KALASALINGAM UNIVERSITY

Anand Nagar, Krishnankoil - 626 190

Department of EEE

M.TECH - POWER SYSTEM ENGINEERING
CURRICULUM

Semester I

Code No.	Subject	L	T	P	C
MAT5101	Applied Mathematics	3	0	0	3
EEE5001	Systems Theory	3	0	0	3
EEE5002	Power System Modelling	3	0	0	3
EEE5003	Computer methods in Power System Analysis	3	0	0	3
EEE5004	Power System Protection	3	0	0	3
EEE****	Elective I	3	0	0	3
EEE5081	Power System Simulation Laboratory	0	0	3	2
	Total	-	-	-	20

Semester II

Code No.	Subject	L	T	P	C
EEE5005	Power System Planning	2	1	0	3
EEE 5006	Power System Dynamics	3	0	0	3
EEE 5007	Flexible AC Transmission Systems	3	0	0	3
EEE 5008	Optimal Power System Operation	3	0	0	3
EEE 5009	Power System Control	3	0	0	3
EEE****	Elective II	3	0	0	3
EEE 5082	Power System Dynamics Laboratory	0	0	3	2
	Total	-	-	-	20

Semester III

Code No.	Subject	L	T	P	C
EEE 6001	Soft Computing	3	0	0	3
EEE****	Elective III	3	0	0	3
EEE****	Elective IV	3	0	0	3
EEE 6098	Project Work Phase-I	0	0	18	6
	Total	-	-	-	15

Semester IV

Code No.	Subject	L	T	P	C
EEE 6099	Project Work Phase-II	0	0	36	12
	Total	-	-	-	12

TOTAL CREDITS – 67

LIST OF ELECTIVES

Code No.	Subject	L	T	P	C
	I Year				
EEE5010	High Voltage Direct Current Transmission	3	0	0	3
EEE5011	Solid State Drives	3	0	0	3
EEE5012	EHV Power Transmission	3	0	0	3
EEE5013	Digital Signal Processing	3	0	0	3
EEE5014	Electrical Distribution System	3	0	0	3
EEE5015	Renewable Power Generation	3	0	0	3
EEE5016	Computer Network Engineering	3	0	0	3
	II Year				
EEE6010	Voltage Stability	3	0	0	3
EEE6011	Evolutionary Computation Techniques	3	0	0	3
EEE6012	Power System Automation	3	0	0	3
EEE6013	Power System Deregulation	3	0	0	3
EEE6014	Power Quality	3	0	0	3

Semester – I

MAT5001	APPLIED MATHEMATICS	L	T	P	C
		3	0	0	3

CLASSICAL OPTIMIZATION TECHNIQUES

Statement of optimization problem – Classification – optimization technique- Unconstrained Optimization – Equality constraints – Inequality constraints – Lagrange Multiplier method – Kuhn-Tucker Condition - Indirect search methods – Gradient of a function – Steepest descent method – Conjugate gradient method – Newton's method.

LINEAR PROGRAMMING

Standard form of Linear programming problem – Definitions and theorems – Solution of linear simultaneous equations – Simplex algorithm – graphical method – Dual simplex method – Transportation problem - Applications.

Z TRANSFORM AND FOURIER TRANSFORM

Z Transform – properties- Region of Convergence – Single and Double side Z Transform – Inverse Z Transform.

Discrete Fourier transform properties-Properties – signals – Inverse Fourier transform- Discrete convolutions – Discrete time Fourier Transform – Radix -2 fast Fourier Transform (FFT) - Decimation in time – Decimation in frequency- comparison between Z Transform and DFT.

WAVELET TRANSFORM

Frames – wavelet series – Multiresolution – analysis – scaling functions and wavelet – Harr, sine and spline wavelets – Iterated filter banks – Construction of compactly supported wavelets – wavelet packets – Bilinear time – frequency distribution.

RANDOM PROCESSES

Classification – stationary random processes – auto correlation – cross correlations – power spectral density – linear system with random input – gaussion Process.

TEXT BOOK:

1. Singiresu S.Rao ,Engineering Optimization , New Age International (P) Ltd , 2001
2. Sanjit K Mitra, Digital signal Processing, Tata McGraw-Hill 3rd Edition, New Delhi, 2006.
3. Stephane Mallat, A Wavelet tour of signal Processing, Academic press, California, 2006.

REFERENCES :

1. S.Salivahanan, A.Vallavaraj and C.Gnanapriya , "Digital signal processing", TMH Edition, New Delhi.

2. Chui C.K., An introduction Wavelets, Academic Press, 1992.
3. Ochi M.K., Applied Probability and Stochastic processes, John Wiley & sons 1992.

EEE5001	SYSTEMS THEORY	L	T	P	C
		3	0	0	3

STATE SPACE ANALYSIS

Realization of State models – Non-uniqueness – Minimal realization – Balanced realization – Solution of state equations – State transition matrix and its properties – Free and forced responses – Properties – Controllability, Observability, Stabilisability and detectability – Kalman decomposition-Minimal and Balanced realization

MIMO SYSTEMS –FREQUENCY DOMAIN DESCRIPTIONS

Properties of transfer functions – Impulse response matrices – Poles and zeros of transfer function matrices – Critical frequencies – Resonance – Steady state and dynamic response – Bandwidth- Nyquist plots-Singular value analysis

ADAPTIVE CONTROL

Classification of adaptive control – Introduction to auto tuning – types of adaptive control- MRAC- MIT rule- Design and approaches –SIR – Introduction, Direct & Indirect method applications

NON-LINEAR SYSTEMS

Types of non-linearity – Typical examples – Equivalent linearization - Phase plane analysis – Limit cycles – Describing functions- Analysis using Describing functions-Jump resonance-Model reduction technique-Dominant pole concept, Pade approximation-Stability of trajectories-Phase pole circuits

STABILITY

Stability concepts – Equilibrium points – BIBO and asymptotic stability – Direct method of Liapunov – Application to non-linear problems – Frequency domain stability criteria – Popov's method and its extensions-stability loop-Kalman's stability

TEXT BOOKS

1. Gopal,M, Modern Control Engineering, Wiley, 1996
2. Ogatta,K., Modern Control Engineering, Pearson Education Asia, 1997

REFERENCE BOOKS

1. Eroni-Umez and Eroni, System dynamics & Control, Thomson Brooks/ Cole, 1998

2. Karl.J.Asborn & B.Jorn Wittermark, Adaptive Control, Pearson Education Singapore 2nd Edition 2003
3. Thaler,G,J.,Automatic control systems, Jaico publishers, 1993
4. John. S. Bay, Linear State Space Systems, McGrawHill International edition, 1999
.

EEE5002	POWER SYSTEM MODELLING	L	T	P	C
		3	0	0	3

INTRODUCTION TO POWER SYSTEM MODELLING

Introduction – Network modeling – Modeling of transmission lines and transformers with off nominal tap ratios

MODELLING OF SYNCHRONOUS MACHINE

Mathematical description of synchronous machine – dqo transformation – per unit representation – equivalent circuit for d and q axis – Steady state analysis – Conditioning of Y Matrix, sis-magnetic saturation – Simplified model with amortisseurs neglected – classical model – constant flux linkage model including the effect of sub transient circuits –reactive capability limits

MODELLING OF EXCITATION SYSTEMS

Excitation system requirements –Types of excitation systems –Dynamic performance machines – control and protective functions – modelling of excitation systems

MODELLING OF SPEED GOVERNING SYSTEM AND PSS

Turbine and Governing System Modelling – Steam turbine Modelling – Power System Stabilizer – Block diagram with AVR and PSS, Block Diagram of PSS with description, system state matrix including PSS

LOAD MODELLING

Basic load modelling – Static load models – Dynamic load models – Acquisition of load model parameters –Measurement based approach – Component based approach-Sample load characteristic- Induction motor equivalent circuits and parameters – free acceleration characteristics – dynamic performance – changes in load torque – effect of three phase short circuit – effect of unbalanced faults.

TEXT BOOKS

1. Prabha Kundur ,Power System stability and control ,Tata MC Graw Hill Edition 1994

REFERENCES

1. Peter W.Sauer and M.A.Pai, Power System Dynamics and Stability", Pearson Education,Inc.,1998

EEE5003	COMPUTER METHODS FOR POWER SYSTEM ANALYSIS	L	T	P	C
		3	0	0	3

POWER SYSTEM REPRESENTATION

Sparse Matrix techniques for large scale power systems: Optimal ordering schemes for preserving sparsity. Flexible packed storage scheme for storing matrix as compact arrays; Factorization by Bifactorization and Gauss elimination methods; Repeat solution using Left and Right factors and L and U matrices

LOAD FLOW STUDY

Bus Classification – Power System Equations-Solution techniques – Newton Raphson method – Decoupled Newton Load flow – Fast Decoupled Load flow method – Convergence criteria and tests – formulation of three phase load flow problem – Continuation power flow

SHORT CIRCUIT STUDIES

Analysis of three phase faults – Admittance matrix equation – impedance matrix equation – fault calculations – Analysis of unbalanced faults – Admittance matrices – fault calculations – Short circuit faults – open circuit faults – Program description and typed solutions

CONTINGENCY ANALYSIS

Contingencies using Z bus in a superposition method – A second method using Z bus for contingencies- Introduction to multiphase (Six phase) system-Mathematical modeling of multiphase (six phase elements)

STABILITY STUDIES

Introduction – Factors influencing transient stability- Swing equation – Numerical Integration Methods – Euler and Fourth Order Runge – Kutta methods – Stability of multi-machine systems

TEXT BOOKS

1. Stagg G.W, El.Abaid A.H , "Computer Methods in power system Analysis, Tata MC GrawHill,1968
2. Singh ,L,P., Advanced Power system Analysis and Design, MC GrawHill-1999

REFERENCE BOOKS:

1. Pai ,M,A.,.Computer techniques in power system analysis-Tata MC GrawHill 1999
2. Hadi Saadat, Power System Analysis, McGrawHill, 2003
3. John J. Grainger, William D.Stevenson,Jr, Power System Analysis", Tata MC Graw Hill Edition, 2003

EEE5004	POWER SYSTEM PROTECTION	L	T	P	C
		3	0	0	3

INTRODUCTION

General philosophy of protection – Characteristic function of protective relays – basic relay elements and relay terminology – R-X diagram – non-critical switching circuits- Safety devices

PROTECTION OF POWER APPARATUS

Protection of generators -stator phase fault protection –lost excitation protection generator off- line protection – Transformer protection – factors affecting differential protection – magnetizing inrush current – Application and connection of transformer differential relays – transformers over current protection – Example motor protection

PROTECTION OF TRANSMISSION SYSTEMS

Bus protection – typical bus arrangements – transformer – bus combination – bus differential systems line protection – classification of lines and feeders – Techniques applicable for line protection – distance protection for phase faults – Fault resistance and relaying – long line protection – Backup remote local and Breaker failure

PROTECTION OF REACTORS, BOOSTERS & CAPACTORS

Placement of reactors in power system – Types of reactor – reactor rating application and protection – booster in the power system – transformer tap changing – protection of boosters – capacitors in an interconnected power system – series – shunt – series shunt connections – protection of capacitors

STATIC RELAYS

Introduction – Basic construction of static protective relay – Characteristics – Function of protective relays – Influence of protective relays – Relays on associated equipment – Advantages – Application – Digital filtering in protection relays

TEXT BOOKS

1. Madhava Rao,T,S., Power System Protection, TMH 1989
2. Paithankar,Y,G., Bhide,S,R., Fundamentals of Power System Protection, Prentice - Hall of India, 2003

REFERENCES

1. Blackburn,J,L.,Power System Protection: Principles and Applications, Marcel Dekker, New York, 1998.

EEE5081	POWER SYSTEM SIMULATION LABORATORY	L	T	P	C
		0	0	3	2

LIST OF EXPERIMENTS

1. Formation of Bus Admittance Matrix (Y Bus) using MATLAB
2. Formation of Bus impedance matrix(Z Bus) using MATLAB
3. Sparse Matrix techniques
4. Optimal ordering schemes
5. Load flow problem using Gauss Siedal method
6. Load flow problem using Newton Raphson method.
7. Load flow problem using Fast decoupled power flow
8. Continuation power flow method
9. Contingency analysis: Generator shift factors and line outage distribution factors
10. Simulation of series RLC circuit using Simulink
11. Economic dispatch with line flow constraints
12. Solution of swing equation

SEMESTER II

EEE 5005	POWER SYSTEM PLANNING	L	T	P	C
		2	1	0	3

LOAD FORECASTING

Objectives of planning – Long and short term planning – load forecasting – characteristics of loads – methodology of forecasting – energy forecasting – peak demand forecasting – non weather and weather forecasting – total forecasting – annual and monthly peak demand forecasting

GENERATOR SYSTEM RELIABILITY ANALYSIS

Reliability concepts – exponential distributions – meantime to failure – series and parallel system – MARKOV process – recursive technique Generator system reliability analysis – probability models for generators unit and loads – reliability analysis of isolated and interconnected system – generator system cost analysis – corporate model – production analysis costing – energy transfer and off peak loading

TRANSMISSION SYSTEM RELIABILITY ANALYSIS

Transmission system reliability model analysis – capacity state classification – average interruption rate method – LOLP method – frequency and duration methods – effects of weather system studies interconnected system reliability

ISOLATED SYSTEM ANALYSIS

Two plant single load system – two plant two load system – load forecasting uncertainly interconnections benefits

D.C TRANSMISSION SYSTEM RELIABILTY EVALUATION

Introduction – system modes of failure – The loss of load approach – frequency & duration approach – spare value assessment – multiple bridge equivalents

TEXT BOOK

1. Sullivan Robert Lee. Power System Planning Mc Graw Hill, 1984 Edition

REFERENCE S

1. Roy Billinton, Power System Stability Evaluation Gorden & Breach Science Publishers, Newyork 1970
2. Wang.X., McDonald,J,R., Modern Power System Planning , Mc Graw Hill,1999

EEE 5006	POWER SYSTEM DYNAMICS	L	T	P	C
		3	0	0	3

SMALL SIGNAL STABILITY ANALYSIS

Classification of stability – Basic concepts and definitions – Stability of Dynamic system- State space representation – Eigen properties of State Matrix – Participation factor- SMIB configuration – Effects of field circuit dynamics – Effect of field flux variation on system stability – Analysis with numeric examples

SMALL SIGNAL STABILITY ENCHANCEMENT

Effect of excitation system – Thyristor excitation system – AVR – Effect of AVR on synchronizing and damping components – principle behind small signal stability – improvement methods – Delta-omega and Delta P – Omega stabilizers

TRANSIENT STABILTY ANALYSIS

Factors influencing Transient stability – numerical integration method – Euler and RK method – Simulation of power system dynamic response-structure of power system model – Synchronous machine representation – transmission network and load representation – overall system equation and their solution – simplified transient stability simulation using simultaneous implicit method – principle behind transient stability enhancement method – Regulated shunt compensation – Dynamic braking – Reactive switching-high speed excitation system.

SUBSYNCHRONOUS OSCILLATION (SSR)

Turbine-Generator torsional Characteristics – torsional interaction with power system control- sub-synchronous resonance – counter measures to SSR problem – impact of network switching disturbances- torsional interaction between closely coupled units – hydro generator – torsional characteristics

VOLTAGE STABILITY

Basic concepts related to Voltage stability – Voltage collapse – classification of voltage stability – voltage stability analysis – prevention of voltage collapse – system design measures – system operating measures

TEXT BOOK

1. Prabha Kundur, Power System stability and control- Tata MC GrawHill Edition

REFERENCES

1. Peter. W. Sauer & M.A Pai, Power System Dynamics and Stability, Pearson Edition, Delhi , 2003
2. Padiyar,K,R., Power System Dynamics, Stability and Control, B.S.Publications, 2nd edition, 2002

EEE 5007	FLEXIBLE AC TRANSMISSION SYSTEMS	L	T	P	C
		3	0	0	3

INTRODUCTION

Lack of control on active and reactive power flow – Conventional control mechanisms- Need for FACTS devices – Advances in power semiconductor devices – Types of FACTS controllers – Importance of FACTS controllers

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 – 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 stability studies- Applications – Improvement of the system stability limit – Enhancement of system damping – Voltage collapse prevention

EMERGING FACTS CONTROLLERS

Static Synchronous Compensator (STATCOM) – Principle of operation – V-I Characteristics – Unified Power Flow Controller (UPFC) – Principle of operation - Modes of Operation – Applications – Modelling of UPFC for Power Flow - Studies

CO-ORDINATION OF FACTS CONTROLLERS

Controller interactions – SVC _ SVC interaction- Co-ordination of multiple controllers using linear control techniques – Control coordination using genetic algorithms

TEXT BOOKS

1. Mohan Mathur.R., Rajiv . K.Varma, "Thyristor – Based Facts Controllers for ElectricalTransmission Systems", IEEE press and John Wiley & Sons, Inc.
   John,A,T., "Flexible A.C. Transmission Systems", Institution of Electrical and Electronic Engineers(IEEE), 1999

REFERENCE S

1. Narain G.Hingorani, Laszio. Gyugy.L, "Understanding FACTS Concepts and Technology of Flexible AC Transmission Systems", Standard Publishers –Delhi 2001.

EEE 5008	OPTIMAL POWER SYSTEM OPERATION	L	T	P	C
		3	0	0	3

ECONOMIC DISPATCH

Incremental cost curve-co-ordination equations without loss and with loss- solution by direct method and λ-iteration method- Base point and participation factors- Economic dispatch controller added to LFC control-Economic dispatch with Piecewise Linear cost functions-Economic dispatch using dynamic programming – transmission system effects -A two generator system - coordination equations, incremental losses and penalty factors

UNIT COMMITMENT

Constraints in unit commitment – Spinning reserve, thermal unit constraints, and other constraints – Solution echniques-Priority List method,Dynamic programming method , Forward DP approach, Lagrangian relaxation method – adjusting λ.

HYDROTHERMAL SYSTEM

Long Range Hydro Scheduling – Short Range Hydro Scheduling - Hydro Electric plant models – Scheduling problems – The Short term Hydrothermal Scheduling problem .

OPTIMAL POWER FLOW

Introduction- Solution of Optimal Power Flow (OPF) – The gradient method, Newton's method, Linear Sensitivity Analysis- LP methods – with real power variables only – LP method with AC power flow variables and detailed cost functions- Security constrained Optimal Power Flow- Interior point algorithm- Bus Incremental costs.

MAINTENANCE SCHEDULING

Factors considered in maintenance scheduling for generator units-turbines-Boilers-Problem statement- Maintenance scheduling using mathematical programming

TEXT BOOK

1. Allen J.Wood and Bruce F Wollenberg, "Power Generation, Operation and Control",John Wiley and sons, Newyork, 1996.

REFERENCE BOOK

1. .Mahalanabis,A,T.,Kothari,A,P.,Ahson,S,I., "Computer Aided Power System Analysis and Control", Tata Mcgraw Hill Publishing Co. Ltd., NewDelhi 1988.

EEE 5009	POWER SYSTEM CONTROL	L	T	P	C
		3	0	0	3

AUTOMATIC GENERATION CONTROL

Fundamentals of speed governing - control of generating unit Power output – composite regulating characteristic of Power Systems – Response rates of turbine – governing systems – fundamentals of automatic generation control – Implementation of AGC - development of state variable model for a two area Power System for use in simulation of AGC-Under frequency Load Shedding - computation of settings for under frequency relays.

REACTIVE POWER AND VOLTAGE CONTROL

Modelling of AVR loops - Components – stability compensation - Production and absorption of reactive Power – methods of voltage control - shunt reactors – shunt capacitors – series capacitors – synchronous condensers – static var systems – Principle of transmission system compensation – modeling of reactive compensating devices – Application of tap changing transformers to transmission systems – distribution system voltage regulation – modeling of transformer ULTC control systems .

SECURITY CONTOL OF POWER SYSTEMS

System operating states by security control functions – monitoring, evaluation of system state by contingency analysis – Linear sensitivity factors, Contingency Selection, Concentric relaxation method and bounding method-corrective controls-Preventive, emergency and restorative .

STATE ESTIMATION

Maximum likelihood Weighted Least Squares Estimation- Concepts, matrix formulation - Example for Weighted Least - Squares state estimation - State estimation of an AC network- development of method - Typical results of state estimation on an AC network- State Estimation by Orthogonal Decomposition algorithm – Introduction to Advanced topics- Detection and Identification of Bad Measurements - Estimation of Quantities Not Being Measured - Network Observability and Pseudo- measurements - Application of Power Systems State Estimation .

SCADA

Energy control centre- Functions - Monitoring, data acquisition and control. System hardware configuration – SCADA and EMS functions- Network topology determination, state estimation, security analysis and control- Various operating states- Normal, alert, emergency, inextremis and restorative- State transition diagram showing various state transitions and control strategies.

TEXT BOOKS:

1 Allen J.Wood and Bruce .F. Woolenberg, “Power Generation Operation and Control”, John Wiley & sons , New York, 1996.

REFERENCES

1. Elgerd O.I, "Electric Energy System Theory - an Introduction" - Tata McGraw Hill, New Delhi – 2002.
2. Mahalanabis A.K., Kothari. D.P. and Ahson.S.I., "Computer Aided Power System Analysis and Control", Tata McGraw Hill publishing Ltd , 1984.
3. Vaibhav Donde, M.A. Pai & Ian A.Hiskens - "Simulation & Optimization in an AGC system after deregulation" IEEE transactions on Power Systems Vol:16, No.3, Aug 2001.

EEE 5082	**POWER SYSTEM DYNAMICS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**2**

1. Transient stability : Swing equation, Euler's method
2. Transient stability: Runge kutta method.
3. Analysis of switching surge using EMTP.
4. Harmonic Analysis using ETAP.
5. Modelling and simulation of Static VAR Compensator
6. Simulation of induction motor starting using PSCAD
7. Simulation of induction motor starting using EMTP software
8. Plotting of PV curve.
9. Eigen Analysis.
10. Small signal Stability Analysis.

Semester – III

EEE 6001	SOFT COMPUTING	L	T	P	C
		3	0	0	3

INTRODUCTION TO SOFT COMPUTING

Conventional Artificial Intelligence system-Fundamental constituents of soft computing,- Computational learning theory- Hybrid soft computing system.

NEURAL NETWORKS

Overview of biological Neuro-system - Mathematical Models of Neurons -Learning rules - Learning Paradigms – Supervised, Unsupervised and reinforcement Learning - Perceptron networks - Training rules – Multilayer perceptron - Back Propagation Algorithm - Associative Memories- Hopfield Networks - Boltzman machine – Self Organizing Map.

FUZZY LOGIC

Fuzzy Sets - Fuzzy rules and Fuzzy reasoning- Fuzzy inference systems- Fuzzy classifiers- Fuzzy logic control- Application of Fuzzy logic

NEURO FUZZY MODELLING

Adaptive Neuro Fuzzy Inference Systems (ANFIS)- architecture-hybrid learning algorithm- Parameter identification-Rule base structure identification – input selection-input space partitioning - Neuro-Fuzzy control.

EVOLUTIONARY COMPUTATION

Robustness of Traditional optimization and search techniques - The goals of optimization Introduction to Evolutionary programming – Evolutionary strategy – Comparison - Genetic Algorithm – Principles of Genetic operators - GA for optimization problems – Implementation issues - Applications.

TEXT BOOKS:

1. J.S.R. Jang, C.T. Sun and E. Mizutani, “Neuro Fuzzy and soft computing”, PHI, 97.
2. Timothy J.Ross. “Fuzzy Logic with Engineering Applications”, McGraw- Hill.
3. Goldberg, Genetic Algorithm in search, Optimization and machine learning, Addison Wesley,1998

REFERENCE BOOKS:

1. Zimmerman H.J. "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.

LIST OF ELECTIVES

EEE5010	HIGH VOLTAGE DIRECT CURRENT TRANSMISSION	L	T	P	C
		3	0	0	3

DC POWER 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.

ANALYSIS OF HVDC CONVERTERS

Pulse number, choice of converter configuration-simplified analysis of Graetz circuit-converter bridge characteristics – characteristics of a twelve pulse converter-detailed analysis of converters

CONVERTER AND HVDC SYSTEM CONTROL

General principles of DC link control-converter control characteristics-system control hierarchy-firing angle control-current and extinction angle control-starting and stopping of DC link-power control-higher level controllers-telecommunication requirements

HARMONICS&FILTERS

Introduction-generation of harmonics-design of AC filters-DC filters-carrier frequency and RI noise.

SIMULATION OF HVDC SYSTEMS

Introduction-system simulation: Philosophy and tools-HVDC system simulation-modeling of HVDC systems for digital dynamic simulation.

TEXT BOOKS

1. Padiyar, K.R., “HVDC Power Transmission System”, Wiley Eastern Limited, New Delhi 1990. First edition.
2. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering” New Age International (P) Ltd., New Delhi, 1990.

REFERENCES

1. Edward Wilson Kimbark, “Direct Current Transmission”, Vol. I, Wiley interscience, New York, London, Sydney, 1971.
2. Arrillaga, J., “High Voltage Direct Current Transmission”, Peter Pregrinus, London, 1983

EEE5011	SOLID STATE DRIVES	L	T	P	C
		3	0	0	3

DRIVE CHARACTERISTICS

Introduction – Classification and advantages -Equations governing motor load dynamics - Equilibrium operating point and its steady state stability - Mathematical condition for steady state stability and Numerical problems - Multi quadrant dynamics in the speed torque plane - Basics of regenerative braking - Typical load torque characteristics - Acceleration, deceleration, starting and stopping.

CONVERTER / CHOPPER FED DC MOTOR DRIVE

Phase controlled drives- four quadrant DC motor drive - Steady state analysis of the single and three phase fully controlled converter fed separately excited D.C motor drive- Continuous and discontinuous conduction mode - Chopper fed D.C drive- Time ratio control and current limit control - four quadrant chopper.

INDUCTION MOTOR DRIVES

Stator voltage control – braking and energy saving - Slip-power recovery drives - Adjustable frequency drives:-V/f control, constant slip-speed control and constant air-gap flux control – principle of vector control –Methods of improving power factor - Basics of voltage/current fed inverters - Block diagram of closed loop drive – switched reluctance and stepper motor drives.

SYNCHRONOUS MOTOR DRIVES

Open loop volts/hertz control and self-control of synchronous motor- Marginal angle control and power factor control – VSI/CSI fed drives – Need for leading power factor operation – excitation system- Permanent magnet synchronous motor.

DESIGN OF CONTROLLERS FOR DRIVES

Transfer function for dc motor, load and converter – Closed loop control with current and speed feedback - Armature voltage control and field weakening mode control - Design of controllers- Current controller and speed controller - Converter selection and characteristics.

TEXT BOOKS

1. R. Krishnan, ‘Electric Motor & Drives: Modelling, Analysis and Control’, Prentice Hall of India, 2001.
2. Bimal K. Bose. ‘Modern Power Electronics and AC Drives’, Pearson Education, 2002.

REFERENCE BOOKS

1. Dubey, G,K.,‘Power Semi-conductor Controlled Drives’, Prentice Hall of India, 1989.
2. Pillai, S,K.,‘A First Course on Electrical Drives’, Wiley Eastern Limited, 1993.

EEE5012	EHV POWER TRANSMISSION NETWORK	L	T	P	C
		3	0	0	3

INTRODUCTION

Standard Transmission Voltages – Average Values of Line Parameters – Power Handling Capacity and Line Loss – Costs of Transmission Lines and Equipment – Mechanical Considerations in Line Performance.

CALCULATION OF LINE PARAMETERS

Calculation of Resistance, Inductance and Capacitance – Calculation of sequence inductances and capacitances – Line parameters for Modes of propagation.

VOLTAGE GRADIENTS OF CONDUCTORS

Charge-Potential Relations for Multi-conductor lines – Surface Voltage Gradient on Conductors – Gradient Factors and their use – Distribution of Voltage Gradient on Sub conductors of Bundle - Voltage Gradients on Conductors in the Presence of Ground Wires on Towers.

CORONA EFFECTS

Power losses and audible losses- I^2R Loss and Corona Loss -Attenuation of Traveling Waves Due to Corona Loss - Audible Noise Generation and Characteristics - Limits for Audible Noise - Day-Night Equivalent Noise Level.

Radio Interference **:** corona pulse generation and properties - Limits for Radio Interference Fields - The CIGRE Formula - The RI Excitation Function -Measurement of RI, RIV and Excitation Function - Design of Filter.

ELECTROSTATIC FIELD OF EHV LINES

Capacitance of Long Object - Calculation of Electrostatic Field of AC Lines Effect of High Field on Humans, Animals, and Plants - Meters and Measurement of Electrostatic Fields - Electrostatic Induction in Unenergised Circuit of a D/C Line - Induced Voltages in Insulated Ground Wires - Electromagnetic Interference.

TEXT BOOK

1. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, New Age International Pvt. Ltd., 1990, Second Edition.

REFERENCE

1. Kuffel, E., Zaengl, W.S., and Kuffel J., High Voltage Engineering Fundamentals, Newness, Second Edition, Butterworth-Heinemann Publishers, New Delhi, 2000

EEE5013	DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

DISCRETE TIME SIGNALS AND SYSTEMS

Discrete Time Signals-Sequences - Stability and Casuality - Linear Shift invariant Systems- Frequency Domain representation of Discrete Time Systems and Signals. Two Dimensional Sequences and Systems-Z-Transform- Theorems and Prospects- Two Dimensional Z-transform-inverse Z- transform. Structures for Discrete time system.

DISCRETE FOURIER TRANSFORM

Representation of Periodic sequences-Fourier Series, Fourier Transform, Discrete Fourier series, Discrete Fourier transform and its properties-Linear and Circular convolutions-Decimation in time and Decimation in frequency, FFT Algorithm (Radix 2)-Two dimensional discrete Fourier transform.

FILTER DESIGN TECHNIQUES

Design of Butterworth and Chebyshev (Analog) filters-Properties of Digital and Analog Filters-Design of Digital filters (FIR & IIR)-FIR design using windows, IIR filter design using Bilinear and impulse invariant transformation-Comparison of IIR and FIR digital filters.

FINITE LENGTH EFFECTS IN DIGITAL FILTERS

Sampling-A/D and D/A conversion-Effect of coefficient of Quantization-Quantization in sampling Analog Signals-Finite Register Length effects in Realisation of Digital Filters-Discrete Fourier transform Computations.

DIGITAL SIGNAL PROCESSORS

Fixed Point DSP Architecture-floating point DSP Architecture – Fixed and floating point number Representations- Study of TMS 320C50 Processors-Basics of Programming using TMS 320C54 Processor.

TEXT BOOKS

1. J.G. Proakis and D.G. Manolakis, 'Digital Signal Processing Principles, Algorithms and Applications', Pearson Education, New Delhi, 2003 / PHI.
2. S.K. Mitra, 'Digital Signal Processing – A Computer Based Approach', Tata McGraw Hill, New Delhi, 2001.

REFERENCES

1. Alan V. Oppenheim, Ronald W. Schafer and John R. Buck, 'Discrete – Time Signal Processing', Pearson Education, New Delhi, 2003.
2. Venkataramani, B., Bhaskar,M., 'Digital Signal Processors, Architecture, Programming and Applications', Tata McGraw Hill, New Delhi, 2003.

EEE5014	ELECTRICAL DISTRUBUTION SYSTEM	L	T	P	C
		3	0	0	3

INTRODUCTION Industrial and commercial distribution systems – Energy losses in distribution system – system ground bunding for safety and protection – comparison of O/H lines and under ground cable system – single phase and three phase unbalanced network model – power flow, short circuit and loss calculations.

RELIABILITY ANALYSIS

Distribution system reliability analysis – reliability concepts – Markov model – distribution network reliability – reliability performance.

DISTRIBUTION SYSTEM PLANNING Distribution system expansion planning – load characteristics – load forecasting – design concepts – optimal location of sub station – design of radial lines – solution technique.

VOLTAGE CONTROL OF DISTRIBUTION SYSTEM
Voltage control – Application of shunt capacitance for loss reduction – Harmonics in the system – static VAR systems – Optimization for loss reduction and voltage improvement.

DISTRIBUTION SYSTEM PROTECTION
System protection – requirement – fuses and section analyzers over current. Under voltage and under frequency protection – coordination of protective device

TEXT BOOKS

1. Sullivan.” Power System Planning, TtaMcGraw Hill
2. Roy Billingtaon , Allan,R,N., Reliability evaluation of power system , Pitman,London, 1984 Edition

EEE5015	RENEWABLE POWER GENERATION	L	T	P	C
		3	0	0	3

PHOTO-VOLTAICS Basic characteristics of sunlight – solar energy resource – photovoltaic cell-characteristics – equivalent circuit – photo voltaic for battery charging – charge regulators – equipments and systems.

WIND TURBINES Wind source – wind statistics - energy in the wind – aerodynamics - rotor types – forces developed by blades – aerodynamic models – braking systems – tower - control and monitoring system – power performance.

EMBEDDED GENERATION Wind driven induction generators-power circle diagram-steady state performance –modeling-integration issues –

impact on central generation- transmission and distribution systems – wind farm electrical design.

BIO MASS POWER

Municipal waste – Methods for obtaining energy from Bio mass –Anaerobic digestion-Ethanol fermentation –Gas holder – Fuel gas – manure – cogeneration of electrical power – Gas turbine topping systems-MHD generator topping – Gas turbine – Combustion chamber – Efficiency of materials for gas turbine.

OTHER RENEWABLE SOURCES Micro-hydel electric systems – power potential – scheme layout – generation efficiency and turbine part flow-isolated and parallel operation of generators – geothermal-tidal and OTEC systems.

TEXT BOOKS

1. John F.Walker & Jenkins. N , 'Wind energy Technology ' , John Wiley and sons, chichester , U.K ,1997.
2. Agarwall ,M,P., ' Future sources of electrical power', S.Chand Co.Ltd., New Delhi, 1999.

REFERENCE

1. Van Overstraeton and Mertens R.P., 'Physics, Technology and use of Photovoltaic', Adam Hilger, Bristol,1996.

EEE5016	COMPUTER NETWORK ENGINEERING	L	T	P	C
		3	0	0	3

PROTOCOLS AND ARCHITECTURES

Protocols-layered approach-OSI model-DoD model-Hierarchical Approach-Local Network Technology- Bus/Tree topology-Ring topology-medium access protocols - Details of IEEE 802 standards.

NETWORK ACCESS PROTOCOL & INTERNETWORKING

Circuit Switched Network Access-Packet Switched Network Access-Broadcast Network Access-Principle of Internetworking-Bridges, Gateways-X, 75-internet protocols-ISO Internet protocol standard.

TRANSPORT PROTOCOL & ROUTING TECHNIQUES

Transport Service protocol Mechanisms-Network Service-Transport standards-Internet Transport protocols-Wireless UDP-Overview of routing techniques.

PRESENTATION/APPLICATION PROTOCOLS

File Transfer Protocols-World Wide Web-Electronic Mail-Overview of ISDN-ISDN Protocols.

NETWORK MANAGEMENT

Architecture of network management-Fault management-Congestion Control Algorithms-Security Management.

TEXT BOOK

1. Andrew Tannenbaum S., "Computer Networks ", 3rd Edition, Prentice Hall of India, 1997.

REFERENCES

1. Stallings, "Data and Computer Communication: Architectures, Protocols and Standards", IEEE Computer Society, 1987.
2. Kernel Texpian A.S., "Communication Network Management ", Prentice Hall, 1992.
3. " Network Management ", Standards, Uylers Black, McGraw Hill, 1995.
4. Commer and Stevens, " Internetworking with TCP/IP Vol.III: Client Server Programming and application ", Prentice Hall , USA, 1994.

SEMESTER III

EEE6010	VOLTAGE STABILITY	L	T	P	C
		3	0	0	3

INTRODUCTION

Voltage instability in power systems- voltage collapse ,causes of voltage instability- voltage instability mechanisms- classification of voltage instability – Transmission system aspects – maximum deliverable power , Power – voltage relationship, P-V and Q-V curves.

GENERATION ASPECTS

Review of synchronous machine theory – Frequency and voltage controllers – Limiting devices affecting voltage stability – Voltage – Reactive power characteristics of a synchronous generator – Capability curves – Effects of machine limitations on deliverable power.

LOAD ASPECTS

Load aspects – Voltage dependence of loads – load restoration dynamics- Induction motors- Load tap changers – Thermostatic load recovery – Generic aggregate load models.

VOLTAGE STABILITY

Loadability limit -sensitivity and bifurcation analysis- Saddle node bifurcation, static approaches-Modal analysis, Eigen value method, Power margin using continuation power flow-L-Index- Dynamic approaches – time domain simulation

VOLTAGE STABILTY ENHANCEMENT

Countermeasures for short term voltage instability – corrective actions against long term instability- Static VAR Compensator for voltage stability Enhancement

TEXT BOOKS

1. T.V Custem,C.Vournas, ‘ Voltage stability of Power systems” Kluwer Academic publishers,1998.

REFERENCE

1. Kundur,P., “Power System Stability and control”, EPRI publications

EEE6011	EVOLUTIONARY COMPUTATION TECHNIQUES	L	T	P	C
		3	0	0	3

INTRODUCTION

History pf Evolutionary computation- Genetic algorithm-Evolutionary stratergy- Evolutionary programming. Derivative methods-Stochastic processes- Modes of stochastic convergence- Schema processing-Transform methods-Fitness land scale- Probably approximately correct(PAC)- Learning Analysis- Limitation of Evolutioonary computation methods- Local performance measures

GENETIC ALGORITHM

Robustness of Traditional optimization and search techniques - The goals of optimization - Genetic Algorithm - An Overview of GA – Genetic operators - GA in problem solving - Implementation - Applications.

EVOLUTIONARY PROGRAMMING

Introduction- Representation- Reproductive Operators- Objective- Population sizes and dynamics- Convergence and stopping criteria

EVOLUTIONARY STRATEGIES

Introduction- ES and Real Valued Parameter optimization problem- Self Adaptation- Exploiting Parallelism- Dynamic Landscape.

HYBRID METHODS

Hybridization of Genetic Algorithm (GA) with Artificial Neural Networks (ANN) , Fuzzy Logic (FL) and other Optimization methods like Particle Swarm Optimization (PSO) and Ant Colony Optimization(ACO)- Case Studies and Application

.

TEXT BOOKS:

1. J.S.R. Jang, C.T. Sun and E. Mizutani, “Neuro Fuzzy and soft computing”, PHI, 1997.
2. Timothy J.Ross. “Fuzzy Logic with Engineering Applications”, McGraw- Hill.
3. Goldberg, Genetic Algorithm in search, Optimization and machine learning, Addison Wesley,1998.
4. Fogel, “ Evolutionary Computation”, Prentice Hall India Publications, 2001.

REFERENCE BOOKS:

1. Kosko. B, "Neural Networks and Fuzzy Systems", Prentice-Hall of India Pvt. Ltd., 1994.
2. Zimmerman H.J. "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.

EEE6012	POWER SYSTEM AUTOMATION	L	T	P	C
		3	0	0	3

INTRODUCTION

Definition of SCADA – Applicable processes – Elements of SCADA systems – SCADA Architecture - Operation and Control using SCADA - Development from telemetry – Dependence on communications & computers.

COMPONENTS OF AUTOMATED SYSTEMS

Sensors, Transducers and Actuators: Forgotten cost - Special considerations - Standardization & Maintenance. Remote Terminal Unit: Communication interface – Protocol detailed – Discrete control – Analog control - Pulse control – Serial control – Monitor discrete & analog signals – Monitor pulse count & serial signals. Master Terminal Unit: Communication interface – Configuring a picture of the process – Data storage – Applications.

COMMUNICATIONS

Analog to digital conversion –Communication models and types – Communication standards - Communications system components – Protocol – Modems – Field buses – Synchronous or asynchronous – Telephone cable or radio.

PROGRAMMABLE LOGIC CONTROLLERS

Structure of PLC - Control program – Programming: Simple Relay Layouts and Schematics - PLC Connections - Ladder Logic Inputs - Ladder Logic Outputs – Tutorial problems - Case studies

SUBSTATIONS AND DISTRIBUTION AUTOMATION

Substation Automation-Structure of Subsystem Automation - Substation communications - Substation functions through SCADA- Distribution Automation- Functions of distribution automation - Distribution Automation for improved Energy Management - Relative rating of communication media for DA- Automation in Process industries: SCADA systems in Industries - Requirements of Industrial Automation System - SCADA System in sugar Industries- Purification Systems - Evaporation - Crystallization - Centrifugation and Sugar Handling

TEXT BOOKS

1. Stuart A. Boyer, "SCADA: Supervisory Control and Data Acquisition", 3rd Edition, ISA-The instrumentation systems and Automation Society.
2. ISA's Practical Guide Series, "Analytical Instrumentation (1996), Maintenance of Instrumentation and systems – 2nd Editions (2005), Fundamentals of Industrial Control – 2nd Edition (2006).

EEE6013	POWER SYSTEM DEREGULATION	L	T	P	C
		3	0	0	3

INTRODUCTION

Introduction and different entities-Back ground and current situation in the world-Benefits form a completive electricity market & effects of deregulation-Review of Economic load dispatch-Recent development in ELD

OPTIMAL POWER FLOW

OPF as a base tool and model- Characteristic features of OPF-Unit commitment basic model and additional issues –Formation of power pools-Energy brokerage system

ROLE OF ISO

Structure of UK and Nordic Electricity sector-Operational planning activities of Gen co and Genco in pool and bilateral markets-UC and deregulated environment –Competitive bidding

TRANSMISSION SERVICES

Power Wheeling- Transmission open access-Types of transmission services in open access-Methods of pricing of power transactions-pricing mechanisms in UK-pricing mechanisms in chile & Sweden- Development in international transmission pricing in chile & Sweden

DEVELOPMENT IN INTERNATIONAL TRANSMISSION

Pricing in Europe-Security management in deregulated environment-Scheduling of spinning reserves & interruptible load options for security management-Congestion management in deregulation-Economic instruments for handling congestion.

TEXT BOOKS

1. Loi Lei Loi, "Power System Restructuring and Deregulation – Trading, performance& information technology", John Wiley Publications.
2. Kankar Bhattarcharya,et,al., Operation of restructured power systems, Kluwer academic publishers,2001.

REFERENCE BOKS:

1. Wood J..WoolenBerg B.F., Power generation and control John Wiley & Sons , 1996.

2. Marija Ilic, F.Galiana, L.Fink, "Power System Restructuring : Engineering and Economics" Kluwer Academic Publishers, 2000.

EEE6014	POWER QUALITY	L	T	P	C
		3	0	0	3

INTRODUCTION

Introduction –Power Quality- overview of power quality phenomena-classification of power quality issues-power quality measures and standards- THD-TIF-DIN-C- message weights-flicker factor- transient phenomena-occurrence of power quality problems-power acceptability curves- IEEE guides- standards and recommended practices.

HARMONICS

Harmonics- individual and total harmonic distortion- RMS value of a harmonic waveform-triplex harmonics- important harmonic introducing devices- SMPS-Three phase power converters-arcing devices- saturable devices- Harmonic Distortion of fluorescent lamps- effect of power system harmonics on power system equipment and loads-Modelling of network and components under non-sinusoidal conditions-transmission and distribution systems- shunt capacitors- transformers- electric machines-ground systems- loads that cause power quality problems- power quality problems created by drives and its impact on drives.

VOLTAGE RELATED PROBLEMS

Sources of sags and interruptions- estimating voltage sag performance-motor starting sags- estimating the sag severity-mitigation of voltage sags- active series compensators-static transfer switches and fast transfer switches- Sources of over voltages- Capacitor switching, lightning- Ferro resonance- mitigation of voltage swells- Surge arresters, low pass filters, power conditioners – Lightning protection, shielding, line arresters, protection of transformers and cables- computer analysis tools for transients, PSCAD and EMTP.

POWER QUALITY MONITORING

Monitoring considerations- Power line disturbance analyzer- per quality measurement equipment- harmonic / spectrum analyzer- flicker meters- disturbance analyzer-applications of expert system for power quality monitoring.

POWER QUALITY IMPROVEMENT

Static compensator – Distribution static compensator- Dynmic voltage restorer – Power factor corrector – Active filters – Shunt active filters- applications – PSCAD / EMTDC simulation of Active filters.

TEXT BOOKS

1. .Arrillaga, J.," Power System Quality Assessment" , John Wiley, 2000.
2. Arrillaga J., Smith,B,C.,Vatsan,N,R and Wood,A,R., "Power System Harmonic Analysis," John Wiley, 1997.

3.

REFERENCE BOOK:

1. Loi Lei Loi, "Power System Restructuring and Deregulation – Trading, performance & information technology", John Wiley Publications.
2. shok,S,A.," Selected Topics in Power quality and customer power " ,Course book for STTP 2004.
3. Surya Santoso, H.Wayne Beaty, Roger .C.Dugan, Mark .F.Mcgranaghan , Electric Power System Quality'Mc Graw hill 2002.
4. .Acha, E., Agelidis,V,G.,Anaya.,O., Laraand T.J.E.Miller, Power Electronic control in electrical systems.
5. Proceeding of VSAG 2005 – National Seminar Power Quality, EEE/A.K.College of Engineering.