

**SYLLABUS PRESCRIBED FOR
MASTER OF ENGINEERING (PART TIME) & (FULL TIME)
ELECTRICAL ENGINEERING
(ELECTRICAL POWER SYSTEM) EXAMINATION
SEMESTER : FIRST**

1 SEPS 1

POWER SYSTEM OPTIMIZATION

SECTION-A

- 1) Introduction to optimization and classical optimization techniques
- 2) Linear Programming : Standard form, geometry of LPP, Simplex Method of solving LPP, revised simplex method, duality, decomposition principle, and transportation problem.
- 3) Non-Linear Problem (NLP) : One dimensional methods, Elimination methods, Interpolation methods
- 4) Non-Linear Programming(NLP): Unconstrained optimization techniques-Direct search and Descent methods, constrained optimization techniques, direct and indirect methods

SECTION-B

- 5) Dynamic Programming: Multistage decision processes, concept of sub-optimization and principle of optimality, conversion of final value problem into an initial value problem.
- 6) CPM and PERT
- 7) Genetic Algorithm: Introduction to genetic Algorithm, working principle, coding of variables, fitness function. GA operators; Similarities and differences between GA and traditional methods; Unconstrained and constrained optimization using Genetic Algorithm, real coded GA, Advanced GA, global optimization using GA.
- 8) Applications to Power system: Economic Load Dispatch in thermal and Hydro-thermal system using GA and classical optimization techniques, Unit commitment problem, reactive power optimization. optimal power flow, LPP and NLP techniques to Optimal flow problems.

References:

1. "Optimization - Theory and Applications", S.S.Rao, Wiley-Eastern Limited
2. "Introduction of Linear and Non-Linear Programming ", David G. Luenberger, Wesley Publishing Company
3. "Computational methods in Optimization ", Polak, Academic Press
4. "Optimization Theory with Applications" Pierre D.A., Wiley Publications
5. "Optimization for Engineering Design: Algorithms and Examples", Kalyanmoy deb, PHI Publication
6. "Genetic Algorithm in Search Optimization and Machine Learning ", D.E. Goldberg, Addison-Wesley Publication, 1989
7. "Advanced Power System Analysis and Dynamics " L.P. Singh, Wiley Eastern Limited.
8. "Power System Analysis ", Hadi Saadat, TMH Publication.
9. " Electrical Energy System : An Introduction ". Olle I.Elewgerd, TMH Publication, New Delhi.

1 SEPS 2

GENERATION PLANNING AND LOAD DISPATCH

SECTION - A

Generation- Fossil fuels, Hydropower and Nuclear power generation systems. Chronological Load Curves, Power duration curve, Integrated duration curve, Hydrography, Flow duration curve, Mass curve for Hydro Power generations. Co-ordination of steam, Hydro and Nuclear power stations. Optimum Generation allocation-Line losses neglected and including the effect of transmission losses for thermal power generations. Long range and short range Hydro generation scheduling. The short term and long term Hydro-thermal scheduling of generation.

Load Forecasting & Generation Planning - Classification of loads -Load forecasting methodology-Energy forecasting-peak demand forecasting-Weather sensitive and Non-weather sensitive forecasting - Total forecast - Annual and Monthly peak demand forecast.

SECTION-B

Generation system cost analysis:

Cost analysis -capacity cost, production cost. Production analysis-production costing, production analysis involving nuclear unit, production analysis involving hydro unit. Fuel inventories-energy transaction and off-peak energy utilization.

Generation System Reliability Analysis – probabilistic generating Unit-Model and Load model, effective load- Reliability analysis for isolated system-Interconnected system- Reliability analysis of interconnected system.

Load dispatch & System Communication – Consideration for centralized control of system operations. Requirements of the central load dispatch centre.

Telemetry-Remote control and data transmission, etc. Power system reforms, deregulation of electric utilities, energy management & conservation.

REFERENCES :

- 1) Power System Planning - R.L. Sullivan, McGraw Hill.
- 2) Economic Control of Interconnected System -Kirchmayers, L.K.,John Wiley and Sons, New York.
- 3) Generation of Electrical Energy - B.R. Gupta, Euresia Publishing House Pvt., Ltd., New Delhi.
- 4) Power System Restructing and Deregulation - by Loi Lei Lai
- 5) Restructed Electrical Power Systems - by Mohammad Shahidehopur, Muwaffaq Alomoush.
- 6) Privatization, Restructing, and Regulation of Network Utilities (Walras-Pareto Lectures) : by David M. Newbery.
- 7) Power to the People : Electric Power Deregulation : An Expose : Jack Duckworth
- 8) Understanding Electric Utilities and De-Regulation, Power Engineering : Lorrin Philipson, et al
- 9) Power Generation, Opearion and Control : A.J. Wood and B.F. Wollenberg:, John Wiley 1996
- 10) Understanding Electric Utilities and De-Regulation (Power Engineering) : by Lorrin Philipson, H. Lee Willis, Lorrion Philipson
- 11) The End of a Natural Monopoly : Deregulation and Competition in the Electric Power Industry : by P.Z.Grossman, D.H. Cole, P.Z. Grossman, D.H. Cole

1SEPS 3 MICROPROCESSOR AND MICROCONTROLLER

SECTION – A

Overview of Intel 8085 microprocessor. 8086 : Architecture, instruction including I/O instructions, bus timing diagram, interrupt structure, ISR minimum and maximum mode, Assembly Language Programming. Hardware and Software debugging aids: 1 Pass and 2 Pass assemblers, cross assemblers, circuit emulators, simulators, linkers, loaders, compiler, cross compiler, logic analyzers.

Types of interfacing devices

SECTION B

8051 Architecture : 8051 Microcontroller Hardware, Input/Output. Pins, ports, and circuits, External Memory, Counter and Timers, Serial Data input/output, Interrupts

Assembly language programming concepts : The mechanics of programming, The assembly language programming process, PAL instructions, Programming tools and techniques, Programming the 8051

Moving Data : Addressing modes, external data moves, code memory read only data moves, push and pop -op codes, data exchanges

Logical Operations : Byte level logical operations, bit level logical operations, rotate and swap operations

Arithmetic Opearions : Flags, incrementing and decrementing, addition, subtraction, multiplication and division, decimal arithmetic

Jumps and Call Instructions : The jump and call program range, jumps, calls and subroutines, interrupts and returns

8051 Microcontroller Design : Microcontroller specification, microcontroller design, testing the design, timing subroutines, look up tables for the 8051, serial data transmission

Applications : Keyboard, displays, pulse measurement, D/A and A/D conversion, multiple interrupts

Serial Data Communication : Network Configuration, 8051 Data Communication.

Digital filters - structures, sampling, recursive, non-recursive A to D & D to A conversion. FIR, IIR & lattice filter structures, Design of FIR digital filters. Window method, Park-McCellan's method. Design of IIR digital filters. Butterworth, Chebyshev.

SECTION-B

Elliptic approximations, low-pass, band-pass, band-stop & high-pass filters. Effect of finite register length in FIR filter design. Multirate signal processing-motivation-application, decimation & interpolation, sample rate conversion, polyphase implementation of sampling rate conversion, Filter bank theory-DFT filter banks, Adaptive filtering theory. DSP Processors and Applications - DSP Microprocessor architectures, fixed point, floating point precision, algorithm design, mathematical, structural and numerical constraints, DSP programming, filtering, data conversion; communication applications. Real time processing considerations including interrupts.

Reference Books :

1. J.G.Proakis and D.G.Manolakis 'Digital Signal Processing Principles, Algorithm and Applications' Prentice Hall 1997
2. A.V.Oppenheim, R.W.Schafer, 'Discrete Time Signal Processing' John Wiley.
3. J.R. Johnson, ' Introduction to Digital Signal Processing Prentice Hall 1992
4. D.J.Defatta, J.G.Dulas. Hodgekiss, 'Digital Signal Processing' J. Wiley and Sons Singapore, 1988
5. L.R.Rabiner & B. Gold - 'Theory & Applications of Digital Signal Processing', Prentice Hall, 1992

1 SEPS 6 POWER SYSTEM LAB.-I

Identify and perform minimum 16 (sixteen) experiments based on syllabus of subjects form Semester-I

THIRD SEMESTER/ SECOND SEMESTER (FULL TIME)

2SEPS1

ADVANCED POWER SYSTEM PROTECTION

SECTION-A

Review of principles of power system equipments protection, configuration of various solid state protection scheme, evaluation of digital relays from electromechanical relays, performance & operational characteristics of digital protection, Basic elements of digital filtering, analog multiplexers, conversions of system: the sampling theorem, signal aliasing error, sample & hold circuit, multiplexers, analog to digital conversion, digital filtering concepts, A digital relay. Hardware & Software.

SECTION – B

Mathematical background to protection algorithm, first derivative (Mann & Morrison) algorithm, Fourier algorithm- full cycle window algorithm, fractional cycle window algorithm, Walsh function based algorithm, least square based algorithm, differential equation based algorithm, travelling wave based technique. Digital differential protection of transformer, digital line differential protection, recent advances in digital protection of power system.

Books Recommended :

- 1) Digital Protection for Power System : A.T.Johns and S.K.Salman, Peter, Published by Peter Peregrinus Ltd. on behalf of the IEE, London, U.K.
- 2) Power System Protection and Switchgear : Badri Ram and D.N.Vishvakarma, Tata McGraw Hill, New Delhi.
- 3) Transmission Network Protection : Theory and Practice, Y.G.Paithankar, Marcel Dekker, New York, U.S.A.
- 4) Fundamentals of Power System Protection : Y.G.Paithankar and S.R. Bhide, Prentice Hall of India, New Delhi.

2 SEPS 2

HIGH VOLTAGE TRANSMISSION

SECTION-A

Introduction of EHV-AC transmission, Tower configuration, Thermal ratings of lines & cables, circuit breakers, insulators for A.C. transmission, Voltage gradients of conductors, Corona effects, power loss & audible noise, radio interferences, electrostatic field of transmission lines, Insulation characteristics of long air gaps. Design of EHV lines based upon steady state limits, transient overvoltages & voltage stability, series shunt compensation, active & reactive power flow control, basics of static VAR compensators

SECTION-B

H.V.D.C. Transmission:

General aspects of comparison between HVDC & HVDC transmission schemes and terminal station layout. Operation of converters as rectifier and as an inverter. Equivalent circuit and operating chart of converter. Control of the converters (ccc & cca) Harmonics and its control, faults protection of line and terminal equipment.

Parallel operation of HVDC and AC, Multiterminal HVDC Systems

REFERENCE BOOKS :

1. Weedy, B.M. : Electric Power Systems, John Wiley & Sons.
2. EHV Transmission Line Reference Book : Edison Electric Inst.
3. Adamson, C & Hingorani N.G. . HVDC Power Transmission, Garraway Publications.
4. Kimbark, E.W. : Direct Current Transmission, Vol.I, John Wiley & Sons.
5. Uhlman, E. : Transmission by D.C.
6. Rakosh Das Beganudre : Extra High Voltage AC Transmission Engineering.

2 SEPS 3

POWER SYSTEM MODELLING & CONTROL

SECTION-A

Transient response and concept of stability in Electrical Power System. Modelling of Power System. Control of voltage, frequency and tie-line power flows, Q-v and P-f control loops, mechanism of real and reactive power control. Mathematical model of speed governing system. Turbine governor contrast as affecting the power system dynamics. Transient and steady state response in the interconnected power systems. (multimedia systems). Excitation systems. Transformation model of exciter system. Analysis using block diagrams. Power systems stabilizers. Dynamic stability (small disturbances), effect of excitation control and turbine dynamics, characteristic equation, method of analysis of the stability of power system. Multi machine systems, Flux decay effects. Multi machine systems with constant impedance loads, matrix representation of a passive network in the transient state, converting to a common reference frame. Converting machine co-ordinates to system reference, relation between machine current and voltages, system order, machine represented by classical methods, multi machines systems study.

SECTION-B

Net interchange tie-line bias control. Optimal, sub-optimal and decentralised controllers. Discrete mode AGC. Time - error and inadvertent interchange correction techniques. On-line computer control. Distributed digital control. Data acquisition systems. Emergency control, preventive control, system, system wide optimization, SCADA.

Self excited electro-mechanical oscillations in power system and the means for control.

REFERENCES :-

- 1) V.Venkov : Transient Processes in Electrical Power System, Mir Publication, Moscow.
- 2) Olle I.Elgard : Electric Energy Systems Theory, Tata McGraw Hill Pub. Co., New Delhi.
- 3) Anderson P.M. & Foad A.A. : Power System Control and Stability, Galgotia Pub.
- 4) Nagrath I.J., Kothari D.P. : Modern Power System Analysis, Tata McGraw Hill Pub. Co., New Delhi.

2SEPS 4

FOURTH SEMESTER COMPUTER METHODS IN POWER SYSTEM ANALYSIS

SECTION - A

1. Representation of power systems for computerised analysis: Mathematical models of synchronous generator for steady state and transient analysis, Transformer with tap changer, transmission line, phase shifter and loads.
2. Topology of Electric Power System-Network Graphs, Incidence matrices, fundamental loop and cutset matrices, primitive impedance and admittance matrices, equilibrium equations of networks. Singular and nonsingular transformation of network matrices.
3. Formation of bus impedance and admittance matrices by algorithm - Modification of bus impedance and admittance matrix to account for change in networks. Derivation of loop impedance matrix. Three phase network elements-transformation matrix -incidence and network matrices for three phase network. Algorithm for formulation of 3 - phase bus impedance matrix.

SECTION-B

4. Short Circuit Studies : Three phase network, Symmetrical components. Thevenin's theorem and short circuit analysis of multi node power systems using bus impedance matrix. Short circuit calculations for balanced and unbalanced short circuits bus impedance and look impedance matrices.
5. Load flow studies : Slick bus, loop buses, voltage control buses, Load flow equations, Power flow model using bus admittance matrix, Power flow solution through Gauss-Seidal and N-R methods - sensitivity analysis, Second order N-R method, fast decoupled load flow method - Sparsity of matrix. Multi area power flow analysis with the line control.
6. Stability studies of Power System - Development of mathematical model for multi machine system stability analysis-Formation of equations and method of solution. Transient stability analysis including synchronous machines, system network and loads. Solution of state equation by modified Euler method and solution of network equations by Gauss-Seidal interactive method.

REFERNCE BOOKS :

- 1) Computer Methods in Power System Analysis : G.W.Stage A.H.Elabiad, McGraw Hill Book Co.
- 2) Computer Techniques in Power System Analysis : M.A. Pai, Tata McGraw Hill Publication.
- 3) Electric Energy System Theory : O.I.Elgard, Tata McGraw Hill Publication.
- 4) Computer Aided Power System Operation and Analysis: R.N.Dhar, Tata McGraw Hill Publication.
- 5) Modern Power System Analysis : I.J.Nagrath, D.E.Kothar, Tata McGraw Hill, New Delhi.

2SEPS 5

FACTS AND POWER QUALITY SECTION-A

Steady state and dynamic problems in AC systems, Flexible AC transmission systems (FACTS), principles of series shunt compensation, description of static var compensation (SAC), thyristor controlled series compensation (TCSC) static phase shifters (SPS), static condenser (STATCON), static synchronous series compensator (SSSC) and unified power flow controller (UPFC), modelling and analysis of FACTS controllers, control strategies to improve system stability.

SECTION-B

Power quality problems in distribution systems, Harmonics, Harmonics creating loads, modelling, harmonic propagation, series and parallel resonance, harmonic power flow, mitigation of harmonics, filters, passive filters, active filters, shunt and series hybrid filters, voltage sag and swells, voltage flicker, mitigation of power quality problems using power electronics conditioners, IEEE standards.

Books Recommended :

- 1) G.T.Heydt : Power Quality, Stars in a Circle Publication, Indiana, 1991.
- 2) E.J.E.Miller : Static Reactive Power Compensation, John Wiley & Sons, New York, 1982.
- 3) Recent Publications on Power Systems and Power Delivery.

2 SEPS 6

POWER SYSTEM LAB.-II

Identify and perform minimum 16 (sixteen) experiments based on syllabus of subjects form Semester-II.

FIFTH SEMESTER/THIRD SEMESTER (FULL TIME)

3 SEPS 1 SEMINAR-I AND DISSERTATION

(As per given scheme)

SIXTH SEMESTER/FOURTH SEMESTER (FULL TIME)

4 SEPS 1 SEMINAR-II AND DISSERTATION

(As per given scheme)
