09 EPS 142	DYNAMICS OF LINEAR SYSTEMS

1. Analysis of control systems in state space; State-Space modeling of synchronous machines, excitation systems, and speed governing systems, transmission lines and induction machines-solution techniques, State -Space equations in Canonical forms, controllability and absorbability, linear time - variant systems.MIMO systems, order of MIMO systems, derivation of state space model of MlMO systems from transfer matrix, non-interaction in MIMO systems Control system design via pole placement, design of state observers (full order and minimum order), effect of addition of observer on a closed loop system,

2. Discrete - time control system: Introduction, spectrum analysis of sampling process, Shannon's sampling theorem, signal reconstruction, difference equations , Z Transforms , transfer function, inverse Z transforms, obtaining response between consecutive sampling instants, mapping between the s-plane and z-planes, Stability analysis of closed loop systems, jury stability test, stability analysis by use of bilinear transformation and Routh stability criterion. State space representation of discrete time systems. Solution techniques,

REFERENCE BOOKS ;

1. K-Ogata "Modern Control Engineering (II Edition)"
2. Nagarath and Gopal, " Control Systems Engineering"
3. Chidambara and Ganapathy, “Introduction to Control of Dynamic Systems"
4. P-M-Anderson and Fouad," Power System Control and Stability"
5. K.Ogata, "Discrete Time Control Systems"

09 EPS 151	ENERGY MANAGEMENT SYSTEMS

History of Energy Management: Energy forecasting, limitations of conventional sources of energy ,Environmental impact of conventional sources of energy, Problems associated with current pattern of energy use in India, options for the future

Non Conventional sources of energy : Global & Indian Non-conventional sources of energy , basic principle of operation of solar photo- voltaic, solar thermal, wind , wave and tidal energy sources.

Energy Auditing: classification of energy audit, measures to be taken up after preliminary and detailed energy audit, power factor improvement & economics of P. F improvement.

Electricity tariffs – Aims and objectives of a good tariffs, Fixed and running charges, types of tariffs. Energy conservation : Basic concepts and methods of energy conservation, Load management, plant operational management Demand side management : Introduction to DSM, Concept of DSM benefits from DSM, DSM Technique time of day pricing, time of day pricing models for planning, load management, peak clipping, peak shifting, valley filling, strategic conservation, energy efficient equipment, socio-economic awareness Programmes.

REFERENCE BOOKS :

1. D. P. Sen Gupta, K. P. Padiyar, Intr5ance SCA, M.A.Pai(Ed) "Recent advances in control and management of Energy systems", Interline publishers, Bangalore.(1993)
2. Ashok V Desai (ED) " Energy Demand analysis management and conservation " Wiley Eastern ltd. New Delhi
3. TERI Reports
4. Jyothi Parekh " Demand side management " TMH Publishers
5. N.K.Bansal , Kleeman-Millin "Renewable Energy Sources and Conservation Technology" , Tata McGraw Hill.
6. Non-Conventional Sources of energy .G.D.Rai

09 EPS 152	DIGITAL SIGNAL PROCESSING

Discrete-Time signals and systems: Introduction, discrete-time signals-sequences, linear shift invariant systems, stability and causality, linear constant-coefficient difference equations, Frequency domain representation of discrete time systems and signals, symmetry properties of Fourier transform, sampling of Continuous time signals, two dimensional sequences and systems (Chapter 1of ref I)

The Z-transform- introduction, Z-Transform, inverse Z-Transform, Z-Transform theorems and properties, system function (Chapter II of ref I)

The discrete Fourier transform: - introduction, representation of periodic sequences- the discrete fourier series, properties of discrete fourier series, summary of properties of DFS representation of periodic sequences, sampling the Z-transform, fourier representation of finite - duration sequences - the discrete fourier transform, summary of properties of the discrete fourier transform, linear convolution using the discrete transform- (Chapter III of ref I)

Flow graph and matrix representation of digital filters - introduction, signal flow graph representation of digital networks, matrix representation of digital networks, basic network structures for IIR systems, transposed forms, basic network structure for FIR systems, Tellegens theorem for digital filter and its application (Chapter IV of ref 1)

Digital filter design techniques:- Introduction, design of IIR digital filters from analog filters, design examples. Analog digital transformation, properties of FIR - digital filters, design of FIR filters, A comparison of IIR and FIR Digital filters, (Chapter V of ref I) Computation of the Discrete fourier transform- Introduction Goertzel algorithm, decimation- in - time FFT algorithms, decimation- in- frequency FFT algorithms, for N and composite numbers, general com[putational consideration in FFT algorithms, Chirp Z-Transform algorithm, (Chapter VI of ref I), DSP processors- a brief discussion,

REFERENCE BOOKS :

1. Alan V Oppenhelm *&* Ronald W Schafer, "Digital Signal Processing", Prentice Hall of India, 1991.
2. John G Proakis et. ah Digital Signal Processing, Principles, Algorithms and Applications Macmilliiti, 1992.
3. Chang, One dimensional digital signal processing.
4. Andrew Antonio, Digital Filters,

09 EPS 152	HVDC POWER TRANSMISSION

1. Dc Power Transmission Technology: Introduction, comparison of AC & DC Transmission, application of DC transmission, description of DC transmission systems, planning, modern trends, thyristor value, introduction, thyristor device, thyristor value, value test , recent trends.
2. Analysis of HVDC converters: Pulse number device of converter configuration, simplified analysis of graetz circuit, converter bridge characteristics of a pulse converter, detail analysis.
3. Converter and HVDC System control: Introduction, principle of DC link controlled, converter controlled 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.
4. Converter faults and protection: Introduction, Converter faults, protection against over current over voltage in a converter station, surge arrestors, protection against over voltages.
5. Smoothing reactor and DC line ; Introduction, Smoothing reactors, DC line, transient over voltages in dc line, protection of DC lines, DC breakers, monopolar operations, effect of proximity of AC and DC transmission lines.
6. Reactive power Control ; Introduction, reactive power requirements in study state VAR systems, reactive power control during transients.
7. Harmonics and filters : Introduction, generation of harmonics design of AC filter, Dc

filters, carrier frequency and RI noise.

8. Multi terminal Dc systems : Introduction , Potential applications of MTDC systems, types of system, control and protection of MTDC systems.

REFRENCE BOOKS:

1. K.R.Padiyar, " HVDC power Transmission" , Wiley Eastern.

09 EPS 152	NONLINEAR AUTOMATIC CONTROL THEORY

1. Describing Function Analysis*:* Introduction to Nonlinear systems, nonlinear control systems, describing functions, describing function analysis –of NL control systems, generalized describing function, dual input describing function, inverse describing function.

2. Phase plane _analysis *:* Introduction, methods for constructing trajectories, obtaining time solutions from phase plane plots, singular points, phase plane analysis of linear control systems, phase *plane* a analysis of non-linear control systems, point-care index of a singular point, bendixson's criterion, stability definitions of non-linear systems, extension of PP concept to higher order systems,

3, Numerical Methods: Introduction, Taylor sires expansion method. Modified -Eulers method- Adams "method, Milnes method ; Runge -Kutta method of " least square fit, *Z* form numerical-calculus method, Poincare Perturbation method, An approximation method for second order system.

4. Liapunov Stability Analysis**:** Introduction, definitions, the first method of liapunov, second method of liapunov, stability analysis of linear systems, stability analysis of non-linear systems, Krasovskis method and variable gradient methods.

5 Optimal and adaptive control systems*:* Introduction, optimization of an autonomous positioning system with ON-QFF non-linearity, simplified switching of second-order autonomous system, introduction to adaptive systems, input adaptation or response optimization, model adaptive systems.

REFERENCE BOOKS:

1. Non-Linear Automatic Control, by John E Gibson, Mc Graw Hill Publication,
2. Modern Control Engineering by Katsuhiko Ogata, Prentiiee Hall of IndiaPublications
3. Introduction to non-Linear analysis WJ Cunningham , Mc Graw Hill Publication*_
4. Analysis and Design of Non-Linear feed back control Systems, by George J Thaler and Marvin P Pastel, Me Graw Hill Publication.

09 EPS 252	AI APPLICATIONS IN POWER SYSTEMS

Introduction: What is AI Definitions, history and evolution of AI, essential abilities of intelligence and AI applications. Problem solving: problem characteristics, problem search strategies, forward and backward reasoning, AND-OR graphs- goal trees, game trees, search methods- informed and uninformed search, breadth first search and depth first search methods.

Knowledge representation: logical formalisms: prepositional and predicate logic: syntax and semantics, wffs, clause form expressions, resolution- use of RRTs for proofs and answers, examples from electric power systems, Non-monotonic logic: TMS, modal, temporal and fuzzy logic.

Structured representation of knowledge: ISA/ISPART trees, associative/ semantic nets, frames and scripts, examples from electric power systems.

Expert system architecture: basic components, rule based systems, forward and backward chaining, ES features, ES development, ES categories, ES tools and examples from electric power systems.

AI languages: LisP and ProLog - Introduction, sample segments, LisP primitives, list manipulation functions, function predicates, variables, iteration and recursion, property lists, sample programs for examples from electric power systems.

REFERENCE BOOKS:

1. D.W.Patterson, ``Introduction to Artificial Intelligence and Expert Systems'', Prentice-Hall of India, 1992.
2. Charniak E. and Mcdermott D., ``Introduction to AI'', Addison-Wesley, 1985.
3. Rich, Elaine, Kevin Knight, ``Artificial Intelligence'', Tata McGraw-Hill, 1991.
4. Nils J.Nilson, ``Problem Solving Methods in AI'', McGraw-Hill, 1971.
5. Nils J.Nilson, ``Principles of AI'', Berlin Springer-Verlag, 1980.
6. Selected topics from IEEE, AIEE and CIGRE Journals.

09 EPS 253	POWER SYSTEM RELIABILITY ENGG.

Basic concepts: adequacy, security, reliability, cost/worth/data, reliability test system (RTS); System adequacy evaluation: RTS, Monte Carlo simulation, contingency enumeration approach, basic distribution systems and reliability assessment; Assessment of reliability worth: interruption costs for commercial, industrial and residential users, interruption energy assessment rate; dependency effects in power system reliability and evaluation of statistical distributions.

REFERENCE BOOKS:

1. Roy Billington – Reliability assessment of large electric power systems, Kluwer Academic Publishers, USA, 1988,
2. R. Billington and A.N. Allen – Reliability evaluation of engineering systems; concepts and techniques, Longman London/ Plenum press, NY, 1983,
3. Hammersley J.M., Handscomb D.C. – Monte Carlo Methods, John Wiley and Sons Inc., NY, 1964
4. IEEE committee report, IEEE reliability test system, IEEE PAS, Vol. PAS98, 1979, pp 2047-54
5. Selected topics from IEEE, AIEE and CIGRE Journals.

09 EMS 252	COMPUTER BASED INDUSTRIAL CONTROL

Concept of Continuous and discrete time Process Control, Single loop and multi loop control, multivariable control, Brief outline of Adaptive control **10 Hrs**

Schematic representation of interconnected systems, supervisory control and data acquisition **6 Hrs**

Direct Digital Control: PID control, Interfacing process with digital control, position algorithm, velocity algorithm, z transform based control algorithms. **10 Hrs**

Programmable controllers, diagrammatic representation, functional blocks, architecture, interfacing, software (basic concepts) **10 Hrs**

Real time programming-multi tasking, state transition diagram, inter task communication, development of algorithm. **8 Hrs**

Outline of real time operating system **6 Hrs**

Modelling, simulation, intelligent controllers, AI based control, fuzzy based control, neural control **6 Hrs**

Computer interfacing, methodology, computer control of process, case study **4 Hrs**

BOOKS:

1. Krishna Kant, Computer based Industiral Control, Prentice Hall (I), 1997
2. Hirota, K., Industrial Applications of Fuzzy Technology, Springer Verlag, 1993

3. Hertz, John, Krogh, Anders, Palmer, Richard, Introduction to Theory of Meural Computation, Addison-Wesley, 1991.
4. Eggebrecht, L. C., Interfacing to the IBM PC, Howard Samson & CO., 1983
5. Ahson, S.I., Microprocessors with application in Process Control, TMH. 1984

09 SCN152	MULTIMEDIA NETWORKS

1. Multimedia communications: Introduction, multimedia information representation, multimedia networks, multimedia applications, media types, communication modes, network types, multipoint conferencing, network QOS application QOS.
2. Multimedia information representation: Introduction, digital principles, text, images, audio, video,
3. Text and image compression: introduction , compression principles, text compression, image compression.
4. Audio and video compression: introduction, audio compression, DPCM, ADPCM, APC, LPC, video compression, video compression principles, h.261, h.263, MPEG, MPEG-1, MPEG-2, MPEG-4 and MPEG-7.
5. Multimedia Information Networks: introduction, network performance parameters, throughput, networking delay, delay variance, error rate, quality of service, QoS perspectives, QoS processing, multimedia transmission, requirements, transmission over WANs, Multimedia Transmission over LANs, ATM networks, Wireless LANs
6. Multimedia transport protocols: RTP and RTCP.
7. Multimedia Management protocols: H.323, SIP, SDP, SAP.

TEXT BOOKS

1. Multimedia Communications: Applications, Networks, Protocols, and Standards, Fred Halsall, Pearson Education, Asia, Second Indian reprint 2002.
2. Multimedia Information Networking, Nalin K. Sharda, PHI,2003.

REFERENCE BOOKS

Ralf Steinmetz, Klara Narstedt, “Multimedia Fundamentals: Vol 1-Media Coding and Content Processing”, Pearson Education, 2004.

a. Prabhat K. Andleigh, Kiran Thakrar, “Multimedia Systems Design”, PHI, 2004.

09 SCE 11	COMPUTER ARCHITECTURE

1. Parallel computer Model: State of computing, multiprocessor & multi-computer multivector & SIMD, VLSI Models (Ref. 2: 1.1 - 1.4) **8Hrs.**

2. Instruction Level parallel Processing Introduction (Ref. 1: 4.1, 4.2, 4.3) Pipe lined processors (Ref. 1: 5.1, 5.2, 5.3)
   Linear and Non-linear pipelines for corruption –carry-save adder pipes for integer multiplication- 4 stage fixed point multiplication of 8 bit integer Non-linear pipe theory – State transition diagram-issue latencies for non-linear pipes-use of delay to improve issue latencies (Ref. 2: 6.1, 6.2, 6.4) Scalar and Super scalar processing – data control and resource dependencies, register renaming –reservation stations-reorder buffers-Case studies-Power PC 620, CISC processors with RISC core-Pentium Pro Case study (Ref.1: 7.7 to 7.10 with enough background from earlier sections to appreciate these articles) branch Control (Ref.1: 8.4 with back ground from earlier sections)
   20Hrs.
3. Data Parallel Architecture: Introduction (Ref.1: 10)-Static and dynamic interconnection networks – omega l and baseline networks (Ref. 2: 2.4) SIMD systems – case study – MPP and CMS (Ref.1: 11.3, 11.4) Vector Processing – Case study – Cray family (Ref.1: 14.3 to 14.7) Introduction to Systolic architecture – example matrix multiplication (Ref. 1: 13.3) **8Hrs.**

   .
4. Multiprocessors and Multicomputers cache coherence and Synchronization mechanism (Ref. 2: 7.2) Three generation of multicomputers (Ref. 2: 7.3)
   10Hrs.

5. Data Flow Architecture: Data Flow and Hybrid Architecture – Data Flow Architecture (Ref. 2: 9.5) **6Hrs.**
6. Case Study: VLIW Architecture (Ref. 2: 4.2.2) – Super scalar and RISC processor (Selected Sections from Chapter 4 and Ref. 2) SPARC.
   8Hrs.

TEXT BOOKS

1. Advanced Computer Architectures – A design space approach, Dezso Sima, Terence Fountain, Peter Kacsuk, Pearson Education 1997.
2. Advanced Computer Architecture Parallelism, Scalability, Programmability, Kai Hwang, Tata Mc Graw Hill, 2003.

09 SCE 152	PATTERN CLASSIFICATION

Introduction:

Machine Perception, Pattern Recognition Systems, The Design Cycle, Learning and Adaptation.

Bayesian Decision Theory:

Bayesian Decision Theory-Continuous Feature, Minimum – Error – Rate Classification, Classifiers, Discriminant Functions, and Decision Surfaces, The Normal Density, Discriminant Functions for the Normal Density, Error Probabilities and Integrals, Error Bounds for Normal Densities, Bayes Decision Theory – Discrete Features,

Maximum- likelihood and Bayesian Parameter Estimation:

Maximum- Likelihood Estimation, Bayesian Estimation, Bayesian parameter estimation, Gaussian Case, General Theory, Sufficient Statistics, Problems of Dimensionality, Component Analysis and Descriminats,

Non Parametric Techniques:

Density Estimation, Parzen Windows, Kn-Nearest- neighbor Estimation, the nearest neighbor Rule, Metrics and Nearest Neighbor Classification, Fuzzy Classification,

Linear Discriminant Functions:

Linear Discriminant Functions and Decision Surface, Generalized Linear Discriminant Functions, The Two Category Linearly Sufferable Case,

Unsupervised Learning and Clustering:

Mixture Densities and Identifiability, Maximum Likelihood Estimates, Applications to Normal Mixtures, Unsupervised Bayesian Learning, Data Discrimination and Clustering, Criterion Functions for Clustering, Iterative Optimization, Hierarchical Clustering, The Problem of Validity, Online Clustering, Graph Theoretic Methods, Component Analysis, Low Dimensional Representation and Multi-Dimensional Scaling.

Multilayer Neural Networks:

Feed Forward Operation and Classification, Back Propagation Algorithm, Error Surfaces, Back Propagation as Feature Mapping, Bayes Theory and Probability, Related Statistical Techniques, Practical Techniques for Improving Back Propagation, Second Order Methods, Additional Networks and Training Methods, Regularization, Complexity Adjustment and Pruning.

Introduction to Biometric Recognition:

Biometric Methodologies: Finger Prints, Hand Geometry, Facial Recognition, Iris Scanning, Retina Scanning. Identification Verification - The Distinction, Performance Criteria.

TEXT BOOKS

1. Richard O. Duda, Peter E. Hart, David G. Stork; "Pattern Classification", A Wiley-Interscience Publication, John Wiley & Sons, Inc, 2000 Second Addition.
2. K. Jain, R. Bolle, S. Pankanti (Eds.), "Biometrics: Personal Identification in Networked Society", Kluwer Academic Publishers, 1999.

09 SCE 252	EMBEDDED & REAL TIME SYSTEMS

1. **Introduction**
   An Embedded System; Characteristics of Embedded Systems; Software embedded into a system; Real Time Definitions, Events and Determinism, Synchronous & Asynchronous Events, Determinism, Time-Loading, Real-Time Design Issues, Example Real Time Systems. **08Hrs.**

2. **Embedded Microcontroller Cores and Architecture** 8051 micro controller; Architecture; Instruction sets; Assembly language programming; I/O port programming; Timer / counter programming;, Serial Communication; Interrupts programming.
   08Hrs.

3. **Real Time specifications and design technique:** Mathemetical specifications, flow charts, structure charts, Finite state automata, data flow diagrams, Petri Nets, Warnier Orr Notation, State charts.
   08Hrs.

4. **Processor And Memory Organization :** Structural Units in a Processor; Memory Devices, Memory selection for an embedded system; Direct Memory Access, DMA controllers; Interfacing Processor, Memory and I/O Devices; Interrupt servicing (handling) mechanism; Context and the periods for context-switching; Deadline and interrupt latency. **08Hrs.**

5. **Language Features:** Parameter passing, Recursion, Dynamic allocation, Typing, exception handling, abstract data typing.
   04Hrs.

6. **Real Time Kernels:** Real Time and Embedded Operating Systems; Interrupt Routines in RTOS environment; co routines, Interrupt driven systems, Foreground/background systems, Full-featured Real Time Operating Systems.

04Hrs.

7. **Inter-Process Communication and Synchronisation Of Processes:** Multiple processes in an application; Problem of sharing data by multiple tasks and routines; Inter Process Communication, Mailboxes, Critical Regions, Semaphores, Deadlock.

04Hrs.

8. **Programming Languages and Tools:** Desired language characteristics; Data typing; Control Structures; Packages; Exception Handling; Overloading; Multitasking; Task Scheduling; Timing specification; Programming environments; Runtime support.

08Hrs.

9. **System Performance Analysis and Optimization:** Response time calculations, Interrupt latency, Time-loading and its Measurement, Reducing response times and time loading, I/O performance

04Hrs.

10. **Fault Tolerance and Reliability:** Reliability definitions, Testing: unit and system level; Fault tolerance-N-version programming, built in test software, CPU and Memory testing.

04Hrs.

TEXT BOOKS

1. Rajkamal; “Embedded Systems Architecture; Programming and Design”; Tata McGraw Hill Publications.
2. Phillip A. Laplante .;: “ Real –Time Systems Design and Analysis” –-3rd Edition, Apr 2004. Wiley-IEEE Press

REFERENCE BOOKS

1. C.M. Krishna; Kang G.Shin; “Real Time Systems”; McGraw-Hill; 1997.
2. Mohammed Ali Mazidi; Janice Gillispie Mazidi “The 8051 Microcontroller and Embedded Systems”; Pearson Education Asia 2002.
3. David E Simon; An Embedded software primer; Addison Wesley; 2000.
4. Raymond J.A. Buhr; Donald L. Bailey; “An Introduction To Real Time Systems”; Prentice Hall International; 1999.
5. Rajkamal, “Microcontrollers: Architecture, Programming, Interfacing and System Design”, Pearson Education.

09 SCS 242	DATA WAREHOUSING & MINING

1. Introduction to data warehousing – The need for data warehousing (1.2), Operational and informational Data stores(1.5), Data warehouse definition and characteristics (1.6), Data warehouse architecture (1.7) **4 Hrs**
2. Data warehousing component - Data warehouse Database (6.2), Sourcing, Acquisition, Cleanup and transformation tools (6.3), Metadata (6.4), Access tools (6.5), Data marts(6.6), Data warehousing administration and management (6.7), Information delivery system. **6 Hrs**
3. Online analytical processing(OLAP) - Need for OLAP (13.1), Multidimensional data model (13.2), OLAP guidelines(13.3), Multidimensional vrs. Muiltirelational (OLAP (13.4), Categorization of OLAP tools (13.5), OLAP tools internet (13.6) **8 Hrs**
4. Statistics- Data counting and probability (15.1), Hypothesis testing (15.2), Contingency Tables, The chi square test, and non casual relationship. **8 Hrs**
5. Introduction to data mining – The motivation (17.2), Learning from past mistake (17.3), Data mining (17.4), Measuring data mining effectiveness(17.5), Embedded data mining into business process (17.6), What is decision tree (18.1), Business score card (18.2), Where to use decision tree (18.3), The general idea (18.4), How the decision tree works (18.5).

   Case study: Prediction wireless communication churn with CART. **10 Hrs**
6. Nearest neighbor and clustering - Where to use clustering and nearest neighbor prediction (20.2), How clustering and nearest neighbor prediction works (20.4) Case study: Image recognition for human handwriting **10 Hrs**

   Genetic Algorithm - What are Genetic Algorithms (21.1), Where to use Genetic Algorithm? (21.2), The general idea (21.3), How the Genetic algorithm works (21.4) Case study: Optimizing predictive customer segment **14 Hrs**

TEXT BOOKS

1. Data warehousing, Data mining and OLAP by Alex Berson & Stephon J. Smith, Tata McGraw Hill.
2. Data Warehousing in the Real World – A Practical Guide for Building Decision Support Systems, Sam Anahory & Dennis Murray, Pearson Education.

REFERENCE BOOKS

1. Data Mining – Introductory and Advanced Topics, Margaret H. Dunham, Pearson Education.
2. Introduction to Data Mining, Pang-Ning Tan, Michael Steinbach, & Vipin Kumar, Pearson Addison Wesley, 2006.

09 SSE 153	MULTIMEDIA INFORMATION SYSTEMS

Multimedia Information, Delay –sensitive and Time-based Media data Modeling, Multimedia storage and retrieval techniques, Multimedia communications: Synchronization delay compensation, QoS negotiations protocols, Architecture and Issues for Distributed Multimedia Systems, Prototype Multimedia systems: Video–on-Demand, Video conferencing.

REFERENCE BOOKS:

1. Grosky WL, Jain R, and Mehrotra R.: "The Handbook of Multimedia Information Management", Prentice -Hall 1997.
2. Koegel Buford JF, : "Multimedia Systems" Addison – Wesley , 1994
3. Relevant Research Papers from Journals / Conferences.

09 SSE 243	SYSTEM PERFORMANCE & EVALUATION

Introduction

Performance evaluation methods, Analytical versus Simulation modeling, Performance measurement and Benchmarking. Workload modeling, Random variables. Commonly used distributions. Stochastic processes, Markov chain models of computer systems, Steady – state Transient analyses, Queuing models.

Single server and multi-server queues, Open and close queuing networks. Discrete event simulation, Simulation Languages

Random Number Generation and Testing, model verification and validation, Analysis of simulation results, Confidence interval Variance reduction techniques.

Case studies of Analytical and simulation studies of computer systems.

REFERENCE BOOKS:

1. Raj Jian. "The Art of Computer Systems Performance Analysis". John Wiley and sons, New York, USA, 1991
2. Trivedi K S, **"**Probability and Statistics with Reliability, Queuing and Computer Science Applications", Prentice Hall of India, Reprinted in 1990
3. Law A M and Kelton W.D. "Simulation Modeling and Analysis ", McGraw Hill, New York, USA, 1991

09 EC0 97	HIGH PERFORMANCE COMPUTING

Performance issues: measurements profiling & development tools. Sustained Vs Peak performance

High Performance sequential computers: Effects of the memory Hierarchy, Out-of-Order execution, super scalar processor,

Vector Processing

Shared-Memory processing: Architecture (Extension of the memory Hierarchy) perforamance paradigm, Open MP.

Distributed memory processing: Architectural issues, (Network & Interconnections), Program paradigm, MPI (+MPI2)

Grids: Computational Grid, Data Grid, Performance of libraries & packages

The productivity crisis & future direction: Development overheads, Petaflops Programming, New parallel languages, UPC, Titanium, and Co-Array FORTRAN.

TEXT BOOKS:

1. Charles Severance and Kevin Dowal, "High-Performance Computing", 2nd Ed, 1998, O'Reilly Gear
2. Rajkumar Buyya,"High Performance Cluster Computing", (paper back) 2nd Ed, Prentice Hall, 1998
3. Lloyd D. Fosdick, etal, "Introduction to High-Performance Scientific Computing", The MIT Press, 1996.

09 EC0 35	ELECTRICAL MACHINE DYNAMICS

Dynamic Equation of motion: Electro mechanical systems-Analytical techniques, Transducers-physical systems, Fundamentals of systems dynamics

Lagrange's equations: Applications of Lagrange's equation to electro mechanical system, Solution of electro dynamical equations, Euler's method, Runge-Kutta method.

Generalized machine concepts: KRON's machine, performance equation, dynamic variables, machines with uniform gap, machines with Saliency

Dynamics of machines: Commutator machines-induction machines-synchronous machines-small oscillations-synchronous machine equation during small oscillations, general equations for small oscillations, representation of the oscillation equations in state variable form. Generalized analysis of N-M winding machines

TEXT BOOKS:

1. Adkins "Generalized theory of Electrical machines", Dover, 1980
2. D.P.Sen Gupta and J.W.Lynn "Generalized theory of machines".

3. Seely “Electro mechanical energy conversion”, MGH 1962
4. Bimbhra PS “Generalized theory of Electrical machines”, Khanna 1995

09 EC0 83	VLSI TECHNOLOGY

Environment for VLSI Technology: Clean room and safety requirements. Wafer cleaning processes and wet chemical etching techniques.

Impurity incorporation: Solid State diffusion modeling and technology; Ion Implantation modeling, technology and damage annealing; characterization of Impurity profiles.

Oxidation: Kinetics of Silicon dioxide growth both for thick, thin and ultra thin films. Oxidation technologies in VLSI and ULSI; Characterization of oxide films; High k and low k dielectrics for ULSI.

Lithography: Photolithography, E-beam lithography and newer lithography techniques for VLSI/ULSI; Mask generation.

Chemical Vapour Deposition techniques: CVD techniques for deposition of polysilicon, silicon dioxide, silicon nitride and metal films; Epitaxial growth of silicon; modeling and technology.

Metal film deposition: Evaporation and sputtering techniques. Failure mechanisms in metal interconnects; Multi-level metallization schemes.

Plasma and Rapid Thermal Processing: PECVD, Plasma etching and RIE techniques; RTP techniques for annealing, growth and deposition of various films for use in ULSI. Process integration for NMOS, CMOS and Bipolar circuits; Advanced MOS technologies

TEXT BOOKS:

1. C.Y. Chang and S.M.Sze (Ed), ULSI Technology, McGraw Hill Companies Inc, 1996.
2. S.K. Gandhi, VLSI Fabrication Principles, John Wiley Inc., New York, 1983.
3. S.M. Sze (Ed), VLSI Technology, 2nd Edition, McGraw Hill, 1988.

REFERENCE BOOKS:

1. Stephena, Campbell, “the Science and Engineering of Microelectronic Fabrication”, Second Edition, Oxford University Press, 2005
2. Yuan Taur, Tak. H. Ning, “Fundamentals of Modern VLSI Devices”, Cambridge University Press, 2003.

09 EC0 62	POWER ELECTRONICS SYSTEM DESIGN WITH ICS

Introduction — measurements techniques for voltages, current, power, p.f in thyristorised AC & DC circuits — other measurement and recording of waveforms — sensing of current, voltage power in thyristorised circuits — sensing of speed, review of PWM ICs basic concepts of digital logic circuits — Design of Combinational and sequential circuits — PLL A/D & D/A converters, 555 timer, Op-amps, Implementation of gating — PLCs developing a microprocessor based system.

TEXT BOOKS:

1. G. K. Dubey “Thyristorised power controller” Wiley Eastern.
2. J. R. Gibson,”Electronic Logic circuits” ELBS

REFERENCE BOOKS:

1. Data Book “National semiconductor” –
2. Data Book I & II “Motorola — Linear ICs”
3. Unitriode Applications data book

09 EC091	DIGITAL SWITCHING SYSTEMS

Introduction: Review of probability, Poisson and exponential distributions, queueing theory, Markov process, Issues, architectures and performance analysis for statistical bandwidth sharing (multiplexing) and traffic switching in telecommunication networks.

Digital Switching: Switching functions, SDS, TDS, Two Dimension switching, Digital switching in analog environment.

Reliability Modeling and analysis: Purpose, system reliability assessment, failures Models, state Transitions Diagram CPC, clock subsystems, N/W Controller subsystem, switching N/W, link and trunk downtimes, call stuffs.

Switching Systems S/W and quality analysis: O.S, Data base Management S/W architecture, calls models, call features, file cycle, Methodology for assessing quality Maintenance

Analysis of Networked switching systems: Scope, digital switching systems Model, H/W architecture, S/W architecture Recovery stating us, Reliability analysis

Advanced Topics: Interconnection networks for circuit and fast packet switching and their blocking and queueing analysis; call processing architectures; switching systems capacity analysis and traffic overload control. Statistical multiplexing; blocking analysis in circuit multiplexed networks with single rate or Multirate traffic, call-level multiplexing, burst-level multiplexing, Models for packetised sources, such as voice and video, Models for

performance analysis of integrated packet networks, calculation of performance measures; analysis and design of traffic controls.

TEXT BOOKS:

1. Syed R. Ali, “Digital switching systems : System Reliability & Analysis”, Tata McGraw hill edition, 2002.
2. John Bellamy, “Digital telephony”, John Wiley and Sons, 1990.
3. J. E. Flood “Telecommunication switching, traffic and Networks”, Pearson Education, 1999

REFERENCE BOOKS:

1. Thiagarajan Viswanathan, “Telecommunication switching systems & networks” PHI, 2001
2. Pattavina, “Switching Theory – Architecture & Performance in Broadband ATM Networks”, John Wiley & Sons, 1998.
3. Hui. J.Y., “Switching and Traffic Theory for Integrated Broadband Networks”, Kluwer, 1990
4. F.J.Redmill and A.R.Valder, “SPC Digital Telephone Exchanges”, IEE (UK) 1990.

09 EC025	DESIGN OF ANALOG & MIXED MODE VLSI CIRCUITS

Introduction to CMOS analog circuits, MOS transistor DC and AC small signal parameters from large signal model, Common source amplifier with resistive load, diode load and current source load, Source follower, Common gate amplifier, Cascode amplifier, Folded Cascode, Frequency response of amplifiers, Current source/sink/mirror, Matching, Wilson current source and Regulated Cascode current source, Band gap reference, Differential amplifier, Gilbert cell, Op-Amp, Design of 2 stage Op-Amp, DC and AC response, Frequency compensation, slew rate, Offset effects, PSRR, Noise, Comparator, Sense Amplifier, Data Converter Fundamentals, Analog Versus Discrete Time signals, Converting analog signals to Digital signals, Sample and Hold Characteristics, Data Architectures, DAC and ADC specifications. Mixed Signal Layout Issues, DAC Architectures,R-2R Ladder Networks, Current steering, Pipeline DAC. ADC Architectures, Flash, The Two step Flash ADC, The Successive Approximation ADC, RF amplifier, Oscillator, PLL, Mixer.

TEXT BOOKS:

1. Phillip. E. Allen, Douglas R. Holberg, “CMOS Analog circuit Design” Oxford University Press, 2002
2. Razavi B., “RF Microelectronics”, Prentice Hall, 1998.

3. Baker, Li, Boyce, “CMOS: Circuit Design, Layout and Simulation”, Prentice Hall of India, 2000
4. Bosco Leung, “VLSI for Wireless Communication”, PH, 2002

REFERENCE BOOKS:

1. Razavi B., “Design of Analog CMOS Integrated Circuits”, TMH, 2003
2. Mukherjee, “VLSI System Design: Introduction to NMOS and CMOS VLSI System Design”, Prentice-Hall, 1986
3. R. L. Geiger, P. E. Allen, and N. R. Strader, “VLSI Design techniques for analog and digital circuits”, McGraw-Hill, 1990
4. T. Lee, "The Design of CMOS Radio-Frequency Integrated Circuits", Cambridge University Press 1998.
5. Reinhold Ludwig, Pavel Bretchko, RF Circuit Design, Pearson Education, 2001

09 EC086	WIRELESS COMMUNICATIONS

Radio propagation: Free space propagation model, Relating power to electric field, reflection, ground reflection diffraction, scattering, practical link budget design using path loss models, outdoor propagation models, indoor propagation models, signal penetration into buildings, ray tracking and site specific modeling, small scale multi-path propagation, impulse response model of a multi-path channel, small scale multi-path measurements, parameters of mobile multi-path channels, types of small scale fading, Rayleigh and Ricean distributions, statistical models for multi-path fading channels.

Diversity techniques: Concepts of Diversity branch and signal paths, Combining and switching methods, C/N, C/I performance improvements, Average P_e, performance improvement, RAKE receiver.

Cellular concept: Frequency reuse, channel assignment strategies, handoff strategies; interference and system capacity, trunking and grade of service, improving coverage and capacity in cellular systems, FDMA, TDMA, spread spectrum multiple access, SDMA, packet Radio, capacity of cellular systems

Personal Mobile Satellite Communications: Integration of GEO, LEO, and MEO Satellite and Terrestrial mobile systems, personal satellite Communications programs.

CDMA Systems Implementation: Is-95 System Architecture, Soft Handoff and Power Control in IS-95 CDMA, cdma2000 System.

Signal reception: Wireless signaling environment, basic receiver signal processing for wireless, blind multi-user detection, linear receivers for synchronous CDMA, blind multi-user detection direct methods, blind multi-user detection subspace methods, performance of blind

multi-user detector, subspace tracking algorithms, blind multi-user detector in multi-path channels.

TEXT BOOKS:

1. **Theodore S. Rappaport**, "Wireless Communications: Principles and Practice," 2nd edition, Prentice Hall of India, 2005.
2. **Kamilo Feher**, "Wireless Digital Communications: Modulation and Spread Spectrum Techniques," Prentice Hall of India, 2004.
3. **Vijay K. Garg**, "IS-95 CDMA and cdma2000," Pearson Education (Asia) Pte. Ltd, 2004.
4. **Xiaodong Wang** and **Vincent Poor**, "Wireless Communication Systems: Advanced Techniques for Signal Reception," Pearson Education (Asia) Pte. Ltd, 2004.

09 EC079	THEORY & DESIGN OF BIO – MEDICAL INSTRUMENTS

Transducers; Ultrasonic Instruments; Electrodynamics & Magnetostrictive Transducers; Force balanced transducers; Fiber optic transducers; Signal Processing Circuitry & Microprocessors; Biotelemetry; Frequency discriminators & Phase Locked loops

TEXT BOOKS:

1. Walter Welkowitz, and others, "Biomedical Instruments-Theory and Design", Academic Press 1992, II edition
2. R.S.C. Cobbold, "Transducers for biomedical measurements: Principle and practice", John Wiley 1974
3. Tatsno Togawa, Toshiyo Tarnura, P.Akeoberg, "Biomedical transducers and instruments" CRC press, 1997

09 EC047	LOW POWER VLSI DESIGN

Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches, Physics of power dissipation in CMOS devices.

Device & Technology Impact on Low Power: Dynamic dissipation in CMOS, Transistor sizing & gate oxide thickness, Impact of technology Scaling, Technology & Device innovation

Power estimation, Simulation Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation.

Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy.

Low Power Design

Circuit level: Power consumption in circuits. Flip Flops & Latches design, high capacitance nodes, low power digital cells library

Logic level: Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic

Low power Architecture & Systems: Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components, low power memory design.

Low power Clock Distribution: Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co design of clock network

Algorithm & architectural level methodologies: Introduction, design flow, Algorithmic level analysis & optimization, Architectural level estimation & synthesis.

TEXT BOOKS:

1. Gary K. Yeap, “Practical Low Power Digital VLSI Design”, KAP, 2002
2. Rabaey, Pedram, “Low power design methodologies” Kluwer Academic, 1997 Kaushik Roy, Sharat Prasad, “Low-Power CMOS VLSI Circuit Design” Wiley, 2000

09 EC077	SYNTHESIS AND OPTIMIZATION OF DIGITAL CIRCUITS

Introduction: Microelectronics, semiconductor technologies and circuit taxonomy, Microelectronic design styles, computer aided synthesis and optimization.

Graphs: Notation, undirected graphs, directed graphs, combinatorial optimization, Algorithms, tractable and intractable problems, algorithms for linear and integer programs, graph optimization problems and algorithms, Boolean algebra and Applications.

Hardware Modeling: Hardware Modeling Languages, distinctive features, structural hardware language, Behavioral hardware language, HDLs used in synthesis, abstract models, structures logic networks, state diagrams, data flow and sequencing graphs, compilation and optimization techniques.

Two level combinational logic optimization: Logic optimization, principles, operation on two level logic covers, algorithms for logic minimization, symbolic minimization and encoding property, minimization of Boolean relations.

Multiple level combinational optimizations: Models and transformations for combinational networks, algebraic model, Synthesis of testable network, algorithm for delay evaluation and optimization, rule based system for logic optimization.

Sequential circuit optimization: Sequential circuit optimization using state based models, sequential circuit optimization using network models.

Schedule Algorithms: A model for scheduling problems, Scheduling with resource and without resource constraints, Scheduling algorithms for extended sequencing models, Scheduling Pipe lined circuits.

Cell library binding: Problem formulation and analysis, algorithms for library binding, specific problems and algorithms for library binding (lookup table F.P.G.As and Antifuse based F.P.G.As), rule based library binding.

Testing: Simulation, Types of simulators, basic components of a simulator, fault simulation Techniques, Automatic test pattern generation methods (ATPG), design for Testability (DFT) Techniques.

TEXT BOOKS:

1. Giovanni De Micheli, “Synthesis and Optimization of Digital Circuits," Tata McGraw-Hill, 2003.
2. Srinivas Devadas, Abhijit Ghosh, and Kurt Keutzer, “Logic Synthesis,” McGraw-Hill, USA, 1994.
3. Neil Weste and K. Eshragian,”Principles of CMOS VLSI Design: A System Perspective,2nd edition, Pearson Education, 2000.
4. Kevin Skahill, “VHDL for Programmable Logic,” Pearson Education, 2000.

09 EC075	SPEECH AND AUDIO PROCESSING

Digital models for the speech signal: Process of speech production, Acoustic theory of speech production, Lossless tube models, and Digital models for speech signals.

Time domain models for speech processing: Time dependent processing of speech, Short time energy and average magnitude, Short time average zero crossing rate, Speech vs silence discrimination using energy & zero crossings, Pitch period estimation, Short time autocorrelation function, Short time average magnitude difference function, Pitch period estimation using autocorrelation function, Median smoothing.

Digital representations of the speech waveform: Sampling speech signals, Instantaneous quantization, Adaptive quantization, Differential quantization, Delta Modulation, Differential PCM, Comparison of systems, direct digital code conversion.

Short time Fourier analysis: Linear Filtering interpretation, Filter bank summation method, Overlap addition method, Design of digital filter banks, Implementation using FFT, Spectrographic displays, Pitch detection, Analysis by synthesis, Analysis synthesis systems.

Homomorphic speech processing: Homomorphic systems for convolution, Complex cepstrum, Pitch detection, Formant estimation, Homomorphic vocoder.

Linear predictive coding of speech: Basic principles of linear predictive analysis, Solution of LPC equations, Prediction error signal, Frequency domain interpretation, Relation between the various speech parameters, Synthesis of speech from linear predictive parameters, Applications.

Speech Enhancement: Spectral subtraction & filtering, Harmonic filtering, parametric re-synthesis, Adaptive noise cancellation.

Speech Synthesis: Principles of speech synthesis, Synthesizer methods, Synthesis of intonation, Speech synthesis for different speakers, Speech synthesis in other languages, Evaluation, Practical speech synthesis.

Automatic Speech Recognition: Introduction, Speech recognition vs. Speaker recognition, Signal processing and analysis methods, Pattern comparison techniques, Hidden Markov Models, Artificial Neural Networks.

Audio Processing: Auditory perception and psychoacoustics - Masking, frequency and loudness perception, spatial perception, Digital Audio, Audio Coding - High quality, low-bit-rate audio coding standards, MPEG, AC-3, Multichannel audio - Stereo, 3D binaural and Multichannel surround sound.

TEXT BOOKS:

1. L. R. Rabiner and R. W. Schafer**,** "Digital Processing of Speech Signals," Pearson Education (Asia) Pte. Ltd., 2004.
2. D. O'Shaughnessy, "Speech Communications: Human and Machine," Universities Press, 2001.
3. L. R. Rabiner and B. Juang, "Fundamentals of Speech Recognition," Pearson Education (Asia) Pte. Ltd., 2004.
4. Z. Li and M.S. Drew**,** "Fundamentals of Multimedia," Pearson Education (Asia) Pte. Ltd., 2004.

09 EC055	• NET TECHNOLOGY

•**Net Framework:** The Architecture of.Net Framework Development Platform, Building, Packaging, Deploying, and Administering Applications and types Shared Assemblies

Common Language Runtime: Type Fundamental Primitive, Reference and Value Types Common Object Operations Type Members Constants and Fields Methods Properties Events Working with Text Enumerated Types and Bit Flags Arrays Interfaces Custom Attributes Delegates Exceptions Automatic Memory Management CLR Hosting AppDomains Refletion

Language Fundamentals: Introduction to C# Expressions and Control Structures Strings and Regular Expressions Arrays and Collections Objects and Classes File and Stream I/O and Object Persistence XML Fundamentals Multithreaded Programming Events and Delegates Reflection and Code Attributes Assemblies and AppDomains COM and Windows Interoperability High Performance Programming

Applications: Introduction to Windows Forms, Windows Forms User Interface Controls, Creating Visually Compelling Windows Forms Applications Consuming Web Services Smart Clients Deploying Windows Applications, Introduction to Web Forms and ASP•NET Web UI Controls State Management in ASP•NET Caching Advanced ASP•NET Deploying ASP•NET Applications Using •NET Data Providers Creating a Custom ADO•NET Data Provider Typed DataSets and XSD Windows Forms Data Binding Web Forms Data Binding Introduction to Web Services Using WSE 2.0 ode Access Security Securing Sensitive Data Securing ASP•NET Web Applications Licensing and Intellectual Property Interface Programming Remoting COM+ Enterprise Services Enterprise Templates

TEXT BOOKS:

1. Jeffery Richter: Applied Microsoft •NET Framework programming, WP Publishers 2003
2. Kevin Hoofman, Lonny Kruger: "Microsoft Visual C# •NET" 2003, Pearson 2005
3. Angshuman Chakraborti, Miscrosoft "•NET Framework", PHI 2002

09 EC092	PARALLEL SYSTEMS

Principles of Pipelining and Vector Processing: Vector Processing Requirements, Characteristics of Vector Processing, Multiple Vector Task Dispatching, Pipelined Vector Processing Methods

Pipeline Computers and Factorization: Scientific Attached Processors, The Architecture of AP 120B, Recent Vector Processors, The Architecture of Cray-1, Pipeline Chaining and Vector Loops, The Architecture of Cyber-205 and CDC-NASF, Vectorization and Optimization Methods, Language Features in Vector Processing, Design of Vectorizing Compilers, Optimization of Vector Operations

Structures and algorithms for Array Processors: SIMD Array Processors, SIMD Computer Organizations, Masking and Data Routing Mechanisms, Inter-PE Communications, SIMD Interconnection Networks, Static versus Dynamic Networks, Mesh-Connected Iliac Networks, Cube Interconnection Networks, Barrel Shifter and Data Manipulator, Parallel Algorithms for Array Processors, SIMD Matrix Multiplication, Associative Array Processing, Associative Memory Organizations

SIMD computers and Performance Enhancement: The Iliac –IV Systems Architecture, Applications of the Iliac –IV, The MPP System Architecture, Processing Array, Memory, and Control

TEXT BOOKS:

1. Hwang and Briggs, " Computer Architecture and Parallel Processing"; MGH.VLSI, 1984
2. Kai Hwang, "Advanced computer architecture"; TMH, 1993
3. Harvey G.Cragon,"Memory System and Pipelined processors"; Narosa Publication, 1998
4. M.J Flynn, "Computer Architecture, Pipelined and Parallel Processor Design"; Narosa Publishing, 1998

REFERENCE BOOKS:

1. D. A. Patterson and J. L. Hennessey, "Computer organization and design," Morgan Kaufmann, 2002.
2. J. P. Hayes, "Computer Architecture and organization"; MGH, 1998
3. R.K.Ghose, Rajat Moona & Phalguni Gupta, "Foundation of Parallel Processing"; Narosa Publications, 1998
4. Kai Hwang and Xu, "Scalable Parallel Computing"; MGH, 1998.

09 EC094	ADVANCED DATA NETWORKS

Introduction: Message & switching, Layering, A distributed algorithm problem.

Physical Layer: Channels & Modems, Error detection, ARQ, Framing, Standard DLCs, Initialization & disconnect for ARQ protocols, PPP at network layer, the transport Layer, Broadband ISDN & the ATM

Delay models in networks Introduction, Queuing Models, M/M/1 queuing system, M/M/m, M/M/• , M/M/m/m & other Markov systems, M/G/1 system, Networks of transmission lines, Time reversibility, Networks of Queues

Multi-access communication: Introduction, Slotted multi-access & aloha system, Splitting algorithms, Carrier sensing, Multi-access reservations, Packet Radio networks

Routing in Data Networks: Introduction, Network algorithms & shortest path routing, Broadcasting routing information : coping with link failures, Flow models, optimal routing, & topological design, characterization of optimal routing, feasible direction methods for optimal routing, projection routing for optimal routing, routing in the codex network

Flow Control: Introduction, window flow control, rate control scheme, overview of flow control in practice, rate adjustment algorithms.

Text Books:

1. W. Stallings, "Data and Computer Communications"

2. J. Martin, “Computer Networks and Distributed Processing”
3. A. S. Tanenbaum, “Computer Networks”

09 EC0 59	OPTICAL COMMUNICATION & NETWORKING

Introduction: Propagation of signals in optical fiber, different losses, nonlinear effects, solitons, optical sources, detectors.

Optical Components: Couplers, isolators, circulators, multiplexers, filters, gratings, interferometers, amplifiers.

Modulation — Demodulation: Formats, ideal receivers, Practical detection receivers, Optical preamplifier, Noise considerations, Bit error rates, Coherent detection.

Transmission system engineering: system model, power penalty, Transmitter, Receiver, Different optical amplifiers, Dispersion.

Optical networks: Client layers of optical layer, SONET/SDH, multiplexing, layers, frame structure, ATM functions, adaptation layers, Quality of service and flow control, ESCON, HIPPI.

WDM network elements: Optical line terminal optical line amplifiers, optical cross connectors, WDM network design, cost trade offs, LTD and RWA problems, Routing and wavelength assignment, wavelength conversion, statistical dimensioning model.

Control and management: network management functions, management frame work, Information model, management protocols, layers within optical layer performance and fault management, impact of transparency, BER measurement, optical trace, Alarm management, configuration management.

Suitable number of Assignments / Tutorials can be given based on the syllabus

TEXT BOOKS:

1. John M. Senior, “Optical fiber Communications”, Pearson edition, 2000.
2. Rajiv Ramswami, N Sivaranjan, “Optical Networks”, M. Kauffman Publishers, 2000.

REFERENCE BOOKS:

1. Gerd Keiser, “Optical Fiber Communication”, MGH, 1 991.
2. G. P. Agarawal, “Fiber Optics Communication Systems”, John Wiley NewYork, 1997
3. P.E. Green, “Optical networks”, Prentice Hall, 1994.

********** **********