2nd Semester

PS – 551 MODERN TRENDS IN POWER SYSTEM OPERATION

Unit 1

Introduction – Custom Power Solutions – Dynamic Voltage Restorer(DVR)- Super conducting Magnetic Energy Storage(SMES)system – Flywheel Energy Storage System(FES) – Automatic VAR Compensator(AVC) – Distribution Static Var Compensator(DSVC) – Distribution Static Compensator(DSTATCOM) – Application and analysis of Passive filter, Active filter and Hybrid filter

Unit 2

Introduction – Deregulation of Electric Utilities – Energy Generation under new environment – Competitive whole sale electricity market – Transmission expansion in new environment – Transmission Open Access – Pricing Electricity in Deregulated environment

Unit 3

Advances in online control of Power System – Application of Internet and GPS in power system control

Unit 4

Distribution automation: Distribution automation – Definitions – Project Planning – Communication, Sensors, Supervisory Control and Data Acquisition (SCADA), Consumer Information systems (CIS), Geographical Information Systems (GIS)

Unit 5

Application of Artificial Neural Networks, Fuzzy, Neuro-fuzzy, Genetic Algorithms and Experts systems in Power System Control

References:

1. 'Power System Restructuring and Deregulation: Trading Performance and Information Technology' - Loi Lei Lai, John Wiley, 2001
2. 'Custom Power'-N G Hingorani, IEEE Spectrum, June 1995
3. 'Proceedings of IEEE' February 2000
4. 'Power System Economics'- Steven Stoft, IEEE Press, 2002

PS 552 ADVANCED CONTROL SYSTEM

Unit 1

The Design Problem, Preliminary design considerations. Basic comparators, cascade compensation in time domain and frequency domain, feedback compensation, Different types of controllers.

Unit 2

State variables, state space representation, Transfer matrix, state model for linear continuous time systems. Eigen values, eigen vectors, Diagonalization, Solution of state equation, concept of controllability and observability. Pole placement by state feedback.

Unit 3

Introduction to discrete time systems , Time domain, representation & transformation analysis of discrete time systems, time domain approach and z domain approach. Pulse transfer function, Controllability and observability of discrete time systems stability analysis in z plane.

Unit 4

Introduction, characteristics limit cycles, singular points, Basic non linear components phase plane methods, Describing functions, Definition, D.F. for basic non linearities, Absolute stability, circle and popov criterion, Liapunov functions.

Unit 5

Linear optimal regulator problem, finite time horizon, Principle of optimality, Hamilton Jacobi equation, Riceati differential equation, steady state solutions (LQR), Algebraic Riceati equation, properties, gain and phase margin, sensitivity, non linearities, optimal state estimation, Kalman filter, Output feedback control (LQG).

Reference Books:

1. Digital Control Engineering - M.Gopal
2. Adaptive and Optimal Control - A.P.Sage & Landue
3. Optimal Control - A.P.Sage
4. Discrete Time Control System - Katsuniko Ogata
5. Modern Control Engineering – Nagarth Gopal

PS- 553 POWER SYSTEM STABILITY AND CONTROL

1. Power System Structure: Operating states, control problem, control loops. Hydraulic and steam turbine, Effect of exciter and governor. Excitation system – requirements, functions, types and modeling of excitation systems.

2. Control of Power and Frequency: Power, Frequency characteristics, control of voltage, frequency and tie-line power flows, Automatic Generation Control, Division of load, Area control, Computer control of load and frequency, under-frequency load shedding.

3. Control of voltage and Reactive Power: Relation between voltage, power and reactive power, Generation and absorption of reactive power, voltage control, and voltage stability analysis.

4. Stability: Concepts, steady state and transient stability, swing equation for single and multi machine system, small signal stability, excitation system, Dynamic and transient stability analysis of single machine and multi-machine systems, power system stabilizer design and analysis for stability problem.

5. Transient Stability: Solution of swing equations, swing curves, stability criterion, Techniques for the improvement of stability, operation under abnormal and distressed condition.

Reference Books :

1. Prabha Kundur, "Power system stability and control", Mc-Graw Hill Inc, New York, 1993.
2. Taylor C.W., "Power System Voltage Stability", Mc-Graw Hill Inc, New York, 1993.
3. Nagrath IJ, Kothari D.P., "Power System Engineering", Tata Mc-Graw Hills, New Delhi 1994.
4. Weedy B.M. "Electric Power System" John Wiley and Sons, 3rd edition.
5. Elgerd O.I., "Electric Energy Systems Theory", TMH, New Delhi, Second Edition 1983.
6. P.S.R. Murthy, "Power System Operation and Control", Tata Mc-Graw Hill, New Delhi 1984.

PS-554 : POWER SYSTEM PLANNING AND MANAGEMENT

1. Introduction of power planning, National and Regional Planning, structure of P.S., planning tools, Electricity Regulation, Electrical Forecasting, forecasting techniques modeling.
2. Generation planning, Integrated power generation cogeneration/captive power, Power pooling and power trading. Transmission and distribution planning. Power system Economics. Power sector finance, financial planning, private participation Rural Electrification investment, concept of Rational tariffs.
3. Power supply Reliablity, Reliability planning. System operation planning, load management, load prediction, reactive power balance, online power flow studies, state estimation, computerized management, power system simulator.
4. Computer aided planning, wheeling.
   Environmental effects, the green house effect, Technological impacts. Insulation coordination. Reactive compensation.
5. Optimal power system expansion planning : Formulation of least cost optimization problem incorporating the capital, operating and maintenance cost of candidate plants of different types (Thermal, Hydro, Nuclear, Non-conventional etc.) and minimum assured reliability constraint – optimization techniques for solution by programming.

Reference Books :

1. Electrical Power System Planning by A.S.Pabla – Machmillan India Ltd.

ELECTIVE II(i)
PS 561 ADVANCE POWER ELECTRONICS

DC-DC Switch Mode converter- Control of DC - DC Converter. BUCK, BOOST, BUCK-BOOST Converters etc.

P.W.M. Converter- PWM Techniques, Current controlled techniques, High Power Factor Converters.

Resonant Converters - Classification, Concepts, Load-Resonant Converters, Resonance-Switch Converters, Zero voltage Switching.

Power Supplies - Linear Power Supplies, Overview of Switching DC Power Supply, Control and Protection of SMPS.

Switching Mode Inverters - Basic concept, 1-Φ, 3-Φ Inverters Switching, Schemes and applications.

References:

1. Power Electronics – Ned Mohan
2. Power Electronics – M. H. Rashid
3. Power Electronics – M. D. Singh
4. Power Electronics – Joseph Vithythal

5. Power Electronics – Philip Kranes
6. Power Electronics – G. K. Dubey

ELECTIVE-II(ii)
PS- 562 POWER SYSTEM TRANSIENTS

1. Origin and nature of transients and surges. Equivalent circuit representations. Lumped and distributed circuit transients. Line energisation and de-energisation transients. Earth and earthwire effects.
2. Current chopping in circuit breakers. Short line fault condition and its relation to circuit breaker duty. Trapped charge effects. Effect of source and source representation in short line fault studies. Control of transients.
3. Lightning phenomena. Influence of tower footing resistance and earth resistance. Traveling waves in distributed parameter multi-conductor lines, parameters as a function of frequency.
4. Simulation of surge diverters in transient analysis. Influence of pole opening and pole closing. Fourier integral and Z transform methods in power system transients. Bergeron methods of analysis and use of EMTP and EMTDC/PSCAD package.
5. Insulation Coordination : overvoltage limiting devices, dielectric properties, breakdown of gaseous insulation, tracking and erosion of insulation, high current arcs.

Reference Books :
1. Power System Transients by Vanikov
2. Power System Transients by C. S. Indulkar and D.P. Kothari
3. Power Circuit breaker theory and design by Flurscheim C.H.
4. EMTP Rulebook
5. EMTDC/PSCAD Rulebook

ELECTIVE II(iii)
PS- 563 REACTIVE POWER CONTROL AND FACTS

Introduction to FACTS- Basic Types of FACTS controllers, Description and definition of FACTS controllers – Benefits from FACTS technology- Static Var Compensator(SVC): Principle of operation, configuration and control, Thyristor Controlled Series compensator(TCSC): Principle of operation, configuration and control, Application of TCSC for damping electromechanical Oscillations, Application of TCSC for mitigation of SSR – Static Compensator(STATCOM): Principle of operation, configuration and control – Static Synchronous Series Compensator(SSSC): Principle of operation, configuration and control, Thyristor Controlled Phase Angle Regulator(TCPAR): Principle of operation, configuration and control, Unified Power Flow Controller(UPFC): Principle of operation, configuration and control, Simulation of UPFC, Steady state model of UPFC, Interline Power Flow Controller(IPFC) - Principle of operation, configuration and control.

Oscillation Stability Analysis and Control: Introduction – Linearised model of power systems installed with FACTS based Stabilisers – Heffron-Phillips model of a SMIB system installed with SVC, TCSC and TCPS – Heffron-Phillips model of a SMIB system with UPFC – Heffron-Phillips model of a Multimachine system installed with SVC, TCSC and TCPS

Analysis and Design of FACTS based stabilisers: Analysis of damping torque contribution by FACTS based stabilisers installed in SMIB systems, Design of robust FACTS based stabilisers installed in SMIB systems by phase compensation method - Selection of installing locations and feed back signal for FACTS based stabilizers

Transient Stability control with FACTS: Introduction – Analysis of Power systems installed with FACTS devices: Power transmission control using Controllable Series Compensation(CSC), Power Transmission Control using SSSC, Power Transmission Control using UPFC, Power Transmission Control using Phase Shifting Transformer(PST), Power Transmission Control using UPFC, Control of FACTS devices for transient stability improvement – General considerations of FACTS control strategy: CSC,SSSC, SVC, STATCOM and UPFC control strategy – General Structure of the FACTS devices control.

References:

1. '*Reactive Power Control in Power Systems*'
   - T J E Miller
   - John Wiley, 1982
2. '*Computer modeling of Electrical Power Systems*'
   - J Arriliga and N R Watson
   - Wiley, 2001
3. '*Understanding FACTS*'
   - N G Hingorani and L Gyugyi
   - IEEE Press, 2000
4. '*Flexible ac Transmission Systems(FACTS)*'
   - Y.H. Song and A.T. Johns
   - IEE Press, 1999

PS -591

COMPUTER APPLICATION IN POWER SYSTEM LABORATORY

1. Simulation of Magnetic Circuits and their Analysis
2. Simulation and Measurements of Single Phase and Three Phase Circuits.
3. Artificial Neural Network Based Load Forecasting
4. Artificial Neural Network Based Price Forecasting
5. Simulating Power Electronic Systems with Simulink
6. Power system simulation by MATLAB using the Power System Blockset
7. Energy conservation in industrial and residential areas through voltage regulation.