PSM-15

MASTER OF TECHNOLOGY
IN
Power System

COMMON CURRICULUM & SYLLABU

Concept and layout of Control and Instrumentation in Thermal Power Plant

Pressure Measurement and measuring instruments

Temperature Measurement and measuring Instruments

Flow measurement and measuring instruments

Level measurement and measuring instruments

Introduction to auto control, Auto control loops used in thermal power stations
Turbo supervisory instrumentation (Parameters limits, Basic concepts of measuring devices),
Commissioning of control loops.

Sensors and Transducer used for power plant, Automatic Turbine Run up System (ATRS)

Analytical Instrumentation for Boiler (Water, Steam ,Flue Gas H2 / O2 / CO2).

Introduction to Distributed Digital Control (DDC), Data Acquisition
System (DAS) and Programmable Logic Control (PLC)

Text:

1. A.K. Sawhney : " Electrical & Electronic Measurements and Instrumentation". Dhanpat Rai and Sons,2003.
2. "Modern Power Station Practice" Volume F, British Electricity International Ltd., Central Electricity Generating Board, Pergamon Press, Oxford, 1991
3. "Control & Instrumentation", NPTI Manuals Volumes I,II,III.

Reference:

1. Principle of Industrial Instrumentation by D. Patranabis: TMH.
2. Sensors & Transducers by D. Patranabis: PHI
3. Transducers & Instrumentation by D. V. S Murty: PHI
4. Electronic & Instrumentation by Kalsi: TMH
5. Instrumentation-Devices & Systems by Rangan, Sarma, Mani: TMH
6. Digital Measurement Techniques by Rathor : Narosa.
7. Principle of Measurement & Instrumantation by Morris : PHI
8. Modern instrumentation & Techniques by Heltrick and Cooper : PHI

Electric drive

PSM 104(b)
Contact: 3L+1T
Credits: 04

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81, Nilgunj Road, Agarpara, Kol-109

Review of Conventional Drives: speed –torque relation, Steady state stability, methods of speed control, braking for DC motor – Multi quadrant operation , Speed torque relation of AC motors, Methods of speed control and braking for Induction motor, Synchronous motor . Criteria for selection of motor for drives.

Converter Control of DC Drives: Analysis of series and separately excited DC motor with single phase and three phase converters operating in different modes and configurations.

Chopper Control of DC Drives: Analysis of series and separately excited DC motors fed from different choppers for both time ratio control and current limit control, four quadrant control.

Design of DC Drives: Single quadrant variable speed chopper fed DC drives, Four quadrant variable speed chopper fed DC Drives, Single phase/ three phase converter, Dual converter fed DC Drive, current loop control, Armature current reversal, Field current control, Different controllers and firing circuits, simulation.

Inverter fed AC Drives: : Analysis of different AC motor with single phase and three phase inverters Operations in different modes and configurations., Problems and strategies.

Cyclo-converter fed AC Drives: Analysis of different AC motor with single phase and three phase cycloconverters Operations in different modes and configurations., Problems and strategies, vector Control and Rotor side Control

AC Voltage controller fed AC Drives: Speed Control and braking, Analysis of different AC motor with single phase and three phase ac voltage controllers. Operations in different modes and configurations. Problems and strategies.

Control and estimation o AC drives: Induction motor: Small signal models, scalar control, FOC control, sensor less control, DTC, adaptive control. Synchronous motor: sin SPM, synchronous reluctance machines, sin IPM machines, trapezoidal SPM, wound fitted SM, sensor-less operation, switched reluctance machines, Dynamics and Modeling of AC Drives.

Text:

1. Bimal.K. Bose, "Power Electronics and Variable frequency drives", Standard Publishers Distributors, New Delhi, 2000
2. Murphy J.M.D, Turnbull, F.G, "Thyristor control of AC motor, Pergamon press, Oxford, 1988.
3. M. H. Rashid, "Power Electronics - Circuits, Devices and Applications", P.H.I Private Ltd. New Delhi, Second Edition, 1994
4. N. Mohan et.al. "Power Electronics- Converters, Applications and Design", John Wiley & Sons (Asia) Private Ltd., Singapore, 1996.
5. Bimal K Bose, " Modern Power Electronics and AC Drives" PHI
6. R. Krishnan, "Electric motor drives: modeling, analysis and control, Pearson.

Reference:

1. Dubey G.K. "Power Semiconductor controlled drives", Prentice Hall inc, A division of Simon and Schester England cliffs, New Jersey 1989.
2. Sheperal, Wand Hully, L.N. "Power Electronic and Motor control" Cambridge University Press Cambridge 1987
3. Dewan,S. Slemon B., Straughen,A. G.R., "Power Semiconductor drives", John Wiley and Sons, NewYork 1984.
4. Dubey G.K. "Power Semiconductor controlled drives", Prentice Hall inc, A division of Simon And Schester England cliffs, New Jersey 1989
5. Dewan,S. Slemon B., Straughen,A. G.R., "Power Semiconductor drives", John Wiley and Sons, NewYork 1984
6. Sen. P.C. "Thyristor DC Drives", John Wiley and sons, NewYork, 1981.

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7. Subramanyam, V. "Electric Drives – Concepts and applications", Tata McGraw Hill Publishing Co., Ltd., New Delhi 2003.

Optimization Techniques

PSM 104(c)
Contact: 4L
Credit: 4

Concept of Maxima & Minima, Single Objective & Multi-Objective Optimization Lagnangian Multiplier Method.

Neural Network: Biological Neural Network, Artificial Neural Network, comparison between human brain vs. ANN, Different types of ANN method, Feed Forward techniques, Radial bias system, recurrent method.

Linear Programming : Graphical Method, Simplex Method, Revised Simplex Method.

Introduction to soft coupling techniques : Advantages, Disadvantages, Application, Genetic Algorithm, Particle Swarm Optimization, Differential Evolution

Application of Soft computing: Economic Load Dispatch using Genetic Algorithm, Particle Swarm Optimization, Differential Evolution.

Reference :

1. S.S.Rao, Engineering Optimization, 3rd Edition, New Age International (P) Ltd.
2. Genetic Algorithm – D.E.Goldberg
3. Principle of soft computing by S.N.Sivanandam & S.N. Deepa
4. Soft computing Technique and its application in electrical Engineering by Chaturvedi, Springer publication
5. Optimization on Power system Operation by Jizhong Zhu Wiley-IEEE Press.
6. An Introduction to Optimization, 3rd Edition by K.P. Chong, Stanislaw H. Zak.

Power System Operation & Control

PSM 201
Contact: 4L
Credit: 4

Optimal Generation Scheduling: Thermal System Dispatching with Network Losses Considered, The Lambda-Iteration Method, Gradient Methods of Economic Dispatch - Gradient Search, Newton's Method, Economic Dispatch with

Piecewise Linear Cost Functions, Economic Dispatch Using Dynamic Programming, Base Point and Participation Factors, Economic Dispatch Versus Unit Commitment,
Coordination Equations, Incremental Losses, and Penalty Factors, The ***B*** Matrix Loss Formula Exact Methods of Calculating Penalty Factors, Reference Bus Versus Load Center Penalty Factors Reference-Bus Penalty Factors Direct from the AC Power Flow

Optimal Power flow:
Optimal var control problem, controllable variables- Transformer taps, Generator voltages, Switchable shunt capacitors and Reactors, Objective functions, network performance constraints, constraints on state variables, Mathematical formulation, Solution of the Optimal Power Flow- The Gradient Method, Newton's Method, Linear Sensitivity Analysis, Linear Programming Methods, Sensitivity Coefficients of an **AC** Network Model
Linear Programming Method with Only Real Power Variables, Linear Programming with AC Power Flow Variables and Detailed Cost Functions, Security-Constrained Optimal Power Flow, Interior Point Algorithm, Bus Incremental Costs

Load Frequency Control: control area concept, Block diagram and LFC of an isolated power system, Governor droop characteristic, AGC, primary and secondary frequency control, LFC of inter-connected power systems, Modes of tie line operation-flat frequency, flat tie line, tie line with frequency bias, Area control error, State space representation of two area system

State Estimation:
Types of estimators–static, dynamic, tracking estimators. Least Squares and Weighted Least squares estimation, formulation, solution techniques, Bad data identification and detection.

Security Analysis:

Normal, Alert, emergency, Restoration states in a power system.
Security analysis, Security assessment, Security monitoring and Security controls
Credible and incredible contingencies, Contingency identification and Contingency ranking, Security Calculation procedures

Deregulation: What is deregulation? Background to deregulation and current situation, Benefits of a competitive electricity market,

***References*:**
1. Power generation, operation, and control, Allen J. Wood, Bruce F, Wollenberg

Power System Apparatus

PEM 202
Contact: 4L
Credit: 4

Circuit Breaker: Introduction, Operating Principle, Detail study on VCB and SF6 Circuit breaker, Ratings, Selection.

Surge Arrester & Surge Absorber. Insulation Co-ordination, BIL

FACTS: concepts and general system consideration: Opportunities for FACTS. Basic types of FACTS controllers. Brief description and definition of FACTS controllers.Shunt connected controllers.Series Connected controllers.Combined Shunt and Series connected controllers.

Static Shunt Compensators: Objectives of Shunt Compensations. Midpoints voltage regulation for line segmentation. Improvements of transient stability, Methods of controllable VAR generation. Variable impedance type static VAR generation, TCR and TSR, FC-TCR (Fixed Capacitor, Thyristor Controlled Reactor), Hybrid VAR Generators. Static VAR Compensator (SVC & STATCOM).

Transfer Function and Dynamic Performance. Power Oscillation, Damping. Transient Stability.

Static Series Compensators: GCSC, TSSC, TCSC and SSSC: Basic Operating Control Schemes for GCSC, TSSC and TCSC.

Static Voltage and Phase Angle Regulators: TCVR and TCPAR.

Unified power flow controllers.

Reference:

1. Understanding FACTS by Narain G. Hingorani & Laszlo Gyugyi: IEEE Press.
2. Power System Switchgear & Protection by Sunil S. Rao.

Power System Protection

PEM 203
Contact: 4L
Credit: 4
Introduction: Relay types & Fault detection principles, CT & PT specification, Sequence filters

Non-Pilot over current protection: principles, Time and/or current grading co-ordination, Directional over current relaying

Differential protection: principles, CT requirements

Non-Pilot Distance Protection: stepped distance protection principles, distance relay types & polar characteristics, phase relays and poly phase relays, distance relay performance and SIR, power swing blocking , distance schemes, under reach and over reach, protection of parallel and multi-ended feeders

Pilot-Distance-protection: Communication channels, Tripping and blocking modes, directional comparison blocking and unblocking, under reaching transfer trip, PUR/POR transfer trip, phase comparison.

Single and three pole auto reclosing in HV and EHV transmission systems.

Bus protection: High & moderately high impedance relaying, CT requirements

Unit Protection of Feeder: Feeder differential protection, including pilot wire, current differential and phase comparison schemes

Protection of transformers: including biased and high impedance differential schemes, CT connections, 2 & 3 point differential protection, earthing transformers

Protection of high voltage capacitor banks: including consideration of inrush currents, over current, over voltage, and differential protection schemes

Protection of large motors: including differential and earth fault protection, thermal overload considerations, starting and stalling currents and the effect of negative phase sequence currents

Protection of large generators: including stator & rotor earth fault protection, biased differential, high impedance differential, negative sequence, under frequency, over/under excitation, reverse power and out-of-step protections

References:

1. Power System Relaying, Stanley H. Horowitz, Arun G. Phadke, John Wiley & Sons
2. Protective Relays Application & Guide, GEC measurements
3. Power system protection, PM Anderson, IEEE Press book

High voltage DC transmission

PSM 204(a)
Credit: 4L
Credits: 04

INTRODUCTION: Introduction to AC and DC Transmission – application of DC Transmission – description of DC transmission – DC system components and their functions – modern trends in DC Transmission
CONVERTER: Pulse Number – Converter configuration – analysis of Graetz circuit – converter bridge characteristics – characteristics of 12 Pulse converters
HVDC CONTROLLERS: General principle of DC link control – converter control characteristics – system control hierarchy – firing angle control – current and extinction angle control – Dc link power control – high level controllers
FILTERS: Introduction to harmonics – generation of harmonics – design of AC filters – DC filters – carrier frequency and RI noise
PROTECTION: Basics of protection – DC reactors – voltage and current oscillations – circuit breakers – over voltage protection – switching surges – lightning surges – lightning arresters for DC systems

Text/Reference:

1. Kimbark, "Direct Current Transmission – Vol. I", John Wiley and Sons Inc., New York, 1971
2. Padiyar. K. R., "HVDC Power Transmission Systems", Wiley Eastern Limited, New Delhi, 2000.
3. Arrillaga. J, "High Voltage Direct Current Transmission", Peter Peregrines, London, 1983

Power System Security & State-estimation

PSM 204 (b)
Contact: 4L
Credit: 4

Contingency Analysis: Calculation of week bus in a Power system, Local Search Technique.

Voltage Stability: Basic concept related to voltage stability, transmission system characteristics, generator characteristics, load characteristics. Voltage collapse, dynamic and static analysis.

Power System Security: Introduction, System State Classification, Security Analysis, Contingency Analysis, Sensitivity Factors, Power System Voltage Stability

An Introduction to State Estimation of Power Systems: Introduction ,Least Squares Estimation : The Basic Solution, Static State Estimation of Power Systems, Tracking State Estimation of Power Systems,Some Computational Considerations, External System Equivalence, Treatment of Bad Data, Network observability and Pseudo-Measurements, Application of Power System State Estimation

Reference:

1. Power system Dynamics and Stability by Peter W. Saner & M.A.Pai: Pearson Edition.
2. Modern Power System Analysis: I. J. Nagrath & D. P. Kothari

Power system transients

PSM 205(a)
Contact: 4L
Credit: 4

Simple switching transients: The circuit closing transient, The recovery transients initiated by the removal of a short circuit, Double frequency transient, Resistance switching, Load switching.

Abnormal switching transients: Current suppression, Capacitive switching, other restriking phenomena, Transformer magnetizing in rush current, Ferro resonance.

Static Circuit Breaker: Commutation transient- the current limiting static circuit-breaker.

Traveling Waves on Transmission Lines: Circuit with distributed constant, The wave equation, Reflection and refraction of traveling wave, Behavior of traveling waves at line termination, Multi conductor system and multi velocity waves.

The behavior of windings under transients condition: Initial voltage distribution when a step function voltage surge strikes a uniform transformer winding.

Transients in integrated Power System : The short line or kilometric fault.

Reference:

(1) Electric transients in power systems by Allan Greenwood.

(2) High voltage engineering by M.S.Naidu and V.Kamaraju.

Power System Planning & Reliability

EPM 205(b)
Contact: 4L
Credit" 4

Load Forecasting: Load Forecasting Categories-Long term, Medium term, short term, very short term Applications of Load Forecasting, Factors Affecting Load Patterns
Medium and long term load forecasting methods- end use models, econometric models, statistical model based learning. Short Term Load Forecasting (STLF): Applications of Load Forecasting, methods- similar day approach, regression methods, time series, ANN, Expert systems, Fuzzy logic based method, support vector machines ANN architecture for STLF, Seasonal ANN, Adaptive Weight, Multiple-Day Forecast, STLF Using MATLAB'S ANN Toolbox, Training and Test Data, Stopping Criteria for Training Process, sensitivity analysis

Power System Reliability: Basic Notions of Power System Reliability- sub systems, reliability indices, outage classification, value of reliability tools, Concepts and methodologies, power system structure, Reliability based planning in power systems, Effect of failures on power system, Planning criteria, Risk analysis in power system planning, multi-state systems.
Basic Tools and Techniques- random processes methods & Markov models, Computation of power system reliability measures by using Markov reward models, Evaluation of reliability indices, Universal Generating Function (UGF) Method, Monte Carlo simulation.
Reliability of Generation Systems- capacity outage calculations, reliability indices using the loss of load probability method, unit commitment and operating constraints, optimal reserve management, single and multi-stage expansion,
Reliability Assessment for Elements of Transmission and Transformation Systems- reliability indices of substations based on the overload capability of the transformers,
evaluation and analysis of substation configurations, Reliability analysis of protection systems for high voltage transmission lines,.

References:

1. Markey operations in electric power systems Forecasting, Scheduling, and Risk Management, Shahidehpour M, Yamin H, Li z, John Wlley & sons
2. Reliability evaluation of power systems, Billinton R, Allan R (1996) Plenum Press New York
3. Computational Methods in Power system Reliability, D. Elmakias, Springer-Verlag

Generation of Non conventional Energy

PSM 205(c)
Contact: 3L+1T
Credits: 04

INTRODUCTION TO SOLAR AND WIND ENERGY: Recent trends in energy consumption – World energy scenario – Energy sources and their availability – Conventional and renewable sources – Need to develop new energy technologies – Solar radiation and measurement – Solar cells and their characteristics – Influence of insulation and temperature – PV arrays – Electrical storage with batteries – Solar availability in Indi8a – Switching devices for solar energy conversion – Stand alone inverters – Charge controllers – Water pumping – Audio visual equipments, Street lighting, Analysis of PV systems

POWER CONDITIONING CONVERTERS:DC Power conditioning converters – Maximum Power point tracking algorithms – AC power conditioners – Line commutated inverters – synchronized operation with grid supply – Harmonic problem

WIND ENERGY CONVERSION SYSTEM: Basic principle of wind energy conversion – nature of wind – Wind survey in India – Power in the wind – components of a wind energy conversion system – Performance of Induction Generators for WECS – Classification of WECS

INDUCTION GENERATOR: Self excited Induction Generator for isolated Power Generators – Theory of self e excitation – Capacitance requirements – Power conditioning schemes – Controllable DC Power from SEIGs

OPTIMISATION TECHNIQUE: Wind / Solar PV integrated systems – selection of power conversion ratio – Optimization of system components – Storage

Text/References:

Rai G.D., "Non – Conventional Energy Sources", Khanna Publishers, 1993.
Rai G.D., "Solar Energy Utilisation", Khanna Publishers, 1993.
Daniel, Hunt V, "Wind Power – A Handbook of WECS", Van Nostrend Co., New York, 1981.
Gary L. Johnson, "Wind Energy Systems", Prentice Hall Inc., 1985.
Freris L. L., "Wind Energy Conversion", Prentice Hall (UK) Ltd., 1990

Generalized Theory of Machine

PSM 301 (A)

1) Elements of generalized theory
   - i) Kron's primitive machine.

2) Linear Transformation in Machines
   - i) Transformation from three phase to two phase (a.b.c. to α.β.o)
   - ii) Transformation from Rotating axes (α.β.o) to stationary axes (d.q.o.)
   - iii) Physical concepts of park's transformation.
   - iv) Transformed impedance Matrix

3) D.C.Machines
   - i) Separately excited D.C. generators.
   - ii) Separately excited D.C. Motors
   - iii) Transfer function of D.C. Machines
   - iv) D.C. series Motors
   - v) D.C.Shunt Machines
   - vi) D.C.Compound Machines
   - vii) Linearization Techniques for small perturbations.
   - viii) Cross field Machines

4) Poly phase Synchronous Machines
   - i) Basic Synchronous Machines parameters.
   - ii) General Machine's equations.
   - iii) Three phase Synchronous Machines (with no Amortisseurs)
   - iv) Balance steady – state analysis.
   - v) Steady – state power- angle characteristics.

5) Ploy phase induction Machines
   - i) Transformation.
   - ii) Electrical performance equations.
   - iii) Analysis of the equivalent circuit.
   - iv) Torque – slip characteristics.
   - v) Effect of voltage & frequency variation on the Induction Motor performance.

Ref : Generalized Theory of Electrical Machines (Dr.P.S.Bimbhra)

MASTER OF TECHNOLOGY
IN
Power System

COMMON CURRICULUM & SYLLABU

Advance Microprocessor & Microcontrollers

PSM 301 (B)

1) **Architecture of the 16 bit 8086 Microprocessor**
   - i) The 8086 Internal Architecture
   - ii) Sequential memory access
   - iii) Key points to remember

2) **Addressing mode of 8086**

3) **The 8086 microprocessors CPU Module design**
   - i) The 8086 CPU Module pin out
   - ii) Clock generation
   - iii) Bus Demultitlexing & Buffering
   - iv) Read & Write cycle timing

4) **Assembly language programming**

5) **Support peripheral Devices.**
   - i) The 8255A Programmable Peripheral Interface
   - ii) The 8254 (8253) Programmable Interval timer
   - iii) The 8259A Programmable Interrupt controller
   - iv) Direct memory access(DMA) and the 8237 DMA Controller
   - v) RS-232 Interface

6) 8086 Interrupt structure, Memory Interfacing & Modules.

7) The 80186 / 80188 Architecture.

8) The 80286 Microprocessors.

9) The 8051 Microprocessor
   - i) 8051 Internal Microcontroller
   - ii) Interfacing the 8051 to External Memory
   - iii) 8051 Interrupt

Reference :

1) The 8086 & 8088 Microprocessor
   A.K.Gautam & A.R.Jaiswal
2) Advance Microprocessor
   B.Ram
3) Microcontroller
   Raj Kamal

Power Plant Engineering

PSM 301(C)

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