

BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ODISHA ROURKELA

Electrical Engineering M.Tech (POWER ENGINEERING AND ENERGY SYSTEM)

SEMESTER- I

(Applicable to the students admitted from the Academic year 2012 – 2013 onwards)

Code No.	Course Title	L	T	P	C
THEORY					
Professional Core					
PSPC101	Power System Engineering	3	1	0	4
PSPC102	Power Apparatus and Systems	3	1	0	4
PSPC103	EHVAC Transmission.	3	1	0	4
Professional Electives -I (Any one)					
PSPE101	Advanced Power Electronics	3	1	0	3
PSPE102	Protection & Digital Relaying	3	1	0	3
Professional Electives –II (Any one)					
PSPE103	Optimization Techniques	3	1	0	3
PSPE104	Power Quality	3	1	0	3
PRACTICAL					
PSPR101	Power System Lab – I	0	0	3	2
PSPR102	Engineering Software Laboratory	0	0	3	2
PSPT101	Pre Thesis Work related Seminar	0	0	3	2
					Total Credit -24

SEMESTER- II

Code No.	Course Title	L	T	P	C
THEORY					
Professional Core					
PSPC201	Power System Transients	3	1	0	4
PSPC202	Power System Dynamics	3	1	0	4
Professional Electives -III (Any one)					
PSPE201	HVDC & Facts Devices	3	0	0	3
PSPE202	Power System Management & Deregulation	3	0	0	3
Professional Electives –I V (Any one)					
PSPE203	Advanced DSP	3	0	0	3
PSPE204	Advanced Control Systems	3	0	0	3
Professional Electives – V (Any one)					
PSPE205	AC and DC Drives	3	0	0	3
PSPE206	Power System Reliability	3	0	0	3
PRACTICAL					
PSPR201	Power System Lab – II	3	1	0	4
PSPT201	Seminar-2: Pre Thesis Work related Seminar	0	0	3	2
PSCV201	Viva Voce- 1	0	0	3	2
					Total Credit -25

PSPC101 POWER SYSTEM ENGINEERING

Module- I

Automatic Generation and Voltage Control:

Turbine & Generator- Load frequency Scheme, Steady state & dynamic analysis in frequency domain for single & two area system, Economic dispatch Control, Automatic Voltage Control. Power flow Analysis- NR and Fast Decoupled methods.

Module- II

Optimal System Operation:

Generation allocation problem formulation, Loss Coefficients, Optimal load flow solution, Hydrothermal Coordination, constraints in Unit- commitment, Unit commitment solution methods.

Module- III

Modeling of Transmission lines & transformers with off-nominal taps.

Sparse matrix technique for large- Scale system problems- Gauss elimination & bi-factorization method. Algorithm for short circuit studies, Z Bus Formulation, Unsymmetrical fault analysis using symmetrical components.

Books Recommended:

1. Stagg G.W., Ebrahimi A.H. " Computer methods in Power system analysis." Mc Graw Hill, 1968.
2. Nagrath & Kothari, "Modern Power System Analysis"
3. Elgerd O.Z, " Electrical Energy System Theory- An

PSPC102 POWER APPARATUS AND SYSTEMS

Module-I

(12 Hrs)

Synchronous Machines: The basis of General Theory and Generalized Equation of A.C machines, Equation in terms of phases variable park's transformation, Various reference frames, Derivation of two-axis equation, Torque equation, Field and damper windings, Equivalent circuits, Operational impedances and frequency response loci, Modified equation with more accurate coupling between field and damper windings.

Selected topics on prime mover and energy supply systems: Governors for hydraulic and steam turbines, Transient droop, speed governing system.

Module-II

(12 Hrs)

Synchronous Generator short circuit and system faults: Symmetrical short circuit of unloaded generator, Analysis of short circuit oscillograms, short circuit of loaded synchronous generator, Unsymmetrical short of synchronous generator, system fault calculation, Sudden load changes, Equivalent circuit under transient condition, Constant flux linkage theorem, Simplified phasor diagram for transient changes.

Selected topics on excitation systems: Modeling of excitation system components, exciter (D.C and A.C), Amplifier, Stabilizing circuit

Module-III

(12 Hrs)

Induction machines: Generator equation of the induction motor (equation), Application of equation in primary and secondary reference frames and complex form of equation, Short circuit and fault current due to the induction motor, fault calculation.

Transformers: Transient phenomena in transformer and transformer protection: General characteristics of over voltage and current inrush, Transient over voltage characteristics, Ferro resonant over voltage, protection against surges and insulation co-ordination.

BOOKS RECOMMENDED :

1. The Generalized theory of electrical machines (Chapters: 1,2,3,4,5,8 and 11 by B.Adkins and R.H. Hiiley.
2. Principle, Operation and Design of power Transformer By S.B Vasitnsky.
3. The J & P transformer Book (Chapter: 22&23) By S. Austen Stigant and A.C Franklin.
4. Power System Stability & Control (Chapters: 8&9) By P.Kundur, McGraw Hill-1994.

PSPC103 EHVAC TRANSMISSIONS

Module- I

(10 hrs)

Introduction to EHV Transmission Comparison of AC and DC Transmission Systems.

Parameters of EHV Lines:- Resistance of conductors, bundle conductors, Inductance of EHV Line configurations line capacitance, Sequence Inductance and capacitance, Line parameters for modes of propagation, resistance and Inductance of Ground returns.

Module- II

(10 hrs)

Voltage Gradient of conductors:- Field of sphere gap, field of line charges and their properties. Charge – potential relations for multi-conductor lines surface voltage gradient and conductors without and with ground wires consideration, gradient factors, Distribution of voltage gradient on sub-conductors of bundle.

Module- III

(10 hrs)

Corona effects- I : Power loss and Audible Noise Corona loss, Charge- Voltage diagram. Attenuation of traveling waves Audible.

Noise: Generation, Characteristics and its limitation, Measurement, meters, 1-phase and 3-phase AN levels, Day-Night equivalent Noise level.

Power frequency voltage control and over-voltage:- Generalised constants, Cascade connection of components-shunt and series compensation. Sub-synchronous Resonance in series- capacitor compensated lines, Static Reactive compensating systems.

Module – IV

(10 hrs)

Over voltage in EHV systems caused by switching operations:-

Origin of over voltage and their types, short circuit current and circuit breaker. Recovery voltage and the circuit breaker, Over voltage caused by interruption of inductive current, Interruption of capacitive currents, Ferro resonance over voltage, calculation of switching surges single phase equivalents, distributed parameter line energized by source, generalized equations for single phase representation, Generalised equation of three phase systems, inverse Fourier transform for the general case, Reduction of switching surges on EHV systems, Experimental and calculated results of switching surge studies.

Books:-

1. Begamudre R.D., "Extra High Voltage A.C. Transmission" Mc Graw Hill 1968.

PSPE101 ADVANCED POWER ELECTRONICS

Model-I

1- Φ and 3- Φ Controlled rectifiers-Average output voltages and currents for R-L. load performance parameters of rectifier 1- Φ and 3- Φ converter.

DC-DC converters: Buck, Boost, Buck-boost and Cuk converters, linear power supplies.

Switch mode DC Power supplies, Fly back converter, Forward converter, push pull converter , half bridge and full bridge converter.

Module-II

Basic concepts of switch mode inverter, pulse width modulated switching scheme , unipolar and bipolar Switching scheme, 1- Φ inverters, push pull inverters, 3- Φ inverters, PWM in 3- Φ voltage source inverters. Reduction of Harmonics , square-wave pulse switching, programmed Harmonic elimination switching.

Module-III

Resonant pulse Converters: Classification of resonant Converters, series Resonant Inverter: Series Resonant inverters with unidirectional switches, series resonant inverters with bi-directional switches. Parallel Resonant Inverters, Zero current switching resonant converters, zero voltage switching resonant converters.

Books for Reference

1. Power electronics, Circuits, devices. Application by M.H.Rashid (PHI)
2. Power electronics, converters ., applications and Design N.Mohan undeland and Robbins John wily and sons inc.
3. Modern Power electronics and AC Drives by B.K .Bose.

PSPE102 PROTECTION AND DIGITAL RELAYING

Module-I

Protection Schemes and Characteristics: Primary and back up protection , current transformers for protection , potential transformer, review of electromagnetic relays static relays , over current relays time current characteristic, current setting time setting, directional relay, static over current relays.

Distance protection: impedance, reactance, mho, angle impedance relays. Input quantities for various types of distance relays, effect of arc resistance on the performance of distance relays, selection of distance relays. MHO relay with blinders, quadrilateral relay , elliptical relay. Restricted mho, impedance directional, reactance relays, swiveling characteristics.

Module-II

Compensation Schemes: Compensation for correct distance measurement, reduction of measuring units switched schemes. Pilot relaying schemes. Wire pilot protection , circulating current scheme, balanced voltage scheme, transley scheme, carrier current protection , phase comparison carrier current protection, carrier aided distance protection.

Module-III

Digital Relaying: Digital relaying algorithms, differential equation technique, discrete Fourier transform technique, walsh-hadamard transform technique, rationalized harr transform technique, removal of dc offset.

Microprocessor based protective relays: over current , directional, impedance, reactance relays. Generalized mathematical expressions for distance relays, mho and offset mho relays, quadrilateral relay, microprocessor implementation of digital distance relaying algorithms.

Text book

1. Power system protection and switchgear by Badri ram and vishwkrama, TMH publication New Delhi 1995.
2. power system protection by Madhava Rao TMH

Reference Books

1. Power system by Ravindra Nath and chandar PHI.

PSPE103 OPTIMIZATION TECHNIQUES

Module-I

Optimization Fundamentals:

Definition, classification of optimization problems, Unconstrained and constrained optimization, optimality conditions.

Linear Programming:

Simplex Method, Duality, Sensitivity methods.

Module-II

Nonlinear Programming:

Powell's method, steepest descent method, conjugates gradient method, Newton's Method GRG method, Sequential quadratic programming, Penalty function method, Augmented Lagrange multiplier method.

Dynamic Programming and Integer Programming

Interior point methods

Karmakar's algorithm , Dual affine, Primal affine , Barrie algorithm.

Module-III

Simulated annealing , Evolutionary Programming , Genetic algorithm and Genetic Engineering.

Finite Element Based Optimization.

Reference Books

1. Ashok D.belegundu and Chrandrapatla T. R " Optimization Concept and Application in Engineering " Prentice Hall, 1999.
2. Rao S.S " Engineering Optimization"
3. Gill , Murray and Wright , " Practical Optimization"
4. James A. Memoh." Electic Power System Application of optimization."
5. song Y. , "Modern Optimization Techniques in power System"

PSPE104 POWER QUALITY

Module-I

Introduction: power quality (PQ) problem, Voltage sag, Swell , Surges, Harmonic, over voltages, spikes, Voltage fluctuations, Transients, interruption overview of power quality phenomenon , Remedies to improve power quality, power quality monitoring.

Interruptions: Definition, Difference between failure, outage, causes and origin of interruptions, limits for the interruption frequency, limits for the interruption duration , costs of interruption, overview of Reliability , evaluation to power quality, comparison of observations and reliability evaluation.

Module-II

Voltage Sag: Characterization of voltage sag , definition, causes of voltage sag , voltage sag magnitude , monitoring, theoretical calculation of voltage sag magnitude , voltage sag calculation in non-radial systems, meshed systems, voltage sag duration.

PQ considerations in Industrial Power Systems: voltage sag effects, equipment behavior of power electronic loads, induction motors , synchronous motors, computers, consumer electronics, adjustable speed AC drives and its operation. Mitigation of AC drives, Adjustable speed DC drive and its operation, mitigation methods of DC drives.

Module-III

Mitigation of Interruptions and Voltage Sags: Overview of mitigation methods- from fault to trip, reducing the number of faults, reducing the fault clearing time changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods . System equipment interface- voltage source converter , series voltage controller , shunt controller , combined shunt and series controller.

Power Quality and EMC Standards: Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage characteristics standards , PQ surveys.

Reference Book:

1. “ Understanding Power Quality Problems” by Math H J Bollen, IEEE Press.
2. Electrical power quality –R C Dugan, M.F,M Granghar, H.W.Beaty-TMH.

PSPR101 POWER SYSTEM LABORATORY-I

1. V/F control of induction Motor.
2. Resonant DC-DC Converter.
3. Surge impedance calculation of a Transmission line.
4. HVDC Power Link model using MATLAB.
5. Stability analysis of synchronous machine by using gain adjustment of ALFC.
6. Economic Load dispatch/Hydrothermal scheduling.

PSPC201 POWER SYSTEMS TRANSIENTS

Module-I (15 Hours)

INTRODUCTION TO FAST TRANSIENTS:

Origin and nature of power system Transients, traveling waves on transmission system, the line equation, the shape attenuation and distortion of waves, reflection of traveling waves , successive reflections, traveling waves on multi conductor systems, transition points on multi conductor circuits.

LIGHTNING : Charge formation , mechanism of lightning stroke. Mathematical model of lightning stroke.

Module-II (15Hours)

THEORY OF GROUNDS WIRES :Direct stoke to a tower, effect of reflection up and down the tower , the counterpoise.

SWITCHING SURGES :

Normal frequency effects, high charging currents, cancellation waves, recovery voltage, restricting phenomena. Protection of transmission systems against surge.

HIGH FREQUENCY OSCILLATIONS AND TERMINAL TRANSIENTS OF TRANSFORMER

Module-III (15 Hours)

INSULATION COORDINATION:

Insulation coordination procedures (IEC) for high voltage systems: Design criteria, classification of overvoltages, insulation design for switching, lightning and temporary overvoltages, pollution, application of arresters for protection of lines and stations, statistical methods of insulation coordination, risk of failure, test prescriptions. Insulation coordination procedures (IEC) for low voltage systems: representative overvoltages, selection of clearance and creepage distances, macro and micro environments, testing techniques, transient (switching and lightning) voltage surge suppression in industrial and commercial electrical installations, protection of electronic devices.

REFERENCES

- 1.Allan Greenwood , Electrical Transients in power Systems , Wiley lterscience, 1991
- 2.Lou Van Der Sluis, Transients in power Systems , John Wiley & Sons Ltd, 2001
- 3.R Rudenterg, Transient Performance of Electric power systems, Phenomenon in Lumped Networks, MGH, 1950
- 4.R Rudenterg, Electric Stroke waves in power systems, Harvard University press, Cambridge, Massachusetts, 1968
- 5.Transmission Line Reference Book, EPRI, USA, 1982 11

PSPC202 POWER SYSTEM DYNAMICS

Module-I (15 Hours)

Power System Stability Problems: Basic concepts and definitions, Rotor angle stability, Synchronous machine characteristics, Power versus angle relationship, Stability phenomena, Voltage stability and voltage collapse, Mid-term and long-term stability, Classification of stability.

Small Signal Stability: State space concepts, Basic linearization technique, Participation factors, Eigen properties of state matrix, small signal stability of a single machine infinite bus system,

Module-II (15 Hours)

Studies of parametric effect: effect of loading, effect of K_A , effect of type of load, Hopf bifurcation, Electromechanical oscillating modes, Stability improvement by power system stabilizers. Design of power system stabilizers.

Large Perturbation Stability: Transient stability: Time domain simulations and direct stability analysis techniques (extended equal area criterion)

Energy function methods: Physical and mathematical aspects of the problem, Lyapunov's method, Modeling issues, Energy function formulation, Potential Energy Boundary Surface (PEBS): Energy function of a single machine infinite bus system, equal area criterion and the energy function, Multimachine PEBS.

Module-III (15 Hours)

Sub Synchronous Oscillations: Turbine generator torsional characteristics, Shaft system model, Torsional natural frequencies and mode shapes, Torsional interaction with power system controls: interaction with generator excitation controls, interaction with speed governors, interaction with nearby DC converters, Sub Synchronous Resonance (SSR): characteristics of series capacitor – compensated transmission systems, self – excitation due to induction generator effect, torsional interaction resulting in SSR, Analytical methods, Counter measures to SSR problems.

Voltage stability, System oscillations

References:

1. Prabha. Kundur, *Power system stability and control*, Tata McGraw-Hill, 1994
2. P. Sauer and M. Pai, *Power system dynamics and stability*, Prentice Hall, 1998. 12

PSPE201 HVDC & FACTS DEVICES

Module-I (15hours)

Introduction: Comparison of AC-DC Transmission, Description and application of HVDC transmission, DC System components and their functions

Analysis of HVDC Converters: Pulse number, Converter configuration, Analysis of Graetz circuit, Bridge characteristics, 12 pulse converter

HVDC Control: Principles of DC Link control-Converter control characteristics- System control, Firing angle control- Current and extinction angle control, DC link power control, Reactive power control and VAR sources, MTDC system- types- control and protection- DC circuit breakers

Module-II. (15hours)

FACTS Concept and General System:

Transmission interconnections, Flow of power in AC system, Power flow and dynamic stability considerations of a transmission interconnection, Relative importance of controllable parameters, Basic types of FACTS controllers, Benefits from FACTS Technology, In-perspective: HVDC or FACTS

Module-III (15hours)

Compensators: Objective of series and shunt compensation, SVC and STATCOM, GCSC, TSSC, TCSC, and SSSC, UPFC, IPFC, Generalized and Multifunctional FACTS Controllers

Books Recommended

- 1.Padiyar K.R., "HVDC Power Transmission System", Wiley Eastern PVT Limited
- 2.Kimbark, "Direct Current transmission", Vol.1, John Wiley, New York, 1971
- 3.Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems. By N. G. Hingorani and L. Gyugi, Standard Publisher Distributors, IEEE Press, Delhi
- 4.Flexible AC Transmission Systems. By J. Arillage 13

PSPE202 POWER SYSTEM MANAGEMENT AND DEREGULATION

Module-I (15 Hours)

Load characteristics and load forecast

Basic definitions- load definitions, load factor definitions, diversity principle in distribution systems, Load Forecast- factors affecting load forecasting methods, small areas load forecasting, spatial load forecasting methods, simulation, trending and mixed load forecasting methods

Basics of Power System Economics & Short-term Operation Planning of Power System, Load curves and load duration curves, Economic load dispatch- concept of marginal cost and Kuhn-Tucker's condition of optimum in power dispatch, participation factors

Module-II (15 Hours)

Classical method to calculate loss coefficients, Loss coefficient calculation using Y-Bus, Loss coefficients using sensitivity factors, Transmission loss coefficients, Transmission loss formula

Power Pools & Electricity Markets

Inter-area transactions, multi-area power interchanges, Energy brokerage systems, Market design and auction mechanism, Pool versus bilateral markets and price formation, Role of independent generators and system operator

Module-III (15 Hours)

Power Sector Financing

Time value of money, utility economic evaluation, Capacity planning issues and methods- Levelizing and levelized bus-bar analysis, Screening curve analysis, Horizon-year generation additions analysis, Capacity planning in competitive environment

References

1. A. J. Wood and B. F. Wollenberg, *Power generation, operation and control*, Wiley-Interscience, 2nd Edition, 1996.
2. H. G. Stoll, *Least-cost electric utility planning*, Wiley-Interscience, 1989.
3. K. Bhattacharya, M. H. J. Bollen and J. E. Daalder, *Operation of restructured power systems*, Kluwer Academic Publishers, USA, 2001.

PSPE203 ADVANCED DIGITAL SIGNAL PROCESSING

Module-I: (15 hours)

Discrete time signals, systems and their representations:

Discrete time signals- Linear shift invariant systems- Stability and causality- Sampling of continuous time signals- Discrete time Fourier transform- Discrete Fourier series- Discrete Fourier transform- Z- transform- Properties of different transforms- Linear convolution using DFT- Computation of DFT

Module II: (15 hours)

Digital filter design and realization structures

Design of IIR digital filters from analog filters- Impulse invariance method and Bilinear transformation method- FIR filter design using window functions- Comparison of IIR and FIR digital filters- Basic IIR and FIR filter realization structures- Signal flow graph representations

Module III (15 hours)

Analysis of finite word-length effects

Quantization process and errors- Coefficient quantisation effects in IIR and FIR filters- A/D conversion noise- Arithmetic round-off errors- Dynamic range scaling- Overflow oscillations and zero input limit cycles in IIR filters

Statistical signal processing

Linear Signal Models . All pole, All zero and Pole-zero models .Power spectrum estimation- Spectral analysis of deterministic signals . Estimation of power spectrum of stationary random signals-Optimum linear filters-Optimum signal estimation-Mean square error estimation- Optimum FIR and IIR filters.

Texts/ References

1. Sanjit K Mitra, Digital Signal Processing: A computer-based approach ,TMH edition .1998
2. Dimitris G .Manolakis, Vinay K. Ingle and Stephen M. Kogon, Statistical and Adaptive Signal Processing, Mc Grow Hill international editions .-2000
3. Alan V . Oppenheim, Ronald W. Schafer, Discrete-Time Signal Processing, Prentice-Hall of India Pvt. Ltd., New Delhi, 1997
4. John G. Proakis, and Dimitris G. Manolakis, Digital Signal Processing(third edition), Prentice-Hall of India Pvt. Ltd, New Delhi, 1997
5. Emmanuel C. Ifeachor, Barrie W. Jervis , Digital Signal Processing-A practical Approach, Addison . Wesley,1993.
6. Abraham Peled and Bede Liu, Digital Signal Processing, John Wiley and Sons, 1976 17

PSPE204 ADVANCED CONTROL SYSTEMS

Module-I :

(14 Hours)

Digital Control : State Space Representations of Discrete Time Systems, Solution of Discrete Time State Equations, Discretization of Continuous Time State Equations. Controllability and observability of Linear Time Invariant Discrete Data Systems, Pole Placement, Deadbeat response, Digital Simulation.

Module -II :

(15 Hours)

Optimal Control : Performance Indices, Quadratic Optimal Regulator / Control Problems, Formulation of Algebraic Riccati Equation (ARE) for continuous and discrete time systems. Solution of Quadratic Optimal Control Problem using Lagrange Multipliers for continuous and discrete-time systems. Evaluation of the minimum performance Index, Optimal Observer, The Linear Quadratic Gaussian (LQG) Problem, Introduction to H_{∞} Control.

Module - III :

(14 Hours)

Non linear Systems : The Aizerman and Kalman Conjectures : Popov's stability criterion, the generalized circle criteria, simplified circle criteria. Simple variable structure systems, sliding mode control, feedback linearization, Model reference adaptive control, (MRAC), Self Tuning Regulator (STR).

Fuzzy Logic Control : Fuzzy sets and crispsets, Fuzzy Relations and composition of Fuzzy Relations, Introduction to Fuzzy Logic Controllers.

Books :

1. Discrete Time Control Systems, by K.Ogata, 2nd edition (2001), Pearson Edu Pub.
2. Digital Control Systems, by B.C. Kuo, 2nd edition (1992), Oxford University Press.
3. Digital Control and State Variable Methods, by M.Gopal, 3rd edition (2009), TMH Edu.
4. Systems and Control by Stanislaw H.Zak, Oxford University Press (2003).
5. Design of Feedback Control Systems by Raymond T. Stefani, B.Shalia, Clement J. Savant, Jr. Gen H. Hostetter, 4th edition (2002), Oxford University Press.
6. Introduction to Control Engineering (Modeling, Analysis and Design) by Ajit K. Mandal, New Age International (P), Ltd., Publishers (2006).
7. Non Linear Systems, by Hassan K. Khallil, 3rd edition (2002), Prentice Hall, Inc. (Pearson Education), Publications.
8. Control Theory (Multivariable and non linear Methods) by Torkel Glad & Lennart Ljung, Taylor & Francis (2009). 16

PSPE205 AC and DC DRIVES

Module-I

12hrs

Introduction to motor drives: Components of power electronic Drives- Criteria for selection of Drive components-match between the motor and the load- Thermal consideration- match between the motor and the power electronics converter- characteristics of mechanical systems- stability criteria.

DC Motor Drives: System model, motor rating, motor-mechanism dynamics-Drive transfer function.

Module- II

14hrs

Phase controlled D C Motor Drives- Steady state analysis of the 3-phase converter controlled DC motors Drive , Steady state solution including Harmonics, Discontinuous current conduction, Transfer functions of the sub systems, two quadrant dc motor drive with field weakening. Four quadrant dc motor drive. Chopper- Controlled DC motor drive: Four quadrant chopper circuit, chopper for inversion. Model of the chopper, steady state analysis of chopper- controlled dc motor drive – continuous and discontinuous conduction operation, closed-loop operation.

Module-III

12hrs

Induction motor drives: Torque speed characteristics of 3-phase induction motor drive, speed control of 3-phase induction motor by varying stator frequency and voltage – impact of non sinusoidal excitation on induction motors- variable frequency converter classifications – variable frequency PWM-VSI drives- variable frequency square wave VSI drives- variable frequency CSI drives-comparison of variable frequency drives- Line frequency variable voltage drives- soft start of induction motors – speed control by static slip power recovery, static Cramer and Scherbius drives.

Text / Reference

1. Ned Mohan etial : Power Electronics , John wiley and sous
2. R.Krishnan :Electric Motor Drives – PHI publication
3. B K Bose :Modern Power Electronics and AC drives, Pearson Education (Asia)
4. P C Sen : Power Electronics TMH Publication
5. Dubey : Power Electronics Drives- Wiley Eastern 6.

PSPE206 POWER SYSTEM RELIABILITY

Module-I (15Hours)

Generating Capacity Basic Probability Methods: The generation system model, Loss of load indices, Equivalent forced outage rate, Capacity expansion analysis, Scheduled outages, Evaluation methods on period basis, Load forecast uncertainty, Forced outage rate uncertainty, Loss of energy indices.

Generating Capacity Frequency & Duration Method: The generation model, System risk indices.

Module-II (15 Hours)

Interconnected Systems: Probability error method in two interconnected systems, Equivalent assisting unit approach to two interconnected systems, Factors affecting the emergency assistance available through the interconnections, Variable reserve versus maximum peak load reserve, Reliability evaluation in three interconnected system, multi connected system, Frequency & duration approach.

Operating Reserve: General concepts, PJM method, Extension to PJM method, Modified PJM method, Postponable outages, Security function approach, Response risk, Interconnected systems.

Module-III (15 Hours)

Composite Generation & Transmission Systems: Radial configurations, Conditional probability approach, Network configurations, State selection, System & load point indices, Application to practical systems, Data requirements for composite system reliability.

Plant & Station Availability: Generating plant availability, Derated states & auxiliary systems, Allocation & effect of spares, Protection systems, HVDC systems.

Distribution Systems Basic Techniques & Radial Networks: Evaluation techniques, additional interruption indices, Application to radial systems, effect of lateral distributor protection, Effect of disconnects, Effect of protection failures, effect of transferring loads, Probability distributions of reliability indices.

Distribution Systems-Parallel & Meshed Networks: Basic evaluation techniques, Inclusion of busbar failures, Inclusion of scheduled maintenance, Temporary & transient failures, Inclusion of weather effects, Common modes failures, Common mode failures & weather effects, Inclusion of breaker failures.

Text Books

1. Billinton Roy & Allan Ronald "Reliability of Power system", Pitman Pub. 1984
2. Richard Elect. Brown, "Electric Power Distribution Reliability", CRC Press

Power System Laboratory-II

1. Power System Analysis using ETAP
2. Optimisation of Power System Operation using MATLAB optimization tool box or MATLAB Programming
3. Simulation of Thyristor Converter using PSCAD
4. DATA Acquisition using SCADA System
5. Simulation of Induction Motor drive using PSCAD
6. Economic Load dispatch.
7. Analog to digital Converter interfacing, Interfacing DAC to Microprocessor
