Department of Electrical & Electronics Engineering

BIRLA INSTITUTE OF TECHNOLOGY, MESRA: RANCHI - 835215

COURSE STRUCTURE AND SYLLABUS OF ME PROGRAMME

Applicable from 2011 BATCH

MEE 1103 ADVANCED DIGITAL SIGNAL PROCESSING

Module - 1

Introduction: Discrete time systems, Discrete time signals, Analysis of discrete-time linear time invariant systems, Difference equation description.

Module - 2

Z-transform, Properties of Z-transform, Inverse of Z-transform, Chrip Z-ransform, Zury's test for stability, Digital filter structures: Direct form I & II, Cascade, Parallel and ladder realizations.

Module - 3

Frequency domain analysis, Discrete Fourier transform (DFT), Properties of DFT, Inverse DFT, Inter relationship with z-transform and Hilbert-transforms, Discrete Hilbert transform, FFT algorithms- Decimation in time and decimation in frequency.

Module - 4

Filter function approximation and transforms: Review of approximation of ideal analog filter response.

IIR filter: Designs based on analog filter approximation impulse invariant, Bilinear transformation, Direct design of IIR filters, Time domain design techniques. Buttorworth, Chebyshev type I & II, Elliptical filters.

Module - 5

Properties and design of FIR filters: Properties, Design techniques - window technique, Frequency sampling comparison of IIR and FIR filters.

Module - 6

Multirate digital signal processing, Introduction, Decimation by factor D, I sampling rate conversion by a rational factor I/D.

Module - 7

Introduction to continuous discrete and fast wavelet transforms.

Families of Wavelets: orthogonal and biorthogonal wavelets, Daubechies' family of wavelets in detail.

Text Books:

1. John G. Proakis, Dimitris G. Mamalakis, Digital Signal Processing, Principles, Algorithms and Applications
2. Alan V. Oppenheim Ronald W. Schafer, Digital Signal Processing, PHI, India.
3. Raghuveer M. Rao, Ajit S. Bopardikar, "Wavelet Transforms: An Introduction.

Reference Book:

1. Antonious, Digital Filter Design, Mc-Graw-Hill International Editions.
2. Wavelate Transform, S. Rao.
3. Wavelate Analysis: "The scalable structure of Information" Springer 2008 – Howard L. Resinkoff, Raymond O. Wells.

MEE 1101 MODERN CONTROL THEORY

1. Introduction

   Systems, modelling, analysis and control, continuous-time and discrete-time.

   (2)

2. State Variable Descriptions

   Introduction, concept of state, state equations for dynamic systems, state diagrams.

   (3)

3. Physical Systems & State Assignments

   Linear continuous-time and discrete-time models, non-linear models, local linearisation of non-linear model.

   (5)

4. Solution of State Equations

   Existence and uniqueness of solution, linear time-invariant continuous-time state equations, linear discrete-time state equations.

   (6)

5. Controllability & Observability

   Concept of controllability & observability, controllability and observability tests for continuous -time systems, controllability and observability of discrete-time systems, canonical forms of state models.

   (10)

6. State models and input-output descriptions

   Input-output maps from state model and vice-versa, transfer matrix, output controllability, reducibility.

   (6)

7. Modal Control

   Introduction, Effect of state feedback on controllability and observability, pole placement by state feedback; Full order observers, Reduced-order observers; deadbeat control by state feedback, deadbeat observers.

   (8)

8. Fractional Order Controller

   Fractional order calculus, Fractional order transfer function modelling, Frequency domain analysis of fractional order controller, Time domain analysis of time domain controller

Books Recommended :

1. Digital Control & State Variable Mathods – M. Gopal, Tata Macgrow
2. Modern Control System Theory by M. Gopal
3. Linear Systems by Thomas Kailath.
4. Modern Control Engg. by K. Ogata.

MEE 1119 CONTROL SYSTEM DESIGN

Module : 1

Performance characteristics of feedback control system & design specification of control loop. Different types of control applications and their functional requirement. Derivation of load-locus(touge/speed characteristics of load). Selection of motors, sensors, derives. Choice of design domain & general guidelines for choice of domain. Controller configuration and choice of controller configuration for specific design requirement. Fundamental principles of control system design. Experimental evolution of system dynamics in time domain and frequency domain.

Modue : 2

Design with PD controller: time interpretation of PD controller, Frequency domain interpretation of PD controller, Summary of the effects of PD controller. Design with PI controller: time domain interpretation of PI controller Frequency domain interpretation of PI controller, summary of the effects of PI Controller, Design with PID Controller, Ziegler Nichols tuning & other Methods

Module :3

Design with lag/lead/lag-lead compensator, time domain interpretation of lag/lead/lag-lead Compensator, Frequency domain interpretation of lag/lead/lag-lead compensator, summary of the effects of lag/lead/lag-lead compensator.

Module :4

Forward & Feed- Forward controller, Minor loop feedback control, concept of Robust design for control system, pole-Zero cancellation design.

Module :5

Sate feedback control, Pole Placement design through state feedback, state feedback with integral control, design state observer.

Module : 6

Design of discrete data control system: digital implementation of analog controller (PID) and lag lead controller, design of discrete date control system in Frequency domain and Z plane.

Module :7

Hardware and Software implementation of Common compensator: physical realization of common compensator with active and passive elements, tunable PID Algorithms- position and velocity algorithms.

Text Books:

i. B.C.Kuo, “Automatic Control System”, 7th Edition PHI.
ii. M.Gopal “Control System Principles & Design”, 2nd Editions, TMH.
iii. J.G.Truxal, “Automatic Feedback Control System”, McGraw Hill, New York.
iv. K. Ogata, “Discrete Time Control System”, 2nd Edition, Preason Education.

Reference Books:

i. Normal Nise, ”Control System Engineering”, 4th Edition.
ii. M.Gopal, ”Digital Control & State Variable Method”, TMH.
iii. B.C.Kuo, ”Digital Control System”, 2nd Edition, Oxford

MEE 1105 OPTIMIZATION IN ENGINEERING DESIGN

Module - 1
INTRODUCTION
Optimal problem formulation, Design variables constraints, Objective function, Variable bounds, Engineering optimization problems, Optimization algorithms.

Module - 2
ONE DIMENSIONAL SEARCH METHODS
Optimality Criteria, Bracketing methods: Exhaustive search methods, Region - Elimination methods; Interval halving method, Fibonacci search method, Golden section search method, Point-estimation method; Successive quadratic estimation method.

Module - 3
Gradient-based methods: Newton-Raphson method, Bisection method, Secant method, Cauchy's (Steepest descent) method and Newton's method.

Module - 4
LINEAR PROGRAMMING
Graphical method, Simplex Method, Revised simplex method, Duality in Linear Programming (LP), Sensitivity analysis, other algorithms for solving LP problems, Transformation, assignment and other applications.

Module - 5
MULTIVARIABLE OPTIMIZATION ALGORITHM
Optimality criteria, Unidirectional search, Direct search methods: Simplex search method, Hooke-Jeeves pattern search method.

Module - 6
CONSTRAINED OPTIMIZATION ALGORITHM
Characteristics of a constrained problem. Direct methods: The complex method, Cutting plane method, Indirect method: Transformation Technique, Basic approach in the penalty function method, Interior penalty function method, convex method.

Module - 7
ADVANCED OPTIMIZATION TECHNIQUES
Genetic Algorithm, Working principles, GAs for constrained optimization, Other GA operators, Advanced GAs, Differences between GAs and traditional methods.
Simulated anneating method, working principles.
Particle swarm optimization method, working principles.

Books Recommended:

1. Optimization for Engineering Design - Kalyanmoy Deb.
2. Optimization Theory and Applications - S.S. Rao.
3. Analytical Decision Making in Engineering Design - Siddal.
4. Linear Programming – G. Hadley

MEE 2101 SOFT COMPUTING TECHNIQUES

Module - 1

Introduction: Background, uncertainty and imprecision, statistics and random processes, uncertainty in Information. Fuzzy sets and membership, chance versus ambiguity, fuzzy control from an industrial perspective, Knowledge based systems for process control, knowledge based controllers, knowledge representation in knowledge based controllers.

Mathematics of Fuzzy Control : Classical sets, Fuzzy sets, Properties of fuzzy sets, operations on fuzzy sets. Classical relations and fuzzy relations - cartesian product, crisp relation, Fuzzy relations, Tolerance and Equivalence Relations, Fuzzy tolerance and equivalence relations, operation on fuzzy relations, The extension principle.

Module - 2

Membership Function: Features of membership functions, standard forms and boundaries, Fuzzyification, Membership value assignment.

Fuzzy-to-Crisp conversions: Lambda-cuts for fuzzy sets, Lambda-cuts for fuzzy relations. Defuzzification Methods

Module – 3

Introduction : Structure and foundation of Single Neuron, Neural Net Architectures, Neural Learning Application, Evaluation of Networks, Implementation.

Supervised Learning - Single Layer Networks, Perceptions, Linear saparability, Perception, Training algorithms, Guarantee of success, Modifications.

Module - 4

Multilayer Networks - Multilevel discrimination, preliminaries, backpropagation algorithm, setting the parameter values, Accelerating the learning process, Applications, RBF Network.

Module - 5

Unsupervised learnings - Winner take all networks, learning vector quantizers, ART, Topologically ortanised networks.

Associative Models - Non-iterative procedures for Association, hopfield networks,

Module - 6

Discussion of Neural Networks and Fuzzy Logic Application in areas of Power Electronics and motor control.

Text Books

1. Fuzzylogic with Engineering Applications - Timothy J. Ross, McGraw-Hill International Editions.

2. Fuzzy Sets and Fuzzy logic: Theory and Applications - George J. Klir and Bo. Yuan, Prentice-Hall of India Private Limited.

3. Neural Networks: A Comprehensive Foundation - Siman Haykin, IEEE, Press, MacMillan, N.Y. 1994.

References:

1. Elements of Artificial Neural Networks - Kishan Mehrotra, Chilakuri K. Mohan, Sanjay Ranka (Penvam International Publishing (India)

MEE 2123 NONLINEAR CONTROL SYSTEMS

Module – 1
Introduction to Nonlinear system, Types of nonlinearities, Characteristics, Linear approximation of nonlinear systems, Linearization of nonlinear state differential equation, Phase plane analysis: Phase plane representation, Phase portrait, graphical method to obtain phase trajectory, Singular points, Limit cycle.

Module – 2
Describing function analysis: Definition, Derivation of Describing functions for common nonlinear elements, Determination of amplitude and frequency of limit cycle using describing function technique.

Module - 3
Direct method of Liapunov: Introduction, Basic concepts, Stability definitions, Stability theorems, Liapunov functions for nonlinear systems, Methods for determination of Liapunov functions, popov stability criteria.

Module – 4
Chaos, fractals and solitans: Introduction, Modelling of dynamical systems: Differential equations and difference equations. Stable, unstable and chaotic systems, Chaos in feedback systems, Types of attractions: Point, periodic, quasiperiodic and strange attractors. Pathways to chaos, Geometry of fractals, Chaotic dynamics on fractals, Characterization of attractors from experimental data

Module – 5
Feedback Linearization: Motivation, Input-output linearization, Full state linearization, State feedback control: Stabilization, Tracking.

Module – 6
Sliding mode control: Sliding mode control: Sliding mode control: Motivation, Stabilization, Tracking, Regulation via integral control.

Module – 7
Gain Scheduling: Scheduling variables, Gain scheduled controller, Gain scheduled PI controller, Modification of gain scheduled controller, Development of a gain scheduled tracking controller for nonlinear systems.

Books Recommended :

1. B. C. Kuo, “Automatic Control System”7th Edition PHI.
2. M. Gopal, “Digital Control & State Variable Method”, TMH.
3. S. Banerjee, “Nonlinear Dynamics”.
4. Slotine, “Nonlinear Control Systems”.
5. Hassan K. Khalil, “Non Linear Systems”.

MEE 2125 STOCHASTIC PROCESSES

Module 1:

Introduction: Probability models in Electrical engineering. Basic concepts of Probability theory. Random experiments. Axioms of probability. Conditional probability. Independence of events. Sequential experiments.

(4)

Module 2:

Random Variables: Definition. Classification. Cumulative distribution function. Probability density function. Functions of Random Variables. Expected values. Moments. Variance and Standard deviation. Markov and Chebyshev inequalities. Testing a fit of a distribution to data. Transform methods: Characteristic function; Probability generating function; Laplace transform of the pdf. Transformation of random variable.

(5)

Module 3:

Multiple Random Variables: Vector random variables. Pairs of random variables. Independence of random variables. Conditional probability and conditional expectation. Multiple random variables. Functions of several random variables. Expected value of function of random variables. Jointly Gaussian random variables.

(4)

Module 4:

Sums of Random Variables and Long-term averages: Sums of random variables: Mean; Variance; pdf of sum of random variables. Sample mean and law of large numbers. Central Limit theorem. Minimum mean square error filtering: Estimating a random variable with a constant; stored data wiener filter; Real time wiener filter.

(4)

Module 5:

Random Processes: Definition. Specification: Joint distribution of time samples; Mean; Autocorrelation and Autocovariance functions. Discrete random processes: iid random processes; sum processes: Binomial counting and Random Walk processes. Continuous-time random processes: Poisson processes; Processes derived from Poisson processes; Wiener process and Brownian Motion. Stationarity. Time Averaging and Ergodicity

(10)

Module 6:

Analysis and Processing of Random signals: Power spectral Density: Continuous and discrete; Power spectral density as a time average. Response of Linear Systems to random signals. Amplitude modulation by random signals. Optimum Linear systems. Kalman Filter. Estimating the Power spectral density. White noise.

(5)

Module 7:

Markov Chains: Markov processes. Discrete-time Markov Chains. Continuous-time Markov Chains. Time reversed Markov Chains.

(4)

Text Book

1. Probability and random Processes for Electrical Engineering- A.Leon-Garcia

Reference Books

2. Probabaility, Random Variables and Stochastic Processes- A. Papoulis & S. U. Pillai.
3. Random Signals- K. Sam Shanmugan & A.M Breipohl.

MEE 1117 OPTIMAL CONTROL THEORY

Module - 1
Introduction:
Optimization overview, flow chart of linear optimal control technique, Parameter optimization, Minimization problem, Tracking problem, Regulator problem. Calculus of variation. Derivation of Eular-Lagrange equation. The problems of Lagrange, Mayer and Bolza

Module - 2
Application of the Eular-Lagrange Equation to a Linear, first order system, Langrange multiplier, Gradient based unconstrained minimization.

Module - 3
Formulation of the general nth-order system problem, The Hamiltonian formulation of classical mechanics, Modified Transversality conditions at $t = t_f$.

Module - 4
Pontryagins maximum principle, Hamilton - Jacobi Equation, Application of variation approach to control problem.

Module - 5
Quadratic form of performance index; statement of LQR problem, solution of finite time and infinite time regulator problem, solution of Riccati equation, Frequency domain interpretation of LQR design, Stability & robustness properties of LQR design, Linear Quadratic Gaussian (LQG) control.

Module - 6
Dynamic Programming: Multistage decision process, Concept of sub-optimization and principle of optimality, Recurrence relationship, computational procedure in dynamic programming

Module - 7
Adaptive Control System:
Adaptive Controllers, Identifications, Decision making, Modification, Application, Classification: Passive, Active, Dynamic Adaptive Control Systems, Adaptive PI controller for D.C. drive, learning machine.

Books Recommended:

1. Optimal control system – D.S. Naidu, CRS Press, 2003.
2. Introduction to optimum design – Jasbir S. Vora – Elsevier 2006.
3. Modern Control Theory – J. T. Tou

MEE 1109 ROBUST CONTROL SYSTEM

Introduction to Robust Control

Modeling, Uncertainty and Robustness, Co-prime factorization, System Stabilities, Sensitivity function, General regulator problem, Small-gain theorem

Norms

Norms of signals, Norms of systems, Relation between signals and systems norm, Computing 2 and ∞ norms, Multivariable norms.

Robustness Concepts

Internal stability, Plant uncertainty, parametric uncertainty, unstructured uncertainty, Linear fractional transformation, Robust stability, Robust performance

H_∞ Design

Mixed sensitivity problem, Augmentation of weighting functions, H_∞ solution, 2 degree of freedom H_∞ design, Optimal H_2 controller design, Loop shaping design procedure.

μ Analysis and Synthesis

Structured singular values, μ –Analysis, consideration of robust performance, D-K iteration method and μ-K iteration method.

Lower order controller design

Balanced truncation method, Singular perturbation approximation, Hankel norm approximation, Reduction via fractional factors.

Robust Control Case studies

Robust control design problems for: inverted pendulum, spring mass damper, Distillation column, electrical drives, aerospace systems.

Recommended Books

- J.C. Doyle, B.A. Francis, A.R. Tannenbaum, Feedback Control Theory, McMillan Publ., New York 1992.
- D.W. Gu, P. Hr Petkov and M.M. Konstantinov, Robust Control Design with MATLAB, Springer Verlag London Limited, 2005.
- S. Skogestad, I. Postelthwaite, Multivariable Feedback Control Analysis and Design. Second Edition. Wiley, chichester, UK, paperback [0-470-01168-8]

MEE 1107 Pattern Recognition

Module - I

Basics of pattern recognition : Overview of pattern recognition, Pattern Recognition Systems, Classification and Description, Pattterns and Feature Extraction, Training and Learning methods, Pattern Recognition approaches.

Module - II

Bayesian decision theory : Classifiers, Discriminant functions, Decision surfaces, Normal density and discriminant functions, Discrete features, Parameter estimation methods, Maximum-Likelihood estimation, Gaussian mixture models, Expectation-maximization method, Bayesian estimation

Module - III

Hidden Markov models for sequential pattern classification : Discrete hidden Markov models, Continuous density hidden Markov models, Dimension reduction methods, Fisher discriminant analysis, Principal component analysis

Module - IV

Non-parametric techniques for density estimation : Parzen-window method, K-Nearest Neighbour method

Module - V

Linear discriminant function based classifiers : Perceptron, Support vector machines, Multicategory Generalization

Module - VI

Non-metric methods for pattern classification : Non-numeric data or nominal data, Decision trees

Module - VII

Unsupervised learning and clustering : Criterion functions for clustering, Algorithms for clustering: K-means, Hierarchical and other methods, Cluster validation

Text Books:

1. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2001

Reference Books:

2. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press, 2009
3. C.M.Bishop, Pattern Recognition and Machine Learning, Springer, 2006

MEE 1111 ESTIMATION & IDENTIFICATION TECHNIQUES

Module - 1

Introduction - Definition of project, purpose, scope, project implementation and cost estimation, Economic operation, State estimation, Security assessment.

(3)

Module - 2

Fundamentals of random signals, Spectral estimation, Optimum (Wiener and Kalman) linear estimation, Estimation of scalar signals, Scalar Wiener filter, Scalar Kalman filter, Estimation of vector signals, Vector Kalman filter, Prediction.

(5)

Module - 3

Introduction to parameter estimation, Least squares and regression models. Least squares estimation, Recursive computation, Finite impulse response (FIR) models, Transfer function models, Probabilistic models for sensors and systems, Probabilistic estimation methods, Linear Kalman filter, Extended Kalman filter and their use in sensor-based estimation problems.

(8)

Module - 4

Estimation Theory: Discrete Line - Baye's theorem, Orthogonal projection Kemma, Prospectics of the minimum variance filters (Kalman filter), Linear exponential Gaussion estimation, Worst ease filter design, Extended Kalman filter, Modified gain extended Kalman filter.

(6)

Module - 5

Estimation Theory: Continuous-line - Continuous-line Kalman filter, Properties of Kalman filter (EKF), Linear minimum variance filter.

(5)

Module - 6

Linear quadratic optimal control, Non-linear systems, System identification, Non-parametric model identification, Correlation and spectral methods, Considerations in practical application.

(5)

Module - 7

Concept of adaptive control, Definitions, Types of adaptivity, Effects of process variation, Control essentials, Ratio of adaptive control and adaptive systems, Determination of adaptation gain, Design of Model Reference Adaptive Systems (MRAS) using Lyapunov theory, Relation between Model Reference Adaptive Systems (MRAS) and Self-Tuning Regulators (STR), Basic approaches and solutions, Transient of disturbances and modelling errors.

(8)

Books Recommended :

1. Optimization, Estimation and Control - A.E. Bryson & Y.C. Ho
2. Applied Optimal Estimation - A. Gelb, NIT Press, Cambridge
3. Optimal Estimation, Identification and Control - RCK Lee, NIT Press, Combridge, Massachusetts, 1964.
4. Stochastic Optimal Linear Estimation and Control - J.S. Meditch, McGraw Hill, N.Y., 1969.

MEE 1113 ROBOTICS AND A.I.

Module 1:

Introduction of Robotics: Evolution of Robots and Robotics. What is and what is not a robot. Robot classification. Robot specifications. Robot applications. Direct Kinematics: Coordinate frames; Rotations; Homogeneous coordinates; D-H representation; The Arm Equation.

(8)

Module 2:

Inverse Kinematics: Inverse kinematics problem, General properties of solutions, Tool configuration, Robotic work cell, Robot Arm Dynamics: Lagrange-Euler formulation; Newton Euler formulation; Generalized D'Alembert equation.

(7)

Module 3:

Workspace Trajectory and Trajectory Planning: Workspace analysis. Workspace envelope. Workspace fixtures. Pick and place operation. Continuous-path motion. Interpolated motion. Straight line motion.

(5)

Module 4:

Control of Robot Manipulators: Computed torque control; Near Minimum time control; Variable structure control; Non-Linear decoupled feedback control; Resolved motion and Adaptive control.

(5)

Module 5:

Robotic Sensors: Different sensors in robotics: Range; Proximity; Touch; Torque; Force and others.

(4)

Module 6:

Robotic Vision: Image acquisition and Geometry. Pre-processing; Segmentation and Description of 3-D structures; Recognition and Interpretation.

(8)

Module 7:

Robot Programming Languages, Robot Intelligence and Task Planning: Characteristics of Robot level languages. Task level languages- with examples C, prolog. Assembly etc. Problem reduction; Use of predicate logic; Robot learning; Expert systems.

(4)

Books Recommended:

1. Fundamental of Robotics: Analysis and Control- Robert J. Schilling.
2. Robotics: Control , Sensing ,Vision and Intelligence- K.S. Fu, R.C. Gonzalez and Lee.
3. Robotics and Control – R. K. Mittal and I. J. Nagrath.

MEE 2121 SYSTEMS BIOLOGY

Module I: Introduction

(A) A Basic Principles, Modelling Natural Systems, Differential Equations, Dynamic Systems Theory, Dealing with uncertainty, The System Biology approach, Cell Chemistry, Model behavior, Typical aspects of Biological Systems and corresponding models.

(B) Biology in Nutshell: The origin of life, Molecular Biology of the cell, Major classes of Biological Molecules, Structural Cell Biology, Expression of Genes, Cell cycle.

[05]

Module II: Biochemical Reactions

(A) Enzyme kinetics and Thermodynamics, The ODE Approach, Biochemical reaction modeling, Fundamental quantities and definitions, Basic principles and assumptions, Elementary reactions, Complex reactions, Parallel reactions, Autocatalytic reactions.

(B) Mathematical representation of Reconstructed Networks: Basic features of Stoichiometric Matrix, Topological properties, Fundamental subspaces of S, The (Right) Null Space of S, The left Null space of S, row and column spaces of S.

[05]

Module III: Dynamic systems Approach

(A) Pathways as Dynamic Systems, The Rote of Feedback, Phase-plane Analysis Nonlinear Dynamics.

[05]

Module IV: Stochastic Modelling and Simulation.

Introduction, Mass action models the average of CME? Stochastic Simulation, AN ODE to Differential Equations, Steady Sate Solution for the master equation, Temporal evolution of average and variance, Generating functions, summary.

[05]

Module V: Dynamic Modelling of Biochemical Networks

Michaeles-Menten modelling, Multinomial Systems, S-System, The Heinrich model MAP Kinase (MAPK) Pathway, The Ras/Raf/MEK/ERK Pathway, Feedback and Oscillations in Signaling pathways.

[05]

Module VI: Modules and Control Mechanisms:

Linear Module, Hyperbolic Model, Sigmoid Module, Robust or Adaptive Module, Feedback Systems.

[05]

Module VII: Modelling of Gen Expression

Modules of Gen Expression, Promoter identification, Modelling specific Processes in Eukaryotic Gen Expression. Modelling the expression of operons in E.Coli.

[05]

Books Recommended :

1. Systems Biology Dynamic Pathway Modeling – Olaf Wolkenhauer
2. System Biology Practice, Concepts, Implementation and Application by E. Klipp, R. Herwing, A. Konald, C. Wierling, H. Lehrach.
3. Systems Biology Properties of Reconstructed Networks – Bernhard O. Palsson

MEE 2117 MICROPROCESSOR APPLICATIONS

Module - 1 & 2

Intel 8086μp family architecture - namely Intel 8086/8088, 80186, 286, 386 Microprocessors. Instruction Enhancements, Addressing Modes, Concepts of segmentation, Real and virtual addressing.

(12)

Module - 3

Assembly language programming using 8086 μp for application oriented implementation. Use of MASM, assembler directives, Assembling, Linking programmes, Use of MACROS and conditional assembly, Program implementation and measurement of execution time. Use of BIOS ROM and DOS functions for program development.

(10)

Module - 4 & 5

Input/output operations using standard peripheral devices, 8255 and its modes, Interrupts, Interrupt driven processing, handshaking operation, Relay switching etc., applications using serial I/O using 8251 for asynchronous/synchronous communication, 8254 timer, 8237 DMA controller, and 8259 priority interrupt controller etc., interface chips.

(12)

Module - 6

A/D and D/A converters, types, speed of operation, execution speeds, Data Acquisition Applications.

(5)

Module - 7

DOS function calls, and writing application oriented programs for I/O control of Machines, Systems and Status.

(6)

Books Recommended :

1. Liu, Yu - Cheng and Gibson, Glenn. A., "Microcomputer Systems: The 8086 Family", Prentice-Hall of India Pvt. Ltd., New Delhi, India.
2. Gaonkar, Ramesh S., "Microprocessor, Architecture, Programming and Applications with 8085/8080 A", New Age International Pvt. Ltd., New Delhi, India.
3. Douglas V. Hall, "Microprocessors and Interfacing - Programming and Hardware", Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.
4. Miller, Alan R, “Assembly Language Techniques for the IBM PC”, BPB Publications New Delhi, India.

(MEE 2115) **Embedded System and Application** **(3-0-0)**

Module-1: Microcontrollers and their architecture: Introduction, general architecture of microcontrollers and microprocessors, types of microcontrollers, embedded processors. Overview of the 8051 family. 8051 architecture- memory organization, registers and I/O ports. Addressing modes , instruction sets, and assembly language programming. Introduction to C programming in 8051, Watchdog timer, Power down mode: idle/sleep mode.

Module-2: Interfacing: Programming timer/counter. Interrupts- handling and programming. Serial communication using 8051-Interfacing with RS232. 8051 interfacing with keyboard, ADC, DAC, and LCD module interface. Application of microntroller for square wave and rectangular wave generation, frequency counter etc.

Module-3: Microcontroller RISC family-ARM processor fundamentals: Register Organisation, pipeline, core. ARM instruction sets: data processing, branch ,load-store, interrupts & program status register instructions. Exceptions & interrupts: handling & priorities. Development & Debugging tools for microcontroller based system design: software and hardware tools like {cross assembler, compiler, debugger, simulator, in-circuit emulator.

Module-4: Embedded System Peripherals: Timers, Counters, example of reaction timer, UART, PWM generation, Controlling a dc motor using a PWM. General purpose processor, application specific instruction-set processor's (ASIP) and ASIC's, semiconductor IC's programmable logic device, Processor selection for embedded systems, special purpose processor.

Module-5: PIC microcontrollers: introduction, architecture (block diagram explanation only), and pin details of PIC 16F877 . Memory organization, ports and timers in PIC 16F877.

Module-6: DSP based control of stepper motor: Basic operation of stepper motors, excitation tables of stepper motor, drive system of stepper motor, implementation of control logic using LF 2407 DSP, programming techniques for speed control of stepper motor.

Module-7: DSP Based Control of BLDC Motor: Principle of BLDC motor, torque generation, BLDC motor control system, Implementation of BLDC motor control system using LF2407, subroutine for PWM generation and speed control of BLDC motor.

Text Books

1. Muhammad Ali Mazidi, The 8051 microcontroller and Embedded System, 2006, Pearson Education.
2. PIC 16F877 data book
3. Hamid A. Toliyat, Steven Campbell-DSP-Based Electro-mechanical Motion Control, CRC Press
4. Andrew N Sloss,Dominic Symes,Chris Wright, ARM Developer's Guide, Elsevier

Reference Books

1. ARM processor Data book
2. Kenneth Ayala, The 8051 Microcontroller, 3/ e, Thomson Publishing, New Delhi
3. David Seal,ARM Architecture Reference Manual
4. Wayne Wolf, Computers as Components: Principles of Embedded Computing system design, Else Vier, 2005

Resource Department/Center

1. Electrical and Electronics Engineering

MEE 1131 ADVANCED POWER SYSTEM ANALYSIS

Module - 1

Introduction - Modelling of power system component, Basic single-phase modelling, Generation, Transmission line, Transformers, Shunt elements.

(3)

Module - 2

Load Flow Analysis - Introduction, Nature of load flow equations, Newton Raphson method: Formulation for load buses and voltage controlled buses in rectangular and polar co-ordinates, Computational steps and flow chart, Computational Aspects of Large Scale System - Introduction, Sparsity oriented technique for reducing storage requirements, Factorization.

(7)

Module - 3

Decoupled load flow: Formulation, Fast decoupled load flow method, Continuation load flow technique, Series load flow technique.

(7)

Module - 4

Short Circuit Analysis - Introduction, Bus impedance matrix and its building algorithm through modifications, Fault calculation uses Z_{bus} and its computational steps. Symmetrical and Unsymmetrical faults.

(10)

Module - 5

Contingency Analysis - Introduction to power system security, Factors affecting power system security, Analysis of single contingencies, Linear sensitivity factors, Analysis of multiple contingencies, Contingency ranking.

(8)

Module - 6

Static state Estimation : Introduction, weighted least square technique, Statistics, Errors and estimates.

(4)

Module - 7

Harmonic Analysis - Power Quality, Sources, Effects of Harmonics, Harmonic load flow analysis, Supression of Harmonics.

(6)

Text Books

1. Power System Analysis - John J. Grainger, William D. Stevenson, Jr.
2. Power System Analysis - L. P. Singh

Reference Books

1. Electric Energy Systems Theory - An Introduction, O.L. Elgerd.
2. Computer Modelling of Electrical Power Systems - J. Arrillaga, N.R. Watson
3. Power System harmonic Analysis, J. Arrillage, B.C. Smith, et al.

MEE 1105 OPTIMIZATION IN ENGINEERING DESIGN

Module - 1
INTRODUCTION
Optimal problem formulation, Design variables constraints, Objective function, Variable bounds, Engineering optimization problems, Optimization algorithms.

Module - 2
ONE DIMENSIONAL SEARCH METHODS
Optimality Criteria, Bracketing methods: Exhaustive search methods, Region - Elimination methods; Interval halving method, Fibonacci search method, Golden section search method, Point-estimation method; Successive quadratic estimation method.

Module - 3
Gradient-based methods: Newton-Raphson method, Bisection method, Secant method, Cauchy's (Steepest descent) method and Newton's method.

Module - 4
LINEAR PROGRAMMING
Graphical method, Simplex Method, Revised simplex method, Duality in Linear Programming (LP), Sensitivity analysis, other algorithms for solving LP problems, Transformation, assignment and other applications.

Module - 5
MULTIVARIABLE OPTIMIZATION ALGORITHM
Optimality criteria, Unidirectional search, Direct search methods: Simplex search method, Hooke-Jeeves pattern search method.

Module - 6
CONSTRAINED OPTIMIZATION ALGORITHM
Characteristics of a constrained problem. Direct methods: The complex method, Cutting plane method, Indirect method: Transformation Technique, Basic approach in the penalty function method, Interior penalty function method, convex method.

Module - 7
ADVANCED OPTIMIZATION TECHNIQUES
Genetic Algorithm, Working principles, GAs for constrained optimization, Other GA operators, Advanced GAs, Differences between GAs and traditional methods.
Simulated anneating method, working principles.
Particle swarm optimization method, working principles.

Books Recommended:

5. Optimization for Engineering Design - Kalyanmoy Deb.
6. Optimization Theory and Applications - S.S. Rao.
7. Analytical Decision Making in Engineering Design - Siddal.
8. Linear Programming – G. Hadley

MEE 2131 POWER SYSTEM OPERATION AND CONTROL

Module - 1

Introduction - Operating States, Preventive and Emergency control, Indian Electricity Grid Code, Co-ordination between different agencies in India.

(7)

Module - 2

Load Frequency Control - Introduction, Types of speed governing system and modelling, Mechanical, Electro-hydraulic, Digital electro-hydraulic governing system, Turbine modelling, Generator-load modelling, Steady-state and dynamic response of ALFC loop, the secondary ALFC loop, Integral control.

(8)

Module - 3

Multi-control-Area System - Introduction, Pool operation, Two-area system, Modelling the tie line, Static and dynamic response of two area system, Tie-line bias control, State space representation of two-area system, Generation allocation, Modern implementation of AGC scheme, Effect of GRC and speed governor dead-based on AGC.

(8)

Module -4

Excitation System - Introduction, Elements of an excitation system, Types of excitation system, Digital excitation system, modelling.

(5)

Module - 5

Optimum Operating Strategies - Introduction, Generation mix, Characteristic of steam and Hydro-electric units, Optimum economic dispatch - neglecting Loss and with transmission loss, Computational steps, Derivation of loss formula, Calculation from Jacobian matrix equation, Economic dispatch for Hydro-thermal plants, Short-term Hydro-thermal scheduling, Hydro-thermal co-ordination, Reactive power scheduling.

(6)

Module - 6

Unit Commitment - Introduction, Constraints in unit commitment, Thermal unit constraints, Hydro-constraints, Unit commitment solution method - Priority list method, Dynamic programming solution.

(5)

Module - 7

Power System Restructuring : introduction, Regulation vs. Deregulation, Competitive Market for Generation, The Advantages of Competitive Generation, Electric Supply Industry Structure Under Deregulation in India. Restructuring Models

(6)

Text Books :

1. Electric Energy Systems Theory an Introduction - Olle I. Elgerd
2. Power Generation Operation and Control - A.J. Wood, B.F. Wollenberg

Reference Books :

3. Power System Deregulation by Loi Lei Lai
4. Power System Stability and Control - P. Kundur

MEE 2137 POWER SYSTEM DYNAMICS

Module - 1

Introduction to Power System Stability problem: Stability classification - Small signal & Transient stability, Rotor angle & Voltage stability, Hierachy of controls in a Power System.

(5)

Module - 2

Synchronous machine modelling: Basic equations, dqo transformation, equations of motion, generator operated as part of large power grid.

(7)

Module - 3

Excitation System: Requirements of excitation system, Elements of excitation system, Types of excitation system, Modelling of excitation system.

(7)

Module - 4

Power system loads: Static load models, Dynamic load models.

(5)

Module - 5

Small Signal (Steady State) Stability: Linearization, State matrix, modal analysis technique.

(7)

Module - 6

Transient Stability Studies: Network performance equations, alternate solution techniques - Runga Kutta & Trapezoidal, Methods of enhancement of transient stability.

(7)

Module - 7

Voltage Stability: Basic concepts related to voltage stability and voltage, Classification, Aspects of voltage stability analysis, Modelling requirements.

(7)

Books Recommended:

1. Power System Stability and Control, P. Kundur.
2. Electric Energy System Theory – O.I. Elgerd
3. Power System Dynamics – K.R.Padiyar

MEE 1133 EHV AC POWER TRANSMISSION

Module - 1

General Background & State of art of EHV AC Transmission Technology
Bundled conductors, Maxwell's Coefficients, Inductance and capacitance matrices
(8)

Module - 2
Surface Voltage gradient on bundled conductors, Mangoldt's formula, Gradient factors.
(6)

Module - 3
Corona Effects : Power Loss, Audible noise, BI & TVI.
(6)

Module - 4
Ground level electrostatic field of EHV Lines
(5)

Module - 5
Power-frequency over voltages & Voltage Control, Series & Shunt Compensation.
(7)

Module - 6
Static Var Compensator: Introduction, Principles of operation, Types of SVC, Introduction to FACTS.
(7)

Module - 7
Switching over-voltages in EHV Systems.
(6)

Books recommended:

1. R.D. Begamudre, Extra High Voltage AC Transmission Engineering, Wiley Eastern Ltd., 1986.
2. S.Rao, EHV AC and HVDC Transmission Engineering & Practice, Khanna Publishers, Delhi, 1990.

MEE 1135 POWER SYSTEM PLANNING & RELIABILITY

Module - 1

Introduction : Hierarchy of modern power system planning, Brief description about short term and long term planning.

Introduction to Reliability Engineering: Definition of reliability, Probabilistic reliability, Repairable and non-repairable items, the pattern of failures with time (non-repairable and repairable items).

(8)

Module - 2

Generation expansion planning: fundamentals, Economic analysis, planning including maintenance scheduling.

(5)

Module - 3

Network expansion planning: Introduction, Heuristic methods, Mathematical optimization methods.

(7)

Module - 4

Reliability Mathematics : The general reliability function, The exponential distribution, Mean time to failure and repair, series and parallel systems, Markov processes, System reliability using network and state space method.

(7)

Module - 5

Static Generating Capacity Reliability Evaluation: Introduction, Capacity outage probability tables, Loss of load probability (LOLP) method, Loss of energy probability (LOLE) method, Frequency and duration approach.

(6)

Module - 6

Spinning Generating Capacity Reliability Evaluation: Introduction, Spinning capacity evaluation, Derated capacity levels.

(6)

Module - 7

Transmission System Reliability Evaluation: Average interruption rate method, the frequency and duration approach, Stormy and normal weather effects, The Markov processes approach, System studies.

(6)

Text Books:

1. Power System Reliability Evaluations - R. Billinton, Gordon and Breach Science Publishers, New York.
2. Modern Power System Planning, X, Wang and J.R. McDonald, McGraw-Hill Book Company.
3. Reliability Modeling in Electric Power Systems, J. Endrenyi, John Wiley & Sons, New York.

Reference Books

1. Practical Reliability Engineering, Patrick D.T. O'Connor, John Wiley & Sons, (Asia) Pte Ltd., Singapore.
2. Reliability of Engineering Systems - Principles and Analysis, I. Ryabinin, MIR Publishers, Moscow.

MEE 1139 MODERN POWER SYSTEM PLANNING

Module - 1

Introduction: Hierarchy of modern power system planning, Brief description about short term and long term planning.

(4)

Module - 2

Load Forecasting: Classification and characteristics of loads, Forecasting methodology (extrapolation and correlation), Energy forecasting, Peak demand forecasting, Non-weather sensitive forecast (NWSF), Weather-sensitive forecast (WSF), Total forecast, Annual and monthly peak demand forecast.

(7)

Module - 3

Power System Reliability Calculation: Mathematical basics for reliability calculation, Power system component reliability models, Reliability of power generation system.

(6)

Module - 4

Power System Probabilistic Production Simulation: Fundamentals of production simulation, Cumulant method in probabilistic production simulation, Equivalent energy function method, Simulation of hydroelectric generating units and pump-storage units.

(7)

Module - 5

Maintenance Scheduling of Generating Units in a Power System: Introduction, Levelized reserve method, Levelized risk method, Maintenance scheduling using soft computing techniques.

(7)

Module - 6

Generation Expansion Planning: Fundamental economic analysis, Generation planning optimized according to generating unit categories (WASP), Generation planning optimized according to power plants (JASP).

(7)

Module - 7

Network Planning: Introduction, Heuristic methods of network planning, Network planning by mathematical optimization, Fast static security contingency analysis, Probabilistic load flow calculation.

(7)

Books Recommended:

1. Modern Power System Planning, X, Wang and J.R. McDonald, McGraw-Hill Book Company.
2. Power System Planning, R.L. Sullivan, McGraw-Hill International Book Company

MEE 1121 HVDC POWER TRANSMISSION

Module - 1

Introduction to HVDC transmission: Comparison with EHV AC power transmission, HVDC system configuration and components.

(6)

Module - 2

Principles of AC/DC conversion: Converter connections, Wave forms, Relevant Equations, Reactive Power requirements

(6)

Module - 3

Harmonics and Filters : Waveforms of a-c bus currents in Star/Star, Star/delta & 12-phase converters and their Fourier-series representations, Non-characteristic harmonics, Harmful Effects of Harmonics, DC side harmonics, Filters and detuning, Cost considerations of filters.

(7)

Module - 4

HVDC system control : CC and CEA controls, Static characteristics of converters, Combined characteristics of rectifier and inverter, Power reversal, Asynchronous & synchronous HVDC links, Frequency Control of A.C. system, Stabilisation & damping of A.C. networks, CP Control

(7)

Module - 5

HVDC circuit Breakers and Protection: Response to dc and ac system faults, DC line fault, AC system fault, Converter fault.

(6)

Module - 6

HVDC systems elements: Converter transformers, D.C. smoothing reactors, Thyristor valves etc., Earth electrodes & earth return

(6)

Module - 7

HVDC links and classification: Monopolar links, Bipolar links, Homopolar links.

HVDC-AC interactions: SCR, Problems with low ESCR system, Solutions to problems associated with weak system.

(7)

Books Recommended

1. HVDC Power Transmission Systems by K. Padiyar, Wiley Eastern Ltd.
2. Direct Current Transmission by E.W.Kimbark, Wiley InterScience-New-York
3. HVDC Transmission by J.Arillaga, Peter Peregrinus Ltd; London U.K.,1983
4. Power Transmission by Direct Current by E.Uhlman, Springer Verlag, BerlinHelberg,1985

MEE 1115 POWER SYSTEM RELIABILITY

Module - 1

Introduction to Reliability Engineering: Definition of reliability, Probabilistic reliability, Repairable and non-repairable items, the pattern of failures with time (non-repairable and repairable items).

(4)

Module - 2

Reliability Mathematics : The general reliability function, The exponential distribution, Mean time to failure and repair, series and parallel systems, Markov processes, System reliability using network and state space method.

(7)

Module - 3

Static Generating Capacity Reliability Evaluation: Introduction, Capacity outage probability tables, Loss of load probability (LOLP) method, Loss of energy probability(LOLE) method, Frequency and duration approach.

(7)

Module - 4

Spinning Generating Capacity Reliability Evaluation: Introduction, Spinning capacity evaluation, Derated capacity levels.

(7)

Module - 5

Transmission System Reliability Evaluation: Average interruption rate method, the frequency and duration approach, Stormy and normal weather effects, The Markov processes approach, System studies.

(7)

Module - 6

Composite System Reliability Evaluation Considering Interconnection: Service quality criterion, Conditional probability approach, Two-plant single load and two load systems. The probability array for two interconnected systems, Loss of load approach, Interconnection benefits.

(7)

Module - 7

Direct Current Transmission System Reliability Evaluation: System models of failure, Loss of load approach, Frequency and duration approach, Spare-valve assessment, multiple bridge equivalents.

(6)

Text Books:

1. Power System Reliability Evaluations - R. Billinton, Gordon and Breach Science Publishers, New York.
2. Reliability Modeling in Electric Power Systems, J. Endrenyi, John Wiley & Sons, New York.

Reference Books

3. Practical Reliability Engineering, Patrick D.T. O'Connor, John Wiley & Sons, (Asia) Pte Ltd., Singapore.
4. Reliability of Engineering Systems - Principles and Analysis, I. Ryabinin, MIR Publishers, Moscow.

MEE 2139 POWER SYSTEM DEREGULATION

Module- 1

Power System Restructuring: introduction, Regulation vs. Deregulation, Competitive Market for Generation, The Advantages of Competitive Generation, Electric Supply Industry Structure under Deregulation in India

(4)

Module- 2

Restructuring Models: Introduction, Monopoly, Single Purchasing Agent Model, Wholesale Competition Model, Pool Model, Bilateral, Different Independent System Operator Model.

(5)

Module- 3

International Experiences: Introduction, North American Deregulation Process: California State, Canada, England and Wales, China

(5)

Module- 4

Competitive Wholesale Electricity Markets: Introduction, Bidding, Market Clearing and Pricing, Central Auction, Unit Commitment Based Auction Model, Market Power and Mitigation

(8)

Module- 5

Transmission Pricing: Introduction, cost components of Transmission system, pricing of transmission services, location based marginal costing.

(5)

Module- 6

Congestion Management: Introduction, Different ways of congestion management, impact on marginal price, congestion pricing, Inter-zonal and intra zonai congestion management.

(5)

Module- 7

Power system Analysis and operation in deregulated environment: Load Flow, OPF, Profit Based Unit commitment, and Automatic Generation Control in Deregulated environment.

(10)

Text Books

1. Power System Deregulation by Loi Lei Lai
2. Course material on "Operation and Management in Restructured Environment"- Edited by Dr. S.N. Singh, IIT, Kanpur

Reference Book

1. Understanding Electric Utilities and Deregulation by L. Philipson, N.L. Willis

MEE 1135 POWER SYSTEM PLANNING & RELIABILITY

Module - 1

Introduction : Hierarchy of modern power system planning, Brief description about short term and long term planning.

Introduction to Reliability Engineering: Definition of reliability, Probabilistic reliability, Repairable and non-repairable items, the pattern of failures with time (non-repairable and repairable items).

(8)

Module - 2

Generation expansion planning: fundamentals, Economic analysis, planning including maintenance scheduling.

(5)

Module - 3

Network expansion planning: Introduction, Heuristic methods, Mathematical optimization methods.

(7)

Module - 4

Reliability Mathematics : The general reliability function, The exponential distribution, Mean time to failure and repair, series and parallel systems, Markov processes, System reliability using network and state space method.

(7)

Module - 5

Static Generating Capacity Reliability Evaluation: Introduction, Capacity outage probability tables, Loss of load probability (LOLP) method, Loss of energy probability (LOLE) method, Frequency and duration approach.

(6)

Module - 6

Spinning Generating Capacity Reliability Evaluation: Introduction, Spinning capacity evaluation, Derated capacity levels.

(6)

Module - 7

Transmission System Reliability Evaluation: Average interruption rate method, the frequency and duration approach, Stormy and normal weather effects, The Markov processes approach, System studies.

(6)

Text Books:

4. Power System Reliability Evaluations - R. Billinton, Gordon and Breach Science Publishers, New York.
5. Modern Power System Planning, X, Wang and J.R. McDonald, McGraw-Hill Book Company.
6. Reliability Modeling in Electric Power Systems, J. Endrenyi, John Wiley & Sons, New York.

Reference Books

2. Practical Reliability Engineering, Patrick D.T. O'Connor, John Wiley & Sons, (Asia) Pte Ltd., Singapore.
2. Reliability of Engineering Systems - Principles and Analysis, I. Ryabinin, MIR Publishers, Moscow.

ME 2159 APPLICATIONS OF POWER ELECTRONICS IN POWER SYSTEMS

Module-I : Introduction

High power devices for power system controllers - characteristics - converters configurations for large power control-Single and three phase converters, Power flow analysis: Component models –Converter model -analysis of converter - Transient and dynamic stability analysis – protection.

(6)

Module-II : **Introduction to Flexible AC transmission systems (FACTS)**

Steady state and dynamic problems in AC systems - Principles of series and shunt compensation . Description of: static var compensation (SVC), Thyristor Controlled series compensators, (TCSC) - Static phase shifters (SPS) - Static condenser (STATCON)

(5)

Module-III : **Other FACTS Devices**

Static synchronous series compensator (SSSC). Unified power flow controller (UPFC) - Modelling and Analysis of FACTS controllers.

(5)

Module-IV : **Wind Energy Systems**

Basic Principle of wind energy conversion - nature of wind - components of a wind energy - conversion system - Performance of induction generators for WECS - classification of WECS. Self excited induction generator for isolated power generators - Theory of self-excitation - Capacitance requirements - Power conditioning schemes - controllable DC Power from SEIGs-system performance. Grid Connected WECS.

(8)

Module-V: Photovoltaic Energy Conversion

Solar radiation and measurement - solar cells and their characteristics - influence of insulation and temperature - PV arrays - Electrical storage with batteries - solar energy availability in India - Switching devices for solar energy conversion, Maximum power point tracking. DC Power conditioning converters,

AC power conditioners - Line commutated inverters - synchronized operation with grid supply

(8)

Module VI : Smart Grid

Principal characteristics of smart Grid, Self Healing Grid, Motivates and includes the Customer, Accommodates all Generation and Storage Options , Integrated Communications,. Sensing and Measurement/Advanced Metering

(5)

Module-VII: Power Quality problems in distribution systems , Harmonics - Harmonics creating loads -modeling - Harmonic propagation, Mitigation of harmonics – Filters -Passive filters-Active filters – Shunt, Series Hybrid filters

(5)

References:

Understanding FACTS**:** concepts and technology of flexible AC transmission systems
Narain G. Hingorani, Laszlo Gyugyi ,IEEE Press, 2000
2 Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Prentice -Hall of India Private Ltd. New Delhi
3. . Rao, S.,"EHVAC and HVDC Transmission", Khanna Publishers, 1991.
4 Rai, G.D.,"Solar Energy Utilisation", Khanna Publishers, New Delhi, 1991.
5.. Gray.L.Johnson, "Wind energy systems", Prentice Hall Inc., 1985

MEE 1155 DYNAMIC ANALYSIS OF ELECTRICAL MACHINES

1. Principles of electromagnetic energy conversion:
General expression of stored magnetic energy, co-energy and force/torque, example using single and doubly excited system; Calculation of air gap mmf and per phase machine inductance using physical machine data; Voltage and torque equation of dc machine, three phase symmetrical induction machine and salient pole synchronous machines in phase variable form.

(8)

2. Introduction to reference frame theory:
Concept of two pole generalized machine. Rotating & transformer voltage, principle of Kron's primitive machine, transformation of three-phase to two phase variables and its vice versa, physical concept of park transformation, d-q axis transformations for three phase R-L and capacitive circuit.

(6)

3. **DC Machine Dynamic Analysis:**
Voltage and torque equations-modeling of different dc motor under normal motoring and fault condition, steady state analysis, state space and transfer function modelling.

(4)

4. Dynamic Modeling of IM:
Dynamic direct and quadrature axis model in arbitrarily rotating reference frames, voltage and torque equations, derivation of steady state phasor relationship from dynamic model, synchronously rotating reference frame model, and stationery reference frame dynamic model. Dynamic model state space equations. Dynamic modelling of high torque cage motors and single phase IM.

(8)

5. Determination of synchronous machine dynamic equivalent circuit parameters:
Dynamic d-q axis modelling of wound field SM, Voltage and torque equation with respect to arbitrary reference and rotating reference frame, steady-state analysis, Dynamic performance under load and torque variation, under fault condition.

(6)

6. Permanent magnet synchronous and BLDC machine:
Surface permanent magnet (square and sinusoidal back emf type) and interior permanent magnet machines, construction, operating principle and true synchronous characteristics, dynamic modeling and self controlled operation; Construction and operation of BLDC Motor, mathematical model of BLDC motor, commutation torque ripples, Impact of motor inductance on the dynamic performance. (8)

7. Analysis of Stepper Motors and Switch Reluctance Motors:
Stepper motors operation, classification, features of stepper motor, operation of switched reluctance motor, expressions of torque.

(4)

Books Recommended :

1. Generalized Theory of Electrical machines- Dr. P.S.Bimbhra
2. Generalized Theory of AC Machines- B. Adkins & R.G. Harley
3. Electric Machinery- A.R. Fitzgrald
4. Dynamic Simulation of Electric Machinery using Matlab/simulink-Chee-Mun Ong

MEE 1151 ADVANCED POWER ELECTRONICS (For MO2012)

1. **Introduction:**
   Power Electronic Devices: (Diodes, Thyristors), Transistors, MOSFET, IGBT, IGCT, etc.- operating principle, Static & dynamic characteristics, Data sheet ratings; Thermal characteristics of power devices; Sample Gate drive circuits;
   (5)

2. **Switched Mode Power Supply:**
   Forward and flyback converter circuits: operation, waveforms analysis, small signal analysis of DC-DC converters and closed loop control.
   (5)

3. **Resonant Converters:** Operating principle, waveforms analysis, switching trajectory, losses and control.
   (4)

4. **PWM inverter modulation strategies & dual bridge:**
   Sine wave with third harmonic, space vector modulation and predictive current control techniques; PWM rectifier; Input side bidirectional power flow requirement for regeneration & Dual thyristor bridge.
   (5)

5. **AC-AC Converter :**
   Cycloconverters: Circuit, operating principle, control, harmonics, power factor and applications; Non-drive application of power electronic converters: Matrix Converter- circuit and its operation.
   (5)

6. **Multi- level inverter :**
   Basic topology and waveform, improvement in harmonics and high voltage application;
   (5)

7. **Introduction to application oriented chips:**
   Industrial PWM driver chips for power supplies such as UC 3843, 3825 or equivalent; Industrial gate driver chips for PWM voltage source inverters with isolation and protection circuits. Intelligent power modules.
   (4)

Reference Books:

1. Power Electronics, circuits, devices & applications- M.H. Rashid
2. Power Electronics: converter, application & design- N. Mohan, T.N. Undeland & Robins
3. Electric Motor Drives- R. Krishnan
4. Modern Power Electronics & Drives-B.K. Bose

MEE 1105 OPTIMIZATION IN ENGINEERING DESIGN

Module - 1
INTRODUCTION
Optimal problem formulation, Design variables constraints, Objective function, Variable bounds, Engineering optimization problems, Optimization algorithms.

Module - 2
ONE DIMENSIONAL SEARCH METHODS
Optimality Criteria, Bracketing methods: Exhaustive search methods, Region - Elimination methods; Interval halving method, Fibonacci search method, Golden section search method, Point-estimation method; Successive quadratic estimation method.

Module - 3
Gradient-based methods: Newton-Raphson method, Bisection method, Secant method, Cauchy's (Steepest descent) method and Newton's method.

Module - 4
LINEAR PROGRAMMING
Graphical method, Simplex Method, Revised simplex method, Duality in Linear Programming (LP), Sensitivity analysis, other algorithms for solving LP problems, Transformation, assignment and other applications.

Module - 5
MULTIVARIABLE OPTIMIZATION ALGORITHM
Optimality criteria, Unidirectional search, Direct search methods: Simplex search method, Hooke-Jeeves pattern search method.

Module - 6
CONSTRAINED OPTIMIZATION ALGORITHM
Characteristics of a constrained problem. Direct methods: The complex method, Cutting plane method, Indirect method: Transformation Technique, Basic approach in the penalty function method, Interior penalty function method, convex method.

Module - 7
ADVANCED OPTIMIZATION TECHNIQUES
Genetic Algorithm, Working principles, GAs for constrained optimization, Other GA operators, Advanced GAs, Differences between GAs and traditional methods.
Simulated anneating method, working principles.
Particle swarm optimization method, working principles.

Books Recommended:
9. Optimization for Engineering Design - Kalyanmoy Deb.
10. Optimization Theory and Applications - S.S. Rao.
11. Analytical Decision Making in Engineering Design - Siddal.
12. Linear Programming – G. Hadley

MEE 2155 Power Electronics Application

Module-I : Electrical vehicles:
Introductions, types of electrical vehicle, energy management in electrical vehicles, features, various subsystem in electrical vehicles. Future scopes

(7)

Module-II : **Hybrid Electrical Vehicle:**
Introduction, Types of hybrid electrical vehicle, series, parallel, series parallel and complex. According to hybridization- micro, mild and heavy HEV, mechanical power splitter and electrical power splitter, advantages and disadvantages, sizing of HEV, Power flow, Energy management,

(6)

Module-III: **Introduction to Flexible AC transmission systems (FACTS)**
Steady state and dynamic problems in AC systems - Principles of series and shunt compensation. Description of: static var compensation (SVC), Thyristor Controlled series compensators, (TCSC) - Static phase shifters (SPS) - Static condenser (STATCON)

(8)

Module-IV : **Wind Energy Systems**
Basic Principle of wind energy conversion - nature of wind - components of a wind energy - conversion system - Performance of induction generators for WECS - classification of WECS. Self excited induction generator for isolated power generators - Theory of self-excitation - Capacitance requirements - Power conditioning schemes - controllable DC Power from SEIGs- system performance. Grid Connected WECS.

(8)

Module-V: Photovoltaic Energy Conversion
Solar radiation and measurement - solar cells and their characteristics - influence of insulation and temperature - PV arrays - Electrical storage with batteries - solar energy availability in India - Switching devices for solar energy conversion, Maximum power point tracking. DC Power conditioning converters,
AC power conditioners - Line commutated inverters - synchronized operation with grid supply

(8)

Module VI : HVDC Transmission
HVDC system control : CC and CEA controls, Static characteristics of converters, Combined characteristics of rectifier and inverter, Power reversal, Asynchronous & synchronous HVDC links, Frequency Control of A.C. system, Stabilisation & damping of A.C. networks, CP Control.

Module-VII: Power Quality problems in distribution systems , Harmonics - Harmonics creating loads -modeling - Harmonic propagation, Mitigation of harmonics – Filters -Passive filters- Active filters – Shunt, Series Hybrid filters (5)

Books Recommended:

Understanding FACTS**:** concepts and technology of flexible AC transmission systems
Narain G. Hingorani, Laszlo Gyugyi ,IEEE Press, 2000
2 Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Prentice -Hall of India Private Ltd. New Delhi
3. . Rao, S.,"EHVAC and HVDC Transmission", Khanna Publishers, 1991.
4 Rai, G.D.,"Solar Energy Utilisation", Khanna Publishers, New Delhi, 1991.
5.. Gray.L.Johnson, "Wind energy systems", Prentice Hall Inc., 1985

MEE 2153 CONTROL OF ELECTRICAL DRIVES

1 **Introduction to Electrical Drives:**
Drive concepts, different machines & load characteristics, equilibrium and steady state stability, four quadrant operation, referred inertia and load torque for different coupling mechanism, thermal selection of machines (7)

2 **DC Motor drives:**
Operating limits using armature voltage control and field control techniques, dynamic model (armature voltage control only) of machine and converters (continuous conduction only), open-loop dynamic performance, closed loop control using single (speed) and two loops (speed, current), implementation of four quadrant operation. modeling and control of separately excited dc machine in field weakening region and discontinuous converter conduction mode, design of close loop speed controller for separately excited dc motors. (9)

3 **Induction motor drives:**
Review of scalar control methods (voltage, constant V/f & frequency) of three phase symmetrical Induction machines, speed control using current controlled VSI drives, close loop speed control with constant v/f control strategy, effects of harmonics and power factor. (5)

4 **Vector control of Induction machines:**
Review of vector control, Implementation of direct & indirect vector control schemes, methods of flux estimation, effect of machine parameter variation on vector control performance, speed sensorless control, Direct Torque Control. (7)

5 **Speed control of wound rotor induction machine:**
Static rotor resistance control, static Scherbius drive using line commutated converter cascade & cycloconverter, close loop speed control using slip power recovery, vector control of wound rotor induction machine using cyclo-converter, introduction to Variable Speed Constant Frequency (VSCF) generation. (6)

6 **Control of synchronous machine:**
Wound field synchronous machine: Constant volts/Hz control, scalar self control (commutator less control), vector control. Control of permanent magnet synchronous machine: Brushless DC machine, surface permanent magnet machine. (5)

7 **Control of Stepper Motors and Switch Reluctance Motors:**
Stepper motors operation, excitation table, control of stepper motor, operation of switched reluctance motor (SRM), expressions of torque, speed control of SRM. (5)

Books Recommended :

- Fundamental of Electrical Drives: G K Dubey
- Modern Power Electronics & Drives: B K Bose
- Electric Motor Drives, modeling analysis and control: R Krishnan

MEE 1159 CHAOS, FRACTALS AND DYNAMICAL SYSTEM

Introduction. Modelling of dynamical system: Differential equations and difference equations. (9)

Stable, unstable and chaotic systems; Examples from electrical, mechanical and fluid-dynamic systems. (8)

Chaos in feedback systems. Types of attractions : Point, periodic, quasiperiodic and strange attractors. Pathways to chaos. Poincare section, Feigenbaum's universality constants, Liapunov exponents. (10)

Geometry of fractals; Chaotic dynamics on fractals; Hausdorff, correlation, information and Liapunov dimensions. (9)

Characterization of attractors from experimental data. Basins of attraction and basin boundaries. Applications in engineering systems. (9)

Books Recommended:

1. **Fractal Calculus (Defunct.Chaos & Dynamical Systems)** – Harrison
2. **Chaos -** Kathleen T. Alligood, Tim D. Sauer, and James A. Yorke

MEE 1137 MODELING & SIMULATION OF POWER ELECTRONICS BASED SYSTEM

Module-I

Basics of Simulation: Block diagram, Transfer Function and State Variable representation of different mechanical and Electrical systems. Classification of systems as linear, nonlinear, continuous time and discrete time systems. (6)

Module-II

Modeling and Simulation of phase controlled DC Converter: Modeling and simulation of single-phase and three-phase AC to DC controlled converter with various load. Modeling and simulation of Buck converter, Boost Converter and Buck-Boost converter. (6)

Module-III

Simulation of DC Drives: Simulation tools and their application in DC drive simulation. Open-loop control of DC motor. Close-loop control of DC Motor. Design of P, PI and PID controller. PWM techniques for DC applications. (6)

Module-IV

Simulation of phase controlled AC Drives: Modeling and simulation of variable voltage variable frequency ac drives, speed control using constant flux, constant slip control. PWM based induction motor drives. (5)

Module-V

Modeling of Different PWM techniques for inverter: Sine-triangle PWM for single and three phase converter. Modelling and simulatios of Space vector PWM, Modeling of Three-level inverter, SPWM techniques for multi-level inverter. (5)

Module-VI

Modeling and simulation of vector controlled AC drives: Direct field oriented current control, direct field oriented voltage control, and indirect field oriented methods. Modeling and imulation of vector controlled induction motor drives, direct torque control of induction motors drives. (8)

Module-VII

Modeling and simulation of Synchronous motor drives: Transient models, simulation of three-phase synchronous machines, simulate the permanent magnet synchronous motor, linearized analysis of synchronous generator under various values of field flux, mechanical loading and inertia. (8)

Books Recommended:

1. Dynamic Simulation of Electric Machinery using Matlab/Simulink-Chee-Mun Ong
2. Low power Electronics design – Christian Piguet
3. Modern Power Electronics & Drives-B.K.Bose
4. Electromagnetic modeling of power electronic converters – J A Ferreira
5. Electric Motor Drives, modelling analysis and control- R. Krishnan

MEE 1151 ADVANCED POWER ELECTRONICS

Module - 1

Characteristics of modern semiconductor power devices: Gate Turn-off Thyristor (GTO), Power Bipolar Transistor, Power MOSFET, Insulated Gate Bipolar Transistor (IGBT), Static Induction Thyristor (SIT), FET-BJT Combination Switch, MOS-Controlled Thyristor, Power Integrated Circuit (PIC), Protection Circuit.

(7)

Module - 2

Linear voltage regulator: DC Voltage Regulator, Linear Regulator, Series Regulator, IC Voltage Regulator, 3-Terminal & 4-Terminal Negative Voltage Regulator, 4-Terminal Positive Regulator, Adjustable 3 and 4-Terminal Regulators, Dual Voltage Regulators, Current Regulator.

(7)

Module - 3

Switching Regulators: Introduction, Circuit Scheme, Basic Switching Regulator, Minimum Load Current and Critical Inductance, Determination of Filter Inductance, Determination of Filter Capacitor, Transistor Switching Losses, Free Wheel Diode Losses, Filter Inductor Losses, Thermal Analysis, Positive Switching Regulator Using IC, Negative Switching Regulator Using IC, Electrical Isolation in Switching Regulator, Optoelectronic Coupler.

(7)

Module - 4

Resonant Converter: Basic Series Resonant Inverter, Series Resonant Inverters with Unidirectional Switches and Anti Parallel Diodes, Frequency-Domain Analysis of Series Resonant Converter, Parallel Link Capacitor Load Series Resonant Converter.

(6)

Module - 5

Frequency-Domain Analysis of Parallel Link Capacitor Load SRC, Quasi-Resonant Converter, Control Scheme for Zero Voltage Switching, Zero Current Switching, Quasi-Resonant Converter.

(6)

Module - 6

Uniterruptible Power Supply: Normal Disturbances in Commercial Power Supply, Power Conditioners Other Than UPS, Isolation Transformer, AC Voltage Regulator, Block Diagram of Tap Changer Regulator, Introduction to Ferro Resonant Regulator.

(6)

Module - 7

Transient Suppressors, Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI) and Their Suppression, Schematic Diagram of OFF-line and ON-line UPS Introduction to PLC and its application

(6)

Text Book

1. M.D. Singh & K.B. Khanchandani, Power Electronics, TMH, Delhi, 2001.
2. P.C. Sen, Power Electronics Tata McGraw Hill.

References

1. V.R. Moorthi, Power Electronics, Device, Circuit and Industrial Applications, Oxford University Press, Delhi, 2005.
2. M.H. Rashid, 'Power Electronics' Pearson Education, 2nd Edition, Singapore,2002.

MEE 2157 (Elective-II) Renewable Sources of Electrical Energy

Module – 1

Energy Scenario: Classification of Energy Sources, Energy resources (Conventional and nonconventional), Energy needs of India, and energy consumption patterns. Worldwide Potentials of these sources. Energy efficiency and energy security. Energy and its environmental impacts. Global environmental concern, Kyoto Protocol, Concept of Clean Development Mechanism (CDM) and Prototype Carbon Funds (PCF). Factors favoring and against renewable energy sources,IRP [6]

Module – 2

Solar Energy: Solar thermal Systems: Types of collectors, Collection systems, efficiency calculations, applications. Photo voltaic (PV) technology: Present status, - solar cells , cell technologies, characteristics of PV systems, equivalent circuit, array design , building integrated PV system, its components , sizing and economics. Peak power operation, Solar tracking system, Standalone and grid interactive systems. [8]

Module – 3

Wind Energy: Wind speed and power relation, power extracted from wind, wind distribution and wind speed predictions. Wind power systems: system components, Types of Turbine, Turbine rating Choice of generators, turbine rating, electrical load matching, Variable speed operation, maximum power operation, control systems, system design features, stand alone and grid connected operation. [6]

Module – 4

Biomass Energy System: Biomass – various resources, energy contents, technological advancements, conversion of biomass in other form of energy – solid, liquid and gases. Gasifiers, Biomass fired boilers, Cofiring, Generation from municipal solid waste, Issues in harnessing these sources. [3]

Module – 5

Hydro energy: Feasibility of small, mini and micro hydel plants scheme layout economics. Tidal and wave energy, Geothermal and Ocean-thermal energy conversion (OTEC) systems – schemes, feasibility and viability. [3]

Module – 6

Energy storage and hybrid system configurations: Energy storage: Battery – types, equivalent circuit, performance characteristics, battery design, charging and charge regulators. Battery management. Fly wheel- energy relations, components, benefits over battery. Fuel Cell energy storage systems. Ultra Capacitors. [4]

Module – 7

Grid Integration: Grid integration with the system: Interface requirements, Stable operation, Transient-safety, Operating limits of voltage, frequency, stability margin, energy storage, and load scheduling. [5]

Books Recommended:

1. Renewable energy technologies - R. Ramesh, Narosa Publication.
2. Energy Technology – S. Rao, Parulkar
3. Non-conventional Energy Systems – Mittal, Wheelers Publication.

Reference Books :

1. Wind and solar systems by Mukund Patel, CRC Press.
2. Solar Photovoltaics for terrestrials, Tapan Bhattacharya.
3. Wind Energy Technology – Njenkins, John Wiley & Sons
4. Solar & Wind energy Technologies – McNeils, Frenkel, Desai, Wiley Eastern.
5. Solar Energy – S.P. Sukhatme, Tata McGraw Hill.
6. Solar Energy – S. Bandopadhay, Universal Publishing.
7. Guide book for National Certification Examination for EM/EA – Book 1

(MEE 2115) **Embedded System and Application** **(3-0-0)**

Module-1: Microcontrollers and their architecture: Introduction, general architecture of microcontrollers and microprocessors, types of microcontrollers, embedded processors. Overview of the 8051 family. 8051 architecture- memory organization, registers and I/O ports. Addressing modes , instruction sets, and assembly language programming. Introduction to C programming in 8051, Watchdog timer, Power down mode: idle/sleep mode.

Module-2: Interfacing: Programming timer/counter. Interrupts- handling and programming. Serial communication using 8051-Interfacing with RS232. 8051 interfacing with keyboard, ADC, DAC, and LCD module interface. Application of microntroller for square wave and rectangular wave generation, frequency counter etc.

Module-3: Microcontroller RISC family-ARM processor fundamentals: Register Organisation, pipeline, core. ARM instruction sets: data processing, branch ,load-store, interrupts & program status register instructions. Exceptions & interrupts: handling & priorities. Development & Debugging tools for microcontroller based system design: software and hardware tools like {cross assembler, compiler, debugger, simulator, in-circuit emulator.

Module-4: Embedded System Peripherals: Timers, Counters, example of reaction timer, UART, PWM generation, Controlling a dc motor using a PWM. General purpose processor, application specific instruction-set processor's (ASIP) and ASIC's, semiconductor IC's programmable logic device, Processor selection for embedded systems, special purpose processor.

Module-5: PIC microcontrollers: introduction, architecture (block diagram explanation only), and pin details of PIC 16F877 . Memory organization, ports and timers in PIC 16F877.

Module-6: DSP based control of stepper motor: Basic operation of stepper motors, excitation tables of stepper motor, drive system of stepper motor, implementation of control logic using LF 2407 DSP, programming techniques for speed control of stepper motor.

Module-7: DSP Based Control of BLDC Motor: Principle of BLDC motor, torque generation, BLDC motor control system, Implementation of BLDC motor control system using LF2407, subroutine for PWM generation and speed control of BLDC motor.

Text Books

5. Muhammad Ali Mazidi, The 8051 microcontroller and Embedded System, 2006, Pearson Education.
6. PIC 16F877 data book
7. Hamid A. Toliyat, Steven Campbell-DSP-Based Electro-mechanical Motion Control, CRC Press
8. Andrew N Sloss,Dominic Symes,Chris Wright, ARM Developer's Guide, Elsevier

Reference Books

5. ARM processor Data book
6. Kenneth Ayala, The 8051 Microcontroller, 3/ e, Thomson Publishing, New Delhi
7. David Seal,ARM Architecture Reference Manual
8. Wayne Wolf, Computers as Components: Principles of Embedded Computing system design, Else Vier, 2005

Resource Department/Center

1. Electrical and Electronics Engineering

MEE 2133 POWER ELECTRONICS SYSTEMS DESIGN

1. Design and selection of passive and active components:
   Design of low power single phase step down transformers, inductors (choke) and filter circuits, Selection of switching devices for specific applications, Design of snubber circuit for them. (9)

Ref: Power Electronics: essentials and applications - L Umanand, Microchip SMPS AC/DC Reference Design, User's Guide,

2. Design of Driver circuits and commutation circuits:
   Driver circuits for Thyristor, BJT, MOSFET/IGBT, design of commutation circuits for forced commutated converter, selection of current, voltage and speed sensor for complete close loop system design.
   (5)

Ref: Power Electronics: essentials and applications - L Umanand

3. AC/DC converter design:
   Diode based single phase half & full converter, Three-phase converter, Thyristor based half and full converter, selection of power components & filter design, different schemes for firing circuits.

Ref: Power Electronics: essentials and applications - L Umanand, (7)

4. DC/DC swithed mode converter design:
   Design of chopper based Buck converter, Boost converter, Buck-Boost converter; Isolated converter, Flyback converter, Schemes for firing circuits. (6)

Ref: Power Electronics: essentials and applications - L Umanand,

5. DC/AC converter design:
   Single phase half, full and three phase square wave inverters, Three phase Voltage source inverter, Fourier analysis of output voltage waveform, selection of active and passive components and their ratings, Design of firing circuit. (5)

Ref: Power Electronics: essentials and applications - L Umanand

6. Switched mode power supply design:
   System specification, Block diagram of SMPS, Design of PFC booster, Full bridge zero voltage transition converters, Single and three phase synchronous buck converter, Auxiliary power supply etc. (6)

Ref: Microchip SMPS AC/DC Reference Design, User's Guide, Power Electronics: essentials and applications - L Umanand,

7. Thermal design:
   Thermal problems in power electronics, Understanding of General thermal flow process, Design of heat sink, selection of cooling techniques. (5)

Ref: Power Electronics: essentials and applications - L Umanand.

MEE 2151 ADVANCED DSP ARCHITECTURE AND PROGRAMMING

Module I

DSP Development System: Introduction to DSP, Example of DSP system A to D signal conversion, DSP support tools, code composer studio, compiler, assembler and linker, input and output with the DSK

Module II

Architecture of C6x Processor: Introduction TMS320 C6x architecture, functional units, fetch and execute packets, pipe lining, registers, Linear and circular addressing modes

Module III

Instruction Set of C6x Processor: Instruction set assembly directives, linear assembly, ASM statement within C, timers, interrupts, multi channel buffering serial ports, direct memory access, memory consideration, fixed and floating points format, code improvement and constraints.

Module IV

Real Time FIR Filtering: Design of FIR filter, FIR lattice structure, FIR implementation using fourier series, windows function, programming examples using C language.

Module V

Real Time IIR Filtering: Design of IIR filter, IIR lattice structure, impulse invariance, bilinear transformation programming examples using C language.

Module VI

Fast Fourier Transform: Introduction, DIT FFT algorithm with Radix 2, DIF FFT algorithm with Radix 2, inverse fast fourier transform, fast convolution, programming example using C language.

Module VII

DSP/BIOS and RTDX Using MATLAB & Lab VIEW: Introduction to DSP/BIOS, RTDX using MATLAB provide interface between PC and DSK, RTDX using Lab VIEW provide interface between PC and DSK.

Books Recommended:

1. Digital signal processing and applications with C6713 and C6416 DSK by Rulph Chassaing, wiley publication.
2. Real-Time digital signal processing based on the TMS320C6000 by Nasser Kehtarnavaz, ELSEVIER publication
3. DSP applications using C and the TMS320c6x DSK by Rulph Chassaing, wiley publication.