induction machine.

Symmetrical and Unsymmetrical 2 phase Induction Machine: Analysis of symmetrical 2 phase induction machine-voltage and torque equations for unsymmetrical 2 phase induction machine-voltage and torque equations in stationary reference frame variables for unsymmetrical 2 phase induction machine-analysis of steady state operation of unsymmetrical 2 phase induction machine- single phase induction motor -Cross field theory of single-phase induction machine.

Modelling of Synchronous Machine: Synchronous machine inductances --voltage equations in the rotor's dq0 reference frameelectromagnetic torque-current in terms of flux linkages-simulation of three phase synchronous machine- modeling of PM Synchronous motor.

Dynamic Analysis of Synchronous Machine: Dynamic performance of synchronous machine, three-phase fault, comparison of actual and approximate transient torque characteristics, Equal area criteria

Text Books:
1. R. Krishnan, "Electric Motor Drives - Modeling, Analysis & control", Pearson Publications,1st edition, 2002.
2. P. C. Krause, Oleg Wasynczuk, Scott D.Sudhoff, "Analysis of Electrical Machinery and Drive systems", IEEE Press, Second Edition.
3 Fitzerald & Kingsley, "Electrical Machinery". McGraw Hill
4. C. V. Jones, Unified Theory of Electrical Machines, Butterworths, 1967.

Reference Books:

1. P.S.Bimbhra, "Generalized Theory of Electrical Machines" Khanna publications, 5th edition-1995
2. Chee Mun Ong, "Dynamic simulation of Electric machinery using MATLAB / Simulink" Prentice Hall.
3 B P Adkins, "The General theory of electrical machines", Pergamon press London

MPE 2.6 POWER ENGINEERING LAB-II

a) Design and Hardware Implementation (Any two)

- Static var compensator
- DC motor drive
- AC motor drive

Speed control of DC motor using three phase fully controlled converter

b) Design and Simulation (Any two)

Variable frequency or Vector control of induction motor
Chopper controlled dc motor drive
Condition monitoring of three-phase induction motor under fault conditions.
Simulation of Four quadrant operation of three-phase induction motor.
Design of switched mode power supplies

Modeling and simulation using PSCAD/ EMTDC :DC motor drive.
Operation of DC motor with armature fed by single and three phase AC-DC converters.

c) Experimentation (Any Four)

V/f control of three phase induction motor
Operation of three phase induction motor on current source inverter
Variable speed constant frequency power operation

- Static Kramer drive
- PLC Controlled Drives

Three phase induction motor drive. Operation of three phase induction motor fed by three phase frequency controlled inverters.
Three phase synchronous motor drive
Three phase half wave cyclo converter

Measurement of audible corona inception voltage and development of glow discharge using corona cage.
Breakdown of air gap under uniform and non-uniform field.
Measurement of Electric Strength of composite insulation materials.

d) DSP Controlled Applications (Any two)

- Closed loop control of DC-DC converter
- Speed control of BLDC / PMSM motor

DSP based speed control of BLDC motor.
Self control operation of Synchronous motors.
Three phase induction motor drive. Operation of three phase induction motor fed by three phase frequency controlled inverters, three phase synchronous motor drive
Modeling of HVDC system in PSCAD

SEMISTER III

MPE 3.1 POWER ELECTRONICS INTERFACES FOR RENEWABLE ENERGY SYSTEMS

Design of Power Electronics Interfaces for Solar PV: Solar PV technologies, MPPT (maximum power point tracking) Design of DC-DC converters for MPPT, MPPT algorithms, Implementation of MPPT control through DSP controllers.
Topologies for grid connected and standalone applications: single phase and three phase systems, Single stage and multistage, isolated and non- isolated. Design of multi stage solar PV grid connected and standalone systems. Low and high power Applications, Control implementation through DSP, Protection system design

Design of Power Electronics Interfaces for WES: Topologies of WES, design considerations for WES with rectifier /inverter system, Power Converters for Doubly Fed Induction Generators (DFIG) in Wind Turbines, Matrix converter topology forgrid connected system.

Design of Power Electronics Interfaces for Fuel Cells: Types of fuel cells, Proton Exchange Membrane (PEM) fuel cell: features and operational characteristics, Design of DC-DC convertersfor PEM fuel cell, MPPT in Fuel Cell, Design considerations for multi-stage converter / inverter system for grid connected operations, Design considerations for protection system.

Hybrid Renewable Energy Systems: Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PVMaximum Power Point Tracking (MPPT).

Reference Books

1. Remus Teodoorescue, Marco Lisserue, Pedro Rodriguez, "Grid Converters for photovoltaic and wind power systems", Wiley IEEE Press
2. Quing Chang Zhong, Thomas Hornik, "Control of Power Inverters in Renewable energy and smart grid integration", Wiley IEEE Press
3. E. Acha, Miller & Others, "Power Electronic Control in Electrical Systems", (Newnes, Oxford publication) – first Edition

MPE 3.2.1 HIGH-VOLTAGE TESTING AND MEASUREMENTS

Specification for High Voltage tests, Dielectric stress, Voltage stress, Insulation coordination, breakdown test of insulating oil, Transformer test with alternating voltage and impulse voltage. Insulation characteristics, types of insulation, types of stress used in high voltage testing. Laboratory test procedures. Testing with power frequency voltage. Partial discharge measurements, the basic PD test circuit, PD currents, PD measuring systems within the PD test circuit.

Reference Books:

1 Dieter Kind , "High Voltage measurement & Testing", John Wiley & Sons
2 Kuffel & Zaengel , "High Voltage Engineering" , Elsevier publications

PE 3.2.2 FINITE ELEMENT METHODS AND APPLICATIONS

Introduction: Basic Concepts of FEM - Variational Formulation of B.V.P - Ritz Method - Finite Element Modeling - Element Equations - Linear and Quadratic Shape functions -

Finite Element Analysis of 2d Problems: Basic Boundary Value Problems in 2 Dimensions - Triangular, quadrilateral, higher order elements -Poisson's and Laplace Equations - Weak Formulation - Elements Matrices and Vectors

ISO Parametric Formulation: Natural Co-ordinate System - Lagrangian Interpolation Polynomials - Iso-parametric Elements -Formulation - Numerical Integration - 1D -2D Triangular elements - rectangular elements

Applications: Introduction, magnetic circuits, reviews of electromagnetic theory, application of finite element method to magnetic circuit design. CAD tools - SPEED™, MAXWELL™ and applications to magnetic circuit design.

Text Books

1 Reddy J.N. "An Introduction to the Finite Element Method", Mc Graw Hill, International Edition,1993.
2 Nicola Biyanchi, "Electrical Machine analysis using Finite Elements", Taylor andFrancis Group, CRC Publishers, 2005.
3 S.J Salon, "Finite Element Analysis of Electrical Machines." Kluwer Academic Publishers, London, 1995, distributed by TBH Publishers & Distributors, Chennai, India

Reference books

1 Segerlind L. J., "Applied Finite Element Analysis ", John Wiley, 1984.
2 Rao S.S., "Finite Element Method in Engineering " , Pergamon Press, 1989.
3 Chandrupatla & Belagundu, "Finite Elements in Engineering ", Prentice Hall of India Private Ltd.,1997.
1. Chary, "Finite Elements and Applications to Electromagnetics", John Wiley and Sons.

MPE 3.2.3 ARTIFICIAL INTELLIGENCE AND ITS APPLICATION TO POWER

Fuzzy Logic: Introduction to Neuro, Fuzzy and soft Computing, Fuzzy Sets, Basic Definition and Terminology, Set theoretic Operations, Member Function Formulation and parameterization, Fuzzy Rules and Fuzzy Reasoning, Extension principle and Fuzzy Relations, Fuzzy If-Then Rules, Fuzzy Reasoning, Fuzzy Inference Systems, Mamdani Fuzzy Models, Sugeno Fuzzy Models.

Neural Networks: Introduction, Supervised Learning Neural Networks, Perceptrons, Adaline, Back propagation Multilayer perceptrons, Radial Basis Function Networks, Unsupervised Learning and Other Neural Networks, Competitive Learning Networks, Kohonen Self Organizing Networks, Learning Vector Quantization, Hebbian Learning.

Neuro Fuzzy Modelling: Adaptive Neuro-Fuzzy Inference Systems, Architecture, Hybrid Learning Algorithm, learning Methods.

Evolutionary computing: Genetic algorithm: Basic concept , encoding , fitness function, Reproduction,Basic genetic programming concepts, differences between GA and Traditional optimization methods, Applications, Variants of GA. Simulated Annealing, Particle Swarm optimization

Applications: Fuzzy logic based controller for Electric Drive, ANN-based Speed Estimation, Flux &Torque Estimation in Induction Motor Drives Application of ANN and Fuzzy logic in Power System – Reliability,load forecasting, Load Dispatch.

Text Books:

1. Sivandudam and Deepapublisher, "Principles of soft computing" John mikey India.
2. J. S. R. Jang, C. T. Sun and E. Mizutani, "Neuro -Fuzzy and Soft Computing", PHI.
3. B. Yegnanarayana, "Artificial Neural Network", PHI
4. Jacek M. Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House
6. H. J. Zimmermann, "Fuzzy set Theory & its Applications", Allied Publishers Ltd.
7. D. Prianleav, "Fuzzy control", Narosa Publication.
8. Davis E. Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning" Addison, Wesley.

Reference Books:

1 Shaykins- Neural Networks: A comprehensive foundation
2 S.Rajasekharan and G.A.V.Pai,"Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2003

MPE 3.2.4 SMART GRID

Introduction to Smart Grid: Evolution of Electric Grid, Concept of Smart Grid, Definitions, Need of Smart Grid, Functions of Smart Grid, Opportunities & Barriers of Smart Grid, Difference between conventional & smart grid, Concept of Resilient & Self Healing Grid, Present development & International policies in Smart Grid. Case study of Smart Grid. CDM opportunities in Smart Grid

Smart Grid Technologies: Part 1: Introduction to Smart Meters, Real Time Prizing, Smart Appliances,Automatic Meter Reading(AMR), Outage Management System(OMS),Plug in Hybrid Electric Vehicles(PHEV), Vehicle to Grid, Smart Sensors, Home & Building Automation, Phase Shifting Transformers

Smart Grid Technologies: Part 2: Smart Substations, Substation Automation, Feeder Automation. Geographic Information System (GIS), Intelligent Electronic Devices (IED) & their application for monitoring & protection, Smartstorage like Battery, SMES, Pumped Hydro, Compressed Air Energy
Storage, Wide Area Measurement System(WAMS), Phase Measurement Unit(PMU).

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

Information and Communication Technology for Smart Grid: Advanced Metering Infrastructure (AMI), Home Area Network (HAN),Neighborhood Area Network (NAN), Wide Area Network (WAN).Bluetooth, ZigBee, GPS, Wi-Fi, Wi-Max based communication, Wireless Mesh Network, Basics of CLOUD Computing & Cyber Security for Smart Grid. Broadband over Power line (BPL). IP based protocols

Reference Books:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai "Integration of Green and Renewable Energy in Electric Power Systems", Wiley
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press
3. Ali Keyhani, "Design of smart power grid renewable energy systems", June 2011, Wiley IEEE press
4. Janaka Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama, "Smart Grid: Technology and Applications", Wiley
5. Jamesc Momoh "Smart grid: Fundamentals of design and analysis'', Wiley IEEE press 2012

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