

**ANNA UNIVERSITY, CHENNAI**  
**AFFILIATED INSTITUTIONS**  
**R - 2009**  
**CURRICULUM I SEMESTER (FULL TIME)**  
**M.E. NETWORK ENGINEERING**

**SEMESTER I**

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
<b>THEORY</b>						
1	MA9219	<a href="#">Operations Research</a>	3	1	0	4
2	NE9211	<a href="#">TCP/IP</a>	3	0	0	3
3	NE9212	<a href="#">Internet and Java Programming</a>	3	0	0	3
4	NE9213	<a href="#">Network Management</a>	3	0	0	3
5	NE9214	<a href="#">Information Theory and Coding</a>	3	0	0	3
6	E1	Elective I	3	0	0	3
<b>PRACTICAL</b>						
7	NE9217	<a href="#">Network Programming Lab</a>	0	0	4	2
<b>TOTAL</b>			<b>18</b>	<b>1</b>	<b>4</b>	<b>21</b>

**LIST OF ELECTIVES**  
**M.E. NETWORK ENGINEERING**

SL. NO	COURSE CODE	COURSE TITLE	L	T	P	C
1	CS9251	<a href="#">Mobile Computing</a>	3	0	0	3
2	NE9251	<a href="#">Reliability Engineering</a>	3	0	0	3
3	AP9252	<a href="#">Neural Networks and Its Applications</a>	3	0	0	3
4	NE9253	<a href="#">Real-Time Embedded Systems</a>	3	0	0	3
5	NE9254	<a href="#">Software Engineering Methodologies</a>	3	0	0	3
6	CS9225	<a href="#">Web Technology</a>	3	0	0	3
7	CP9253	<a href="#">High Speed Switching Architecture</a>	3	0	0	3
8	NE9256	<a href="#">Genetic Algorithms and Applications</a>	3	0	0	3
9	CU9224	<a href="#">Satellite Communication</a>	3	0	0	3
10	NE9257	<a href="#">Multimedia Compression Technologies</a>	3	0	0	3
11	NE9258	<a href="#">Advanced Algorithms</a>	3	0	0	3
12	NE9259	<a href="#">Telecommunication and Switching Techniques</a>	3	0	0	3
13	NE9260	<a href="#">Storage Area Networks</a>	3	0	0	3
14	NE9261	<a href="#">Enterprise Networks</a>	3	0	0	3
15	NE9262	<a href="#">Optical Communication Systems and Networking</a>	3	0	0	3
16	NE9263	<a href="#">Distributed Computing</a>	3	0	0	3
17	CS9256	<a href="#">Multimedia Systems</a>	3	0	0	3
18	CS9266	<a href="#">Agent Based Intelligent Systems</a>	3	0	0	3
19	NE9266	<a href="#">Simulation of Communication Systems and Networks</a>	3	0	0	3
20		Special Elective	3	0	0	3

<b>UNIT I</b>	<b>QUEUEING MODELS</b>	<b>12</b>
Poisson Process – Markovian Queues – Single and Multi-server Models – Little’s formula – Machine Interference Model – Steady State analysis – Self Service Queue.		
<b>UNIT II</b>	<b>ADVANCED QUEUEING MODELS</b>	<b>12</b>
Non- Markovian Queues – Pollaczek Khintchine Formula – Queues in Series – Open Queueing Networks – Closed Queueing networks.		
<b>UNIT III</b>	<b>SIMULATION</b>	<b>12</b>
Discrete Even Simulation – Monte – Carlo Simulation – Stochastic Simulation – Applications to Queueing systems.		
<b>UNIT IV</b>	<b>LINEAR PROGRAMMING</b>	<b>12</b>
Formulation – Graphical solution – Simplex method – Two phase method – Transportation and Assignment Problems.		
<b>UNIT V</b>	<b>NON-LINEAR PROGRAMMING</b>	<b>12</b>
Lagrange multipliers – Equality constraints – Inequality constraints – Kuhn - Tucker conditions – Quadratic Programming.		

**L + T: 45+15 =60 PERIODS**

#### REFERENCES

1. Winston.W.L. “Operations Research”, Fourth Edition, Thomson – Brooks/Cole, 2003.
2. Taha, H.A. “Operations Research: An Introduction”, Ninth Edition, Pearson Education Edition, Asia, New Delhi, 2002.
3. Robertazzi. T.G. “Computer Networks and Systems – Queuing Theory and Performance Evaluation”, Third Edition, Springer, 2002 Reprint.
4. Ross. S.M., “Probability Models for Computer Science”, Academic Press, 2002.

<b>UNIT I</b>	<b>INTRODUCTION</b>	<b>9</b>
Network architecture-Standards and underlying technologies-Internet addressing- ARP - RARP-BOOTP-DHCP.		
<b>UNIT II</b>	<b>INTERNET PROTOCOL</b>	<b>9</b>
IP Datagram-IP Package-IP forwarding and routing algorithms-computing paths-RIP-OSPF-ICMP-IGMP.		
<b>UNIT III</b>	<b>TCP</b>	<b>9</b>
TCP header- services-Connection establishment and termination - Interactive data flow - Bulk data flow – Flow control and Retransmission - TCP timers - Urgent Data processing – Congestion control – Extension headers.		

**UNIT IV IP SWITCHING AND TRAFFIC ENGINEERING 9**  
Switching technology- MPLS fundamentals – signaling protocols – LDP – IP traffic engineering – ECMP – SBR – Routing extensions for traffic engineering – Traffic engineering limitations and future developments.

**UNIT V IPv6 9**  
IP security protocol-IPv6 addresses –Packet format-Multicast-Anycast-ICMPv6- Interoperation between IPv4 and IPv6-QoS –Auto configuration.

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Douglas E. Comer, "Internetworking with TCP/IP Principles, Protocols, and Architecture"- 5<sup>th</sup> edition Volume-1, Prentice Hall-2006.
2. Adrian Farrel, "The Internet and its Protocols- A Comparative approach" Morgan Kaufmann, 2004.
3. W.Richard Stevens "TCP/IP Illustrated,The Protocols". Volume I, Pearson Education India 2003.
4. Behrouz A.Forouzan,"TCP/IP Protocol Suite"-3<sup>rd</sup> edition-Tata McGraw Hill-2006.
5. Pete Loshin"IPv6 Theory, Protocol and Practice, 2<sup>nd</sup> edition", Morgon Kaufmann-December-2003.
6. Comer D.E & Stevens D.L "Internetworking TCP/IP- Volume III",Prentice Hall of India –1997.

**NE9212 INTERNET AND JAVA PROGRAMMING LT P C  
3 0 0 3**

**UNIT I INTRODUCTION 9**  
Introduction to the Internet and World Wide Web - World Wide Web Consortium (W3C) - History of the Internet History of the World Wide Web - History of SGML -XML Introduction to HyperText Markup Language - Editing HTML - Common Elements – Headers - Linking - Images - Unordered Lists - Nested and Ordered Lists - HTML Tables-Basic HTML Forms

**UNIT II DYNAMIC HTML 9**  
Dynamic HTML Object Model and Collections, Event Model, Filters and Transitions, Data Binding with Tabular Data Control, Dynamic HTML-Structured Graphics ActiveX Controls, Dynamic HTML-Path, Sequencer and Sprite ActiveX Controls.

**UNIT III JAVASCRIPT 9**  
JavaScript, Introduction to Scripting, Control Statements, Functions, Arrays, Objects.

**UNIT IV XML 9**  
Creating Markup with XML -Parsers and Well-formed XML Documents -Parsing an XML Document with msxml - Document Type Definition (DTD) - Document Type Declaration - Element Type Declarations - Attribute Declarations - Document Object Model - DOM Implementations - – DOM Components - path - XSL: Extensible Stylesheet Language Transformations (XSLT)

**UNIT V PERL, CGI AND PHP****9**

Perl - String Processing and Regular Expressions - Form Processing and Business Logic - Server-Side Includes - Verifying a Username and Password - Using DBI to Connect to a Database -PHP - Form Processing and Business Logic --Connecting to a Database - Dynamic Content in PHP

**TOTAL: 45 PERIODS****REFERNCES**

1. Deitel & Deitel Internet & World Wide Web How to Program, Pearson Education India -Third Edition -2004
2. Deitel & Deitel XML How to Program, Pearson Education,2001
3. Robert W.Sebesta , “ Programming withWorld Wide Web”,Pearson Education ,2009
4. Negrino and Smith Javascript for the World Wide Web, 5th Edition, Peachpit Press 2003.
5. Deitel & Deitel Perl How to Program, Pearson Education, 2001
6. Benoit Marchal, XML by Example, 2nd Edition, Que/Sams 2002.

**NE9213****NETWORK MANAGEMENT****LT P C  
3 0 0 3****UNIT I FUNDAMENTALS OF COMPUTER NETWORK TECHNOLOGY 9**

Network Topology, LAN, Network node components- Hubs, Bridges, Routers, Gateways, Switches, WAN, ISDN Transmission Technology, Communications protocols and standards

**UNIT II OSI NETWORK MANAGEMENT 9**

OSI Network management model-Organizational model-Information model, communication model. Abstract Syntax Notation - Encoding structure, Macros Functional model CMIP/CMIS

**UNIT III INTERNET MANAGEMENT(SNMP) 9**

SNMP-Organizational model-System Overview, The information model, communication model-Functional model, SNMP proxy server, Management information, protocol remote monitoring

**UNIT IV BROADBAND NETWORK MANAGEMENT 9**

Broadband network s and services, ATM Technology-VP,VC,ATM Packet, Integrated service, ATMLAN emulation, Virtual Lan. ATM Network Management-ATM Network reference model, integrated local management Interface. ATM Management Information base, Role of SNMD and ILMI in ATM Management, M1, M2, M3, M4 Interface. ATM Digital Exchange Interface Management

**UNIT V NETWORK MANAGEMENT APPLICATIONS 9**

Configuration management, Fault management, performance management, Event Correlation Techniques security Management, Accounting management, Report Management, Policy Based Management Service Level Management

**TOTAL: 45 PERIODS**

## REFERENCES

1. Mani Subramanian, "Network Management Principles and practice ", Addison Wesley New York, 2000.
2. Salah Aiidarous, Thomas Plevayk, "Telecommunications Network Management Technologies and Implementations ", eastern Economy Edition IEEE press, New Delhi, 1998.
3. Lakshmi G. Raman, "Fundamentals of Telecommunication Network Management ", Eastern Economy Edition IEEE Press, New Delhi, 1999.

NE9214

INFORMATION THEORY AND CODING

LT P C  
3 0 0 3

### UNIT I INFORMATION THEORY 9

Information entropy and Mutual Information, Markov Sources, Capacity of the Discrete Noiseless Channel, – source encoding, Shannon's first fundamental theorem, source with finite memory, discrete channel with discrete noise,

### UNIT II LOSSLESS COMPRESSION 9

Compression principles-source encoders and destination encoders-entropy encoding – source encoding -text compression –static Huffman coding dynamic coding –arithmetic coding –Lempel ziv-welsh Compression.

### UNIT III AUDIO, IMAGE AND VIDEO COMPRESSION 9

Audio compression–DPCM-Adaptive PCM –adaptive predictive coding-linear Predictive coding-code excited LPC-perpetual coding -JPEG ,JBIG,Video compression –principles-H.261-H.263-MPEG 1, 2, 4.

### UNIT IV BLOCK AND CYCLIC CODES 9

Structure of Linear block codes, Matrix description of linear block codes, hamming code, polynomial description of cyclic codes, matrix description, cyclic codes for correcting double error, first error correction.

### UNIT V CONVOLUTIONAL CODES 9

Trees, and Trellis diagram, polynomial and matrix description of convolution codes, error correction, and some simple convolution codes, syndrome decoding, viterbi algorithm..

**TOTAL: 45 PERIODS**

## REFERENCES

1. Fred Halsall, "Multimedia Communications, Applications Networks Protocols & Standards", Pearson education, Asia 2002;
2. Simon Haykin, Digital Communication, John Wiley ,2007
3. Proakis, J.G. "Digital Communication", McGraw-Hill, New York 1989.
4. Benede Ho. S, Biglieri E, Principles of Digital Transmission with wireless applications, Planum series in Telecommunications, 1999.
5. Viterbi, A J and Omura J K, Principles of Digital Communication and Coding, McGraw Hill 1979.
6. Blahut R.E, Theory and practice of error control codes, Addition Wesley publication company, London1984.

**LIST OF EXPERIMENTS**

1. Write a program to transfer a File using TCP.
2. Write a program to transfer Files using UDP.
3. Write a program to capture packets through the network interface
4. Simulate the functions of Data Link layer
5. Simulate Selective repeat algorithm
6. Implementation of Go-Back-N protocol
7. Implementation of IP fragmentation and Reassembly
8. Demonstrate SSL client/Server architecture
9. Demonstrate a simple multicast client/server
10. Test the Transaction TCP in client/server architecture

**TOTAL: 60 PERIODS**

- UNIT I WIRELESS COMMUNICATION FUNDAMENTALS 9**  
Introduction – Wireless transmission – Frequencies for radio transmission – Signals – Antennas – Signal Propagation – Multiplexing – Modulations – Spread spectrum – MAC – SDMA – FDMA – TDMA – CDMA – Cellular Wireless Networks.
- UNIT II TELECOMMUNICATION SYSTEMS 11**  
GSM – System Architecture – Protocols – Connection Establishment – Frequency Allocation – Routing – Handover – Security – GPRS.
- UNIT III WIRELESS NETWORKS 9**  
Wireless LAN – IEEE 802.11 Standards – Architecture – Services – HIPERLAN – Adhoc Network – Blue Tooth.
- UNIT IV NETWORK LAYER 9**  
Mobile IP – Dynamic Host Configuration Protocol – Routing – DSDV – DSR – AODV – ZRP – ODMR.
- UNIT V TRANSPORT AND APPLICATION LAYERS 7**  
TCP over Wireless Networks – Indirect TCP – Snooping TCP – Mobile TCP – Fast Retransmit / Fast Recovery – Transmission/Timeout Freezing – Selective Retransmission – Transaction Oriented TCP – WAP – WAP Architecture – WDP – WTLS – WTP – WSP – WML –WML Script – WAE – WTA.

**TOTAL: 45 PERIODS**

## REFERENCES

1. Jochen Schiller, "Mobile Communications", Second Edition, Pearson Education, 2003.
2. William Stallings, "Wireless Communications and Networks", Pearson Education, 2002.
3. Kaveh Pahlavan, Prasanth Krishnamoorthy, "Principles of Wireless Networks", First Edition, Pearson Education, 2003.
4. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "Principles of Mobile Computing", Springer, 2003.
5. C.K.Toh, "AdHoc Mobile Wireless Networks", First Edition, Pearson Education, 2002.
6. Burkhardt, "Pervasive Computing", First Edition, Pearson Education, 2003.

**NE9251**

**RELIABILITY ENGINEERING**

**LT P C  
3 0 0 3**

### **UNIT I PROBABILITY PLOTTING AND LOAD-STRENGTH INTERFERENCE 9**

Statistical distribution , statistical confidence and hypothesis testing ,probability plotting techniques – Weibull, extreme value ,hazard, binomial data; Analysis of load – strength interference , Safety margin and loading roughness on reliability.

### **UNIT II RELIABILITY PREDICTION, MODELLING AND DESIGN 9**

Statistical design of experiments and analysis of variance Taguchi method, Reliability prediction, Reliability modeling, Block diagram and Fault tree Analysis ,petric Nets, State space Analysis, Monte carlo simulation, Design analysis methods – quality function deployment, load strength analysis, failure modes, effects and criticality analysis.

### **UNIT III ELECTRONICS AND SOFTWARE SYSTEMS RELIABILITY 9**

Reliability of electronic components, component types and failure mechanisms, Electronic system reliability prediction, Reliability in electronic system design; software errors, software structure and modularity, fault tolerance, software reliability, prediction and measurement, hardware/software interfaces.

### **UNIT IV RELIABILITY TESTING AND ANALYSIS 9**

Test environments, testing for reliability and durability, failure reporting, Pareto analysis, Accelerated test data analysis, CUSUM charts, Exploratory data analysis and proportional hazards modeling, reliability demonstration, reliability growth monitoring.

### **UNIT V MANUFACTURE AND RELIABILITY MAQNGEMENT 9**

Control of production variability, Acceptance sampling, Quality control and stress screening, Production failure reporting; preventive maintenance strategy, Maintenance schedules, Design for maintainability, Integrated reliability programmes , reliability and costs, standard for reliability, quality and safety, specifying reliability, organization for reliability.

**TOTAL: 45 PERIODS**

## REFERENCES

1. Patrick D.T. O'Connor, David Newton and Richard Bromley, Practical Reliability Engineering, Fourth edition, John Wiley & Sons, 2002
2. David J. Klinger, Yoshinao Nakada and Maria A. Menendez, Von Nostrand Reinhold, New York, "AT & T Reliability Manual", 5th Edition, 1998.
3. Gregg K. Hobbs, "Accelerated Reliability Engineering - HALT and HASS", John Wiley & Sons, New York, 2000.
4. Lewis, "Introduction to Reliability Engineering", 2nd Edition, Wiley International, 1996.

AP9252

NEURAL NETWORKS AND ITS APPLICATIONS

LT P C  
3 0 0 3

UNIT I

BASIC LEARNING ALGORITHMS

9

Biological Neuron – Artificial Neural Model - Types of activation functions – Architecture: Feedforward and Feedback – Learning Process: Error Correction Learning –Memory Based Learning – Hebbian Learning – Competitive Learning - Boltzman Learning – Supervised and Unsupervised Learning – Learning Tasks: Pattern Space – Weight Space – Pattern Association – Pattern Recognition – Function Approximation – Control – Filtering - Beamforming – Memory – Adaptation - Statistical Learning Theory – Single Layer Perceptron – Perceptron Learning Algorithm – Perceptron Convergence Theorem – Least Mean Square Learning Algorithm – Multilayer Perceptron – Back Propagation Algorithm – XOR problem – Limitations of Back Propagation Algorithm.

UNIT II

RADIAL-BASIS FUNCTION NETWORKS AND SUPPORT VECTOR MACHINES RADIAL BASIS FUNCTION NETWORKS

9

Cover's Theorem on the Separability of Patterns - Exact Interpolator – Regularization Theory – Generalized Radial Basis Function Networks - Learning in Radial Basis Function Networks - Applications: XOR Problem – Image Classification.

Support Vector Machines:

Optimal Hyperplane for Linearly Separable Patterns and Nonseparable Patterns – Support Vector Machine for Pattern Recognition – XOR Problem -  $\epsilon$ -insensitive Loss Function – Support Vector Machines for Nonlinear Regression

UNIT III

COMMITTEE MACHINES

9

Ensemble Averaging - Boosting – Associative Gaussian Mixture Model – Hierarchical Mixture of Experts Model(HME) – Model Selection using a Standard Decision Tree – A Priori and Postpriori Probabilities – Maximum Likelihood Estimation – Learning Strategies for the HME Model - EM Algorithm – Applications of EM Algorithm to HME Model

NEURODYNAMICS SYSTEMS

Dynamical Systems – Attractors and Stability – Non-linear Dynamical Systems- Lyapunov Stability – Neurodynamical Systems – The Cohen-Grossberg Theorem.



**UNIT IV            ATTRACTOR NEURAL NETWORKS****9**

Associative Learning – Attractor Neural Network Associative Memory – Linear Associative Memory – Hopfield Network – Content Addressable Memory – Strange Attractors and Chaos - Error Performance of Hopfield Networks - Applications of Hopfield Networks – Simulated Annealing – Boltzmann Machine – Bidirectional Associative Memory – BAM Stability Analysis – Error Correction in BAMs - Memory Annihilation of Structured Maps in BAMS – Continuous BAMs – Adaptive BAMs – Applications

**ADAPTIVE RESONANCE THEORY**

Noise-Saturation Dilemma - Solving Noise-Saturation Dilemma – Recurrent On-center – Off-surround Networks – Building Blocks of Adaptive Resonance – Substrate of Resonance Structural Details of Resonance Model – Adaptive Resonance Theory – Applications

**UNIT V            SELF ORGANISING MAPS****9**

Self-organizing Map – Maximal Eigenvector Filtering – Sanger's Rule – Generalized Learning Law – Competitive Learning - Vector Quantization – Mexican Hat Networks - Self-organizing Feature Maps – Applications

**PULSED NEURON MODELS**

Spiking Neuron Model – Integrate-and-Fire Neurons – Conductance Based Models – Computing with Spiking Neurons.

**TOTAL: 45 PERIODS****REFERENCES:**

1. Satish Kumar, "Neural Networks: A Classroom Approach", Tata McGraw-Hill Publishing Company Limited, New Delhi, 2004.
2. Simon Haykin, "Neural Networks: A Comprehensive Foundation", 2ed., Addison Wesley Longman (Singapore) Private Limited, Delhi, 2001.
3. Martin T.Hagan, Howard B. Demuth, and Mark Beale, "Neural Network Design", Thomson Learning, New Delhi, 2003.
4. James A. Freeman and David M. Skapura, "Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Education (Singapore) Private Limited, Delhi, 2003.

**NE9253****REAL TIME EMBEDDED SYSTEMS****LT P C  
3 0 0 3****UNIT I            INTRODUCTION****10**

Real Time System – Embedded Systems – Architecture of Embedded System - Simple Programming for Embedded System – Process of Embedded System Development - Pervasive Computing – Information Access Devices – Smart Cards – PIC Microcontroller – ARM Processor.

<b>UNIT II</b>	<b>EMBEDDED/REAL TIME OPERATING SYSTEM</b>	<b>9</b>
Operating System Concepts: Processes, Threads, Interrupts, Events - Real Time Scheduling Algorithms - Memory Management – Overview of Operating Systems for Embedded, Real Time, Handheld Devices – Target Image Creation – Programming in Linux, RTLinux, VxWorks, uC/Os-overview.		
<b>UNIT III</b>	<b>CONNECTIVITY</b>	<b>9</b>
Wireless Connectivity - Bluetooth – Other short Range Protocols – Wireless Application Environment – Service Discovery – Middleware.		
<b>UNIT IV</b>	<b>REAL TIME UML</b>	<b>8</b>
Requirements Analysis – Object Identification Strategies – Object Behavior – Real Time Design Patterns.		
<b>UNIT V</b>	<b>SOFTWARE DEVELOPMENT AND CASE STUDY</b>	<b>9</b>
Concurrency – Exceptions – Tools – Debugging Techniques – Optimization – Case Studies -Interfacing Digital Camera with USB port and Data Compressor.		

**TOTAL: 45 PERIODS**

## REFERENCES

1. R.J.A.Buhr, D.L.Bailey, "An Introduction to Real-Time Systems", Prentice-Hall International, 1999.
2. David E-Simon, "An Embedded Software Primer", Pearson Education, 2007. (UNIT – II)
3. C.M.Krishna, Kang G.Shin, "Real Time Systems", Mc-Graw Hill, 1997. (UNIT- II)
4. B.P.Douglass, "Real Time UML 2<sup>nd</sup> Edition", Addison-Wesley 2000. ((UNIT – IV)
5. J.Schiller, "Mobile Communication", Addison-Wesley, 1999. (UNIT – III)
6. Dr.K.V.K.K.Prasad, "Embedded/Real Time Systems: Concepts, Design and Programming", DreamTech press, Black Book, 2005. (UNIT – I)
7. R.Barnett, L.O.Cull, S.Cox, "Embedded C Programming and the Microchip PIC", Thomason Learning 2004. (UNIT – I)
8. Wayne Wolf, "Computers as Components - Principles of Embedded Computer System Design", Mergen Kaufman Publisher, 2006.
9. Sriram V Iyer, Pankaj Gupta, "Embedded Real Time Systems Programming", Tata Mc-Graw Hill, 2004.

<b>NE9254</b>	<b>SOFTWARE ENGINEERING METHODOLOGIES</b>	<b>LT P C</b>
		<b>3 0 0 3</b>

<b>UNIT I</b>	<b>9</b>
Definition – systems approach – modeling the process and lifecycle – meaning of process – software process models – tools and techniques – practical process modeling – information systems – planning and managing the project – tracking project – project personnel – effort estimation – risk management – project plan – process models and project management	

**UNIT II** **9**  
 Capturing the requirements – requirements process – requirements elicitation – types – characteristics – modeling notations – specification languages – prototyping – documentation – validation and verification – measures – specification techniques – designing the system – decomposition and modularity – architectural styles and strategies – issues – characteristics – improvement techniques – design evaluation, validation – documentation

**UNIT III** **8**  
 Considering objects – object orientation – OO development – use cases – representing OO – OO system design – program design – OO measurement – writing programs – standards – procedures – guidelines – documentation – programming process

**UNIT IV** **9**  
 Testing the program – faults – failures – issues – unit testing – Integration testing – testing OO systems – test planning – automated testing tools - testing the system – principles – function testing – performance testing – reliability, availability and maintainability – acceptance testing – installation testing – automated system testing – test documentation – testing safety critical systems – delivering the system – training – documentation

**UNIT V** **10**  
 System maintenance – the changing system – nature of maintenance – problems – measuring maintenance characteristics – techniques and tools – software rejuvenation – evaluation approaches – selection – assessment vs. prediction - evaluating products, processes and resources – improving predictions, products, processes and resources – guidelines – decision making in software engineering – licensing – certification and ethics

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Shari Lawrence Pfleeger, Joanne M. Atlee, Software Engineering: Theory and Practice, Prentice Hall, 2006
2. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, Fundamentals of Software Engineering, Prentice Hall, 2002

**CS9225** **WEB TECHNOLOGY** **LT P C**  
**3 0 0 3**

**UNIT I** **9**  
 Web essentials – clients – servers - communication – markup languages – XHTML – simple XHTML pages style sheets – CSS

**UNIT II** **9**  
 Client side programming – Java script language – java script objects – host objects : Browsers and the DOM

**UNIT III** **9**  
 Server side programming – java servlets – basics – simple program – separating programming and presentation – ASP/JSP - JSP basics ASP/JSP objects – simple ASP/JSP pages.

**UNIT IV** **9**  
Representing Web data – data base connectivity – JDBC – Dynamic Web pages – XML – DTD – XML schema – DOM – SAX – Xquery.

**UNIT V** **9**  
Building Web applications - cookies – sessions – open source environment – PHP – MYSQL – case studies.

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Jeffrey C Jackson, “ Web Technology – A computer Science perspective”, Persoson Education, 2007.
2. Chris Bates, “Web Programming – Building Internet Applications, “Wiley India, 2006.

**CP9253** **HIGH SPEED SWITCHING ARCHITECTURE** **LT P C**  
**3 0 0 3**

**UNIT I LAN SWITCHING TECHNOLOGY** **9**  
Switching Concepts, switch forwarding techniques, switch path control, LAN Switching, cut through forwarding, store and forward, virtual LANs.

**UNIT II ATM SWITCHING ARCHITECTURE** **9**  
Blocking networks - basic - and- enhanced banyan networks, sorting networks - merge sorting, re-arrangable networks - full-and- partial connection networks, non blocking networks - Recursive network construction, comparison of non-blocking network, Switching with deflection routing - shuffle switch, tandem banyan switch.

**UNIT III QUEUES IN ATM SWITCHES** **9**  
Internal Queueing -Input, output and shared queueing, multiple queueing networks – combined Input, output and shared queueing - performance analysis of Queued switches.

**UNIT IV PACKET SWITCHING ARCHITECTURES** **9**  
Architectures of Internet Switches and Routers- Bufferless and buffered Crossbar switches, Multi-stage switching, Optical Packet switching; Switching fabric on a chip; Internally buffered Crossbars.

**UNIT V IP SWITCHING** **9**  
Addressing model, IP Switching types - flow driven and topology driven solutions, IP Over ATM address and next hop resolution, multicasting, Ipv6 over ATM.

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Achille Pattavina, “Switching Theory: Architectures and performance in Broadband ATM networks ",John Wiley & Sons Ltd, New York. 1998
2. Elhanany M. Hamdi, “High Performance Packet Switching architectures”, Springer Publications, 2007.
3. Christopher Y Metz, “Switching protocols & Architectures”, McGraw - Hill Professional Publishing, NewYork.1998.
4. Rainer Handel, Manfred N Huber, Stefan Schroder, “ATM Networks - Concepts Protocols, Applications”, 3<sup>rd</sup> Edition, Addison Wesley, New York. 1999.

**UNIT I** **9**  
 Fundamentals of genetic algorithm: A brief history of evolutionary computation-biological terminology-search space -encoding, reproduction-elements of genetic algorithm-genetic modeling-comparison of GA and traditional search methods.

**UNIT II** **9**  
 Genetic technology: steady state algorithm - fitness scaling - inversion. Genetic programming - Genetic Algorithm in problem solving

**UNIT III** **9**  
 Genetic Algorithm in engineering and optimization-natural evolution –simulated annealing and Tabu search .Genetic Algorithm in scientific models and theoretical foundations.

**UNIT IV** **9**  
 Implementing a Genetic Algorithm – computer implementation - low level operator and knowledge based techniques in Genetic Algorithm.

**UNIT V** **9**  
 Applications of Genetic based machine learning-Genetic Algorithm and parallel processors, composite laminates, constraint optimization, multilevel optimization, real life problem.

**TOTAL: 45 PERIODS**

#### REFERENCES

1. Melanie Mitchell, 'An introduction to Genetic Algorithm', Prentice-Hall of India, New Delhi, Edition: 2004
2. David.E.Golberg, 'Genetic algorithms in search, optimization and machine learning', Addition-Wesley-1999
3. S.Rajasekaran and G.A Vijayalakshmi Pai,'Neural Networks, Fuzzy logic and Genetic Algorithms, Synthesis and Applications', Prentice Hall of India, New Delhi-2003.
4. Nils.J.Nilsson,'Artificial Intelligence- A new synthesis', Original edition-1999.

**UNIT I** **ELEMENTS OF SATELLITE COMMUNICATION** **8**  
 Satellite Systems, Orbital description and Orbital mechanics of LEO, MEO and GSO, Placement of a Satellite in a GSO, Satellite – description of different Communication subsystems, Bandwidth allocation.

**UNIT II** **TRANSMISSION, MULTIPLEXING, MODULATION, MULTIPLE ACCESS AND CODING** **12**  
 Different modulation and Multiplexing Schemes, Multiple Access Techniques – FDMA, TDMA, CDMA, and DAMA, Coding Schemes.

<b>UNIT III SATELLITE LINK DESIGN</b>	<b>9</b>
Basic link analysis, Interference analysis, Rain induced attenuation and interference, Ionospheric characteristics, Link Design with and without frequency reuse.	
<b>UNIT IV SATELLITE NAVIGATION AND GLOBAL POSITIONING SYSTEM</b>	<b>8</b>
Radio and Satellite Navigation, GPS Position Location Principles, GPS Receivers and Codes, Satellite Signal Acquisition, GPS Receiver Operation and Differential GPS	
<b>UNIT V APPLICATIONS</b>	<b>8</b>
Satellite Packet Communications , Intelsat series – INSAT series –VSAT, mobile satellite services, IMMERSAT, Satellite and Cable Television, DBS (DTH), VSAT, Satellite Phones.	

**TOTAL: 45 PERIODS**

**REFERENCES**

1. Wilbur L. Pritchard, H.G. Suyderhoud ,Robert A.Nelson, Satellite Communication Systems Engineering, Prentice Hall, New Jersey, 2006.
2. Timothy Pratt and Charles W.Bostain, Satellite Communications, John Wiley and Sons, 2003.
3. D.Roddy, Satellite Communication, McGrawHill, 2006.
4. Tri T Ha, Digital Satellite Communication, McGrawHill,1990.
5. B.N.Agarwal, Design of Geosynchronous Spacecraft, Prentice Hall, 1993

<b>NE9257</b>	<b>MULTIMEDIA COMPRESSION TECHNOLOGIES</b>	<b>LT P C 3 0 0 3</b>
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<b>UNIT I INTRODUCTION</b>	<b>9</b>
Special features of Multimedia – Graphics and Image Data Representations – Fundamental Concepts in Video and Digital Audio – Storage requirements for multimedia applications -Need for Compression - Taxonomy of compression techniques – Overview of source coding, source models, scalar and vector quantization theory – Evaluation techniques – Error analysis and methodologies	
<b>UNIT II TEXT COMPRESSION</b>	<b>9</b>
Compaction techniques – Huffmann coding – Adaptive Huffmann Coding – Arithmetic coding – Shannon-Fano coding – Dictionary techniques – LZW family algorithms.	
<b>UNIT III AUDIO COMPRESSION</b>	<b>9</b>
Audio compression techniques - $\mu$ - Law and A- Law companding. Frequency domain and filtering – Basic sub-band coding – Application to speech coding – G.722 – Application to audio coding – MPEG audio, progressive encoding for audio – Silence compression, speech compression techniques – Formant and CELP Vocoders	
<b>UNIT IV IMAGE COMPRESSION</b>	<b>9</b>
Predictive techniques – DM, PCM, DPCM: Optimal Predictors and Optimal Quantization – Contour based compression – Transform Coding – JPEG Standard – Sub-band coding algorithms: Design of Filter banks – Wavelet based compression: Implementation using filters – EZW, SPIHT coders – JPEG 2000 standards - JBIG, JBIG2 standards.	

**UNIT V VIDEO COMPRESSION****9**

Video compression techniques and standards – MPEG Video Coding I: MPEG – 1 and 2 – MPEG Video Coding II: MPEG – 4 and 7 – Motion estimation and compensation techniques – H.261 Standard – DVI technology – PLV performance – DVI real time compression – Packet Video.

**TOTAL: 45 PERIODS****REFERENCES**

1. Khalid Sayood : Introduction to Data Compression, Morgan Kauffman Harcourt India, 2<sup>nd</sup> Edition, 2000.
2. David Salomon : Data Compression – The Complete Reference, Springer Verlag New York Inc., 2<sup>nd</sup> Edition, 2001.
3. Yun Q.Shi, Huifang Sun : Image and Video Compression for Multimedia Engineering - Fundamentals, Algorithms & Standards, CRC press, 2003.
4. Peter Symes : Digital Video Compression, McGraw Hill Pub., 2004.
5. Mark Nelson : Data compression, BPB Publishers, New Delhi, 1998.
6. Mark S.Drew, Ze-Nian Li : Fundamentals of Multimedia, PHI, 1<sup>st</sup> Edition, 2003.
7. Watkinson, J : Compression in Video and Audio, Focal press, London. 1995.
8. Jan Vozer : Video Compression for Multimedia, AP Profes, New York, 1995

**NE9258****ADVANCED ALGORITHMS****LT P C  
3 0 0 3****UNIT I INTRODUCTION****9**

Mathematical Background - Design and Analysis of algorithms – Time and Space Complexity - Basic concepts

**UNIT II SORTING AND ORDER STATISTICS****9**

Internal sort algorithms - Analysis - Worst-case - Average case - Sorting in Linear Time - Medians and order statistics - Augmenting Data Structures - Red Black Trees - Dynamic - Order Statistics - FFT - Algorithm - Implementation.

**UNIT III DESIGN TECHNIQUES****9**

Divide and Conquer - Dynamic Programming - Greedy method - Backtracking -- Branch & Bound – Classical examples - Analysis.

**UNIT IV GRAPH AND PARALLEL ALGORITHMS****9**

Graphs - Representation - Traversals - Topological sort - Minimum spanning tree - Shortest paths – Bi connected and strongly connected components - Parallel algorithms - Sorting - Matrix multiplication - Numerical - Graph.

**UNIT V SELECTED TOPICS****9**

NP Completeness - Approximation algorithms - Matrices - Transitive closure - Warshall's - Kronrod's algorithm - Computational Geometry

**TOTAL: 45 PERIODS**

## TEXT BOOKS

1. T.H. Cormen, C.E. Leiserson, R.L. Rivest, Introduction to Algorithms, McGraw Hill Book Company, 2002

## REFERENCES

1. M.J. Quinn, Designing Efficient Algorithms for Parallel Computers, McGraw Hill Book Company, 1998
2. Sara Baase, "Computer Algorithms : Introduction to Design and Analysis, Addison Wesley Publishing Company, 1998
3. Donald.E.Knuth, Art of Computer Programming – Vol (1, 2, 3), Addison Wesley Professional,1997,1998

**NE9259 TELECOMMUNICATION AND SWITCHING TECHNIQUES LT P C  
3 0 0 3**

### **UNIT I EVOLUTION OF TELECOMMUNICATION SWITCHING AND CIRCUIT 9**

Evolution of Public Switched Telecommunication Networks Strowger exchange, Crossbar exchange, Stored programme exchange Digital exchange – Basic Telecommunication equipments – Telephone handset, Hybrid circuit, Echo suppressors and cancellers, PCM coders, Modems and Relays.

### **UNIT II ELECTRONIC SWITCHING 9**

Circuit Switching, Message switching, Centralized stored programme switching, Time switching, Spare switching, Combination switching – Digital switching system hardware configuration, Switching system software, Organization, Switching system call processing software, Hardware software integration.

### **UNIT III TELECOMMUNICATION SIGNALLING AND TRAFFIC 9**

Channel associated signaling, Common channel signaling, SS7 signaling protocol, SS7 protocol architecture, Concept of Telecommunication traffic, Grade of service, Modeling switching systems, Blocking models and Delay systems.

### **UNIT IV INTEGRATED DIGITAL NETWORKS 9**

Subscriber loop characteristics, Local access wire line and wire less PCM / TDM carrier standards transmission line codes, Digital multiplexing techniques, Synchronous, Asynchronous, Plesiocronous multiplexing techniques, SONET / SDH, Integrated Digital Network (IDN) environment – Principles of Integrated Services Digital Network (ISDN) – Cellular Mobile Communication Principles.

### **UNIT V DATA NET WORKS 9**

Data transmission in PSTN – Connection oriented and Connection less protocols – packet switching – ISO-OSI architecture-Satellite based data networks – Multiple access techniques – LAN, WAN – standards – TCP / IP – Internet – Principle of ATM networks.

**TOTAL: 45 PERIODS**

## TEXT BOOK

1. Viswanathan. T, "Telecommunication Switching System and Networks", Prentice Hall of India Ltd., 1994.
2. Behrouz Forouzan, "Introduction to Data Communication and Networking", McGraw-Hill, 1998.



## REFERENCES

1. L.S.Lawton, "Integrated Digital Networks, Galgotta Publication Pvt., Ltd., New Delhi, 1996.
2. Syed R. Ali, "Digital Switching Systems", McGraw-Hill Inc., New York, 1998.

**NE9260**

## **STORAGE AREA NETWORKS**

**LT P C**  
**3 0 0 3**

### **UNIT I**

**9**

Introduction – Storage and networking concepts – SCSI bus architecture – Networking in front of the server – Networking behind the server – Network -attached Storage – Fibre channel internals – Layers – Data encoding – Framing protocol – class of service – flow control – Name and addressing conventions.

### **UNIT II**

**9**

SAN topologies – Point-to Point – Arbitrated Loop – Loop Addressing-Loop Initialization-Port Login-Loop port state machine – Design considerations for Arbitrated Loop – Fabrics – Fabric login – Simple Name Server – State Change Notification – Private Loop Support – Fabric Zoning – Building Extended SANs.

### **UNIT III**

**9**

Fibre Channel Products – Gigabit Interface Converters (GBICs) – host Bus Adapters – Fibre channel RAID – Fibre channel JBODs – Arbitrated Loop Hubs – hub Architecture – Unmanaged Hubs – Managed Hubs – Switching Hubs – Fabric Switches – Fibre Channel-to-SCSI Bridges – SAN software Products – Problem isolation in SANs – Isolation Techniques – Fibre channel Analyzers.

### **UNIT IV**

**9**

Management Studies – Storage Network Management – In-Band management – Out-of-Band Management-SNMP-HTTP-TELNET – Storage Network Management Issues – Storage Resource Management – Storage Management – Storage, Systems, and Enterprise Management Integration.

### **UNIT V**

**9**

Application Studies – Full-motion video – LAN free and Server free Tape Backup – server clustering – Internet Service Providers – Campus storage networks – Disaster recovery. Fiber Channel futures – Bandwidth – Fiber channel over Wide Area Networking – Coexistence within Enterprise Networks – Total SAN solutions.

**TOTAL: 45 PERIODS**

### **TEXT BOOK**

1. Tom Clark, "Designing Storage Area Networks", Addison-Wesley Professional, 1st edition, 1999
2. Alex Goldman, "Storage Area Networks Fundamentals", Cisco Press 2002

**UNIT I INTRODUCTION TO NETWORK CONCEPTS, STANDARDS AND PROTOCOLS 9**

Introduction to Computer Networks - Networking Standards and Reference Models - Computer Network Protocols – Data Communication Fundamentals - Transmission Basics and Networking Media

**UNIT II LOCAL AND WIDE AREA NETWORK TOPOLOGIES AND HARDWARE 9**

Physical and Logical Topologies - Network Switching - Ethernet Local Area Networks - Networking Hardware - Wide Area Networking Technologies -WAN Topologies - WANs and WAN Transmission Methods - WAN Implementation and Remote Connectivity

**UNIT III ENTERPRISE NETWORKING WITH WINDOWS 2000 AND NETWARE 9**

Network Operating Systems - Networking with Windows 2000 – Enterprise Networking with NetWare - NetWare Based Networking

**UNIT IV ENTERPRISE NETWORKING WITH UNIX 9**

Networking with UNIX – Internetworking with TCP/IP for Enterprise Applications - Networking with TCP/IP: Internet, Intranet and Extranet - Internet Applications for Enterprise

**UNIT V ENTERPRISE NETWORK MANAGEMENT 9**

Troubleshooting Network Problems - Maintaining and Upgrading Computer Networks - Managing Network Design and Implementation - Enterprise Network Security: Issues, Concepts, and Techniques - Introduction to Network Security - Ensuring Network Integrity and Availability

**TOTAL: 45 PERIODS****TEXTBOOK**

1. Tamara's Network+ - Guide Networks, Second edition, published by Thomson Learning, 2002.

**NE9262 OPTICAL COMMUNICATION SYSTEMS AND NETWORKING LT P C  
3 0 0 3****UNIT I INTRODUCTION AND TECHNOLOGY 9**

Telecommunication networks - First \_second generation of optical Networks - multiplexing techniques - Network evolution - Light propagation in optical fiber - bandwidth - chromatic dispersion -Nonlinear effects - couplers -isolators and circulators - multiplexers and filters -optical amplifiers - Transmitters - detectors - switches - wavelength converters.

**UNIT II MODULATION, DEMODULATION AND TRANSMISSION OF OPTICAL SIGNAL 9**

Modulation - Demodulation - transmission system engineering -Optical amplifiers - crosstalk - dispersion - fiber non linearities - wavelength stabilization - overall design considerations.

**UNIT III NETWORKS 9**  
SONET / SDH - Computer Interconnects - Metropolitan Area Networks - Layered architecture - Broadcast networks : -Topologies for broadcast networks -Media - access control protocols - Test beds - optical layer - Node designs - network design and operation - routing and wavelength assignment.

**UNIT IV CONTROL AND MANAGEMENT 9**  
Network Management functions - configuration Management - performance management - fault management - optical safety - service interface.

**UNIT V ACCESS NETWORKS & SWITCHING 9**  
Network architecture overview - today's access networks - future Access networks - optical access network architecture - application area - OTDM - mux and demuxing - synchronization - broadcast OTDM networks - switch bared networks - OTDM Test beds

**TOTAL: 45 PERIODS**

**TEXT BOOK**

1. Rajiv Ramaswamy and Kumar N.Sivarajan, "Optical Networks – A Practical Persepctive", Morgan Kauffman, 2004

**REFERENCES**

1. D.W.Smith, Optical Network Technology, Chapman and Hall, London, 1995

**NE9263 DISTRIBUTED COMPUTING LT P C  
3 0 0 3**

**UNIT I INTRODUCTION 9**  
Characterization of Distributed Systems - Examples - Resource Sharing and the Web - Challenges - System Models - Architectural and Fundamental Models - Networking and Internetworking - Types of Networks - Network Principles - Internet Protocols - Case Studies.

**UNIT II PROCESSES AND DISTRIBUTED OBJECTS 9**  
Interprocess Communication - The API for the Internet Protocols - External Data Representation and Marshalling - Client-Server Communication - Group Communication - Case Study - Distributed Objects and Remote Invocation - Communication Between Distributed Objects - Remote Procedure Call - Events and Notifications - Java RMI - Case Study.

**UNIT III OPERATING SYSTEM ISSUES – I 9**  
The OS Layer - Protection - Processes and Threads - Communication and Invocation – OS Architecture - Security - Overview - Cryptographic Algorithms - Digital Signatures - Cryptography Pragmatics - Case Studies - Distributed File Systems - File Service Architecture - Sun Network File System - The Andrew File System

**UNIT IV OPERATING SYSTEM ISSUES – II 9**  
Name Services -Domain Name System - Directory and Discovery Services - Global Name Service - X.500 Directory Service - Clocks, Events and Process States - Synchronizing Physical Clocks - Logical Time And Logical Clocks - Global States - Distributed Debugging - Distributed Mutual Exclusion – Elections – Multicast Communication Related Problems.



## REFERENCES

1. Ralf Steinmetz and Klara Nahrstedt , Media Coding and Content Processing, Prentice hall, 2002.
2. Vaughan T, Multimedia, Tata McGraw Hill, 1999.
3. Mark J.B., Sandra K.M., Multimedia Applications Development using DVI technology, McGraw Hill, 1992.
4. K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovacovic, D. A. Milovacovic , Multimedia Communication Systems: Techniques, Standards, and Networks, Prentice Hall, 1<sup>st</sup> Edition, 2002
5. Ze-Nian Li and Mark S. Drew, Fundamentals of Multimedia, Pearson, 2004.

**CS9266**

**AGENT BASED INTELLIGENT SYSTEMS**

**LT P C  
3 0 0 3**

**UNIT I INTRODUCTION 9**

Definitions - Foundations - History - Intelligent Agents-Problem Solving-Searching - Heuristics -Constraint Satisfaction Problems - Game playing

**UNIT II KNOWLEDGE REPRESENTATION AND REASONING 9**

Logical Agents-First order logic-First Order Inference-Unification-Chaining- Resolution Strategies-Knowledge Representation-Objects-Actions-Events

**UNIT III PLANNING AGENTS 9**

Planning Problem-State Space Search-Partial Order Planning-Graphs-Nondeterministic Domains-Conditional Planning-Continuous Planning-Multi-agent Planning

**UNIT IV AGENTS AND UNCERTAINTY 9**

Acting under uncertainty – Probability Notation-Bayes Rule and use - Bayesian Networks-Other Approaches-Time and Uncertainty-Temporal Models- Utility Theory - Decision Network – Complex Decisions

**UNIT V HIGHER LEVEL AGENTS 9**

Knowledge in Learning-Relevance Information-Statistical Learning Methods-Reinforcement Learning-Communication-Formal Grammar-Augmented Grammars-Future of AI

**TOTAL: 45 PERIODS**

**TEXT BOOK:**

1. Stuart Russell and Peter Norvig, “Artificial Intelligence - A Modern Approach”, 2<sup>nd</sup> Edition, Prentice Hall, 2002

**REFERENCES:**

1. Michael Wooldridge, “An Introduction to Multi Agent System”, John Wiley, 2002.
2. Patrick Henry Winston, Artificial Intelligence, 3<sup>rd</sup> Edition, AW, 1999.
3. Nils.J.Nilsson, Principles of Artificial Intelligence, Narosa Publishing House, 1992.

**UNIT I MODELLING OF COMMUNICATION SYSTEM 9**  
Model of speech and picture signals, Pseudo noise sequences, Non-linear sequences, Analog channel model, Noise and fading, Digital channel model-Gilbert model of bustry channels, HF, Troposcatter and satellite channels, Switched telephone channels, Analog and Digital communication system models, Light wave system models.

**UNIT II SIMULATION OF RANDOM VARIABLES AND RANDOM PROCESS 9**  
Univariate and multivariate models, Transformation of random variables, Bounds and approximation, Random process models-Markov AND ARMA Sequences, Sampling rate for simulation, Computer generation and testing of random numbers

**UNIT III ESTIMATION OF PERFORMANCE MEASURES 9**  
Quality of an estimator, estimator for SNR, Probability density functions of analog communication system, BER of digital communication systems, Monte carlo method and Importance sampling method, estimation of power spectral density of a process

**UNIT IV COMMUNICATION NETWORKS 9**  
Queuing models, M/M/1 and M/M/1/N queues, Little formula, Burke's theorem, M/G/1 queue, Embedded Markov chain analysis of TDM systems, Polling, Random access systems

**UNIT V NETWORK OF QUEUES 9**  
Queues in tandem, store and forward communication networks, capacity allocation, Congestion and flow chart, Routing model, Network layout and Reliability

**TOTAL: 45 PERIODS**

**TEXT BOOK:**

1. M.C.Jeruchim, Philip Balaban and K.Sam Shanmugam, "Simulation of communications systems", Plenum Press, New York, 1992

**REFERENCES:**

1. A.M.Law and W.David Kelton, "Simulation Modelling and analysis", Mc Graw Hill Inc., New York, 1991
2. J.F.Hayes, "Modelling and Analysis of Computer Communication networks, Plenum Press, New York, 1984
3. Jerry Banks and John S.Carson, Discrete-event system Simulation, Prentice Hall, Inc., New Jersey, 1984