Syllabi & Scheme of Examination

Under Choice Based Credit System

MASTER OF TECHNOLOGY

COMPUTER SCIENCE AND ENGINEERING

Department of Computer Science and Applications

Chaudhary Devi Lal University, Sirsa

Chaudhary Devi Lal [illegible]

Scheme of Examination for Master of Technology in Computer Science and Engg

(M. Tech. CSE)

under Choice Based Credit System

M.Tech-1st First Semester

Paper Code	Nomenclature of Paper	Credit	Int Marks	Ext Marks	Total Marks
MT-FT-11	Advanced Data Structure	4	30	70	100
MT-FT-12	Advanced Algorithmics	4	30	70	100
MT-FT-13	Advanced Computer Architecture	4	30	70	100
MT-FT-14	Advanced Database Systems	4	30	70	100
MT-FT-15	Advanced Software Engineering	2.5	30	45	75
MT-FT-16	S/W Lab – I Based on MT-FT-11	2.5	30	45	75
MT-FT-17	S/W Lab – II Based on MT-FT-14	2	50	-	50
MT-FT-18	Seminar	27			700
	Total				

M.Tech-2nd Semester

Paper Code	Nomenclature of Paper	Credit	Int Marks	Ext Marks	Total Marks
MT-FT-21	Advanced Computer Networks	4	30	70	100
MT-FT-22	Object Oriented Analysis And Design Using UML	4	30	70	100
MT-FT-23	Advanced Operating Systems	4	30	70	100
MT-FT-24	Theory Of Computation	4	30	70	100
MT-FT-25	Elective-I	4	30	70	100
MT-FT-26	S/W Lab – I Based On MT-FT-22	2.5	30	45	75
MT-FT-27	S/W Lab – II Based On MT-FT-23	2.5	30	45	75
MT-FT-28	Seminar	2	50	-	50
Total		27			700

ELECTIVE-I

i) INFORMATION SECURITY
ii) SOFT COMPUTING
iii) HIGH PERFORMANCE NETWROKS

Note: During the first 3 semesters (semester I to semester III), students have to earn a total of 11 credits from Open Elective courses offered by various departments of the university. In each of the first three semesters of M.Tech the students will have register for and earn a minimum of 2 credits and a maximum of 6 credits.

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L/T	P	Credit	Int	Ext
4	-	4	30	70

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Unit-I

Basic Concepts of OOPs – Templates Function and class templates – Algorithms: performance analysis: time complexity and space complexity– ADT – List (Singly– Doubly and Circular) Implementation – Array – Pointer – Cursor Implementation

Unit-II

Stacks and Queues – ADT– Implementation and Applications – Trees – General– Binary – Binary Search – Expression Search – AVL – Introduction to Red Black trees and Splay tree – B Trees – Implementations – Tree Traversals

Unit-III

Set – Implementation – Basic Operations on Set – Priority Queue – Implementation – Graphs – Directed Graphs – Shortest Path Problem – Undirected Graph – Spanning Trees – Graph Traversals: hash table representation: hash functions: collision resolution: separate chaining: open addressing: linear probing: quadratic probing: double hashing: rehashing

Unit-IV

Issues – Managing Equal Sized Blocks – Garbage Collection Algorithms for Equal Sized Blocks – Storage Allocation for Objects with Mixed Sizes – Buddy Systems – Storage Compaction Unit V: Searching Techniques – Sorting – Internal Sorting – Bubble Sort – Insertion Sort – Quick Sort – Heap Sort – Bin Sort – Radix Sort – External Sorting – Merge Sort – Multiway Merge Sort – Polyphase Sorting – Design Techniques – Divide and Conquer – Dynamic Programming – Greedy Algorithm – Backtracking – Local Search Algorithms

References:

- Mark Allen Weiss, Data Structures and Algorithm Analysis in C++, Pearson Education, 2002.
- Aho Hopcroft Ullman, Data Structures and Algorithms, Pearson Education, 2002.
- Horowitz Sahni, Rajasekaran, Computer Algorithms, Galgotia, 2000.
- Tanenbaum A.M., Langsam Y, Augenstien M.J., Data Structures using C & C++, Prentice Hall of India, 2002.
- Data structures, Algorithms and Applications in C++, Sahni, University Press (India) Pvt. Ltd, 2nd edition, Universities Press Orient Longman Pvt. Ltd.
- Data structures and Algorithms in C++, Michael T. Goodrich, R. Tamassia and Mount, Wiley student edition, John Wiley and Sons.

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UNIT – I

Algorithms: Role of algorithm in computing, Asymptotic Notations, Standard notations and common functions. Recurrence: The maximum-subarray problem, Strassen's algorithm for matrix multiplication, substitution and recursion-tree method for solving recurrences, master method for solving recurrences, Proof of the master theorem, Probabilistic Analysis and Randomized Algorithms.

UNIT – II

Sorting: Bubble sort, Heap, Building and maintaining heap, Heapsort, Quicksort, Lower bounds for sorting, Counting sort, radix sort, bucket sort. Advanced Data Structures: Splay Trees, Top-down splay trees, Red-black Trees, Deterministic skip lists, AA-Trees, Trie, Treaps, K-d Trees.

UNIT – III

Advanced Design and Analysis: Dynamic Programming: matrix-chain multiplication, Longest common subsequence, optimal binary search tree, Greedy algorithms: Huffman codes. Graph Algorithms: Storage of graphs, traversing a graph, Topological sort, Minimum Spanning Trees, Shortest path problems: Single source and All-pairs shortest path, Maximum Flow networks, matching in bipartite graphs.

UNIT – IV

Miscellaneous Topics: Knapsack Problem and Memory functions, Approximate String Matching, Chinese remainder theorem, Integer factorization, naïve-string matching, Rabin-karp string matching, String matching with finite automata, Knuth-moris-pratt algorithm, finding convex hull, Polynomial time, verification and reducibility, NP-completeness and proofs.

References:

- Cormen, Thomos, Leiserson, Introduction to Algorithms, Prentice Hall of India Learning.
- Horowitz, Ellis and Sahni, Sartaj, Fundamentals of Computer Algorithms, University Science Press.
- Anany Levitin, "Introduction to Design and Analysis of Algorithms", Pearson Education.
- Cooper A., "Computability Theory", Chapman and Hall/ CRC Press.
- Robert Sedgewick and Kevin Wayne, Algorithms 4e, Pearson Education India.
- Steven Skiena, The Algorithm Design Manual, Springer India.
- Reiter, Johnson, "imits of Computation, Chapman and Hall/ CRC Press.

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UNIT-I

Concurrent and Parallel Execution: Types and levels of parallelism, classifications of parallel architectures.

Instruction-Level-Parallel Processors: Dependencies between instruction. Principles of Pipelining. Pipelined instruction processing. Synchronous & asynchronous pipeline. Linear Pipeline-clocking & timing control, speedup, efficiency & throughput. Non linear pipeline-reservation table, latency analysis, collision free scheduling, internal data forwarding.

Warehouse-Scale Computers (WSC) to Exploit Request-Level and Data-Level Parallelism: Programming models and workloads for WSC, architecture of warehouse-scale computers

UNIT-II

Superscalar pipeline design- structure, data dependencies, pipeline stalling, in-order issue, out of order issue. VLIW architecture. Branch handling- delayed branching, branch processing, multiway branching, guarded execution. Code scheduling- basic block scheduling, loop scheduling, global scheduling.

UNIT-III

Memory Hierarchy Technology : inclusion, coherence and locality, virtual memory models, TLB, paging and segmentation, memory replacement policies, cache addressing models, cache performance issues, interleaved memory organisation.

Unit-IV

MIMD Architectures: Architectural concepts of Distributed MIMD

Shared-Memory MIMD architectures: Dynamic interconnection networks- shared path, switching networks- crossbar & multistage networks. Cache coherence problem, Hardware based cache coherence protocol-Snoopy cache protocol, directory scheme, hierarchical cache coherence protocol. UMA, NUMA, CC-NUMA and COMA multiprocessors.

References

- Hennessy J.D., Patterson D.A., "Computer Architecture A Quantitative Approach", Elsevier India.
- Sima D., Fountain T., Kasuk P., "Advanced Computer Architecture-A Design space Approach," Pearson Education.
- Hesham El-Rewini, MostafaAbd-El-Barr, "Advanced Computer Architecture and Parallel Processing", Wiley India Pvt. Ltd.

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- Rajaraman V. & Murthy C.S.R., [illegible] Learning.
- David Culler, "Parallel Computer Architecture", Elsevier India.
- Stallings W., "Computer Organization and Architecture", Pearson Education.

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UNIT – I

Database System Concepts and Architecture: Three - Schema Architecture and Data Independence, ER Diagrams, Naming conventions and Design Issues. Relational Model Constraints and Relational Database Schemas, EER model: Subclasses, Super classes, Inheritance, Specialization and Generalization, Constraints and characteristics of specialization and Generalization.

UNIT – II

Object Model: Overview of Object-Oriented concepts, Object identity, Object structure, Type constructors, Encapsulation of operations, Methods, and Persistence, Type hierarchies and Inheritance, Complex objects. Query Processing and Optimization: Using Heuristics in Query Optimization, Semantic Query Optimization, Database Tuning in Relational Systems.

UNIT – III

Databases for Advance Applications: Architecture for parallel database; Distributed database concepts, Data fragmentation, Replication, and allocation techniques, Overview of Client-Server Architecture, Active Database Concept and Triggers, Temporal Databases Concepts, Spatial and Multimedia Databases, Deductive Databases, XML Schema, Documents and Databases

UNIT – IV

Principles of Big Data: Ontologies and Semantics: Classifications, The Simplest of Ontologies, Ontologies, Classes with Multiple Parents, Choosing a Class Model. Data Integration and Software Interoperability Versioning and Compliance Issues, Stepwise Approach to Big Data Analysis, Failures and Legalities.

Text Books:

1. Elmasri and Navathe, "Fundamentals of Database Systems", Pearson Education.
2. Jules J. Berman, "Principles of Big Data", Elsevier India.

Reference Books:

- Date C.J., "An Introduction to Database Systems", Pearson Education.
- Hector G.M., Ullman J.D., Widom J., "Database Systems: The Complete Book", Pearson Education.
- Silberschatz A., Korth H., Sudarshan S., "Database System Concepts", Tata McGraw Hill.

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Unit-I

Introduction: Life cycle models, Requirement Analysis and specification, Formal requirements specification, Fundamental issues in software design, goodness of design, cohesions, coupling. Function-oriented design.

Unit-II

Structured analysis and design, overview of object –oriented concepts, Unified Modeling Language, unified design process.

Unit-III

User interface design, coding standards and guidelines, code walkthrough and reviews,Unit testing, black box and white box testing, integration and system testing, software quality and reliability.

Unit-IV

SEI CMM, ISO 9001 and Six Sigma, clean room testing technique, Software maintenance issues and techniques.Software reuse.Client-Server software development.

Reference:

- Ivan Sommerville, Software Engineering, Addison Wesley.
- Pressman Roger, Software Engineering –A Practitioner's Approach.
- Richard Fairley, Software Engineering Concepts, Tata McGraw Hill.
- Pankaj Jalote, An Integrated Approach to Software engineering, Narosa Publication.

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4 - 4 30 70

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Unit-I

Review of Basic Network Architectures: OSI reference model, TCP/IP reference model, ATM reference model; Applications(WWW, Audio/Video Streaming, Video conference, Networked Games, Client/Server); Traffic Characterization (CBR, VBR); Switching Paradigms; Multiplexing; Error Control; Flow Control, FTH, DTH, PON, ISDN, DSL, CATV, SONET, Optical Networks.

Unit-II

Local Area Network Technologies: Fast Ethernet, Gigabit Ethernet, IEEE 802.11 WLAN, Bluetooth, Connecting LANs, VLANS, Internetworking: Interdomain Routing, BGP, IPv6, Multicast Routing Protocols, Multi Protocol Label Switching, Virtual Private Networks, High speed transport protocols, Quality of Service Mechanisms, Improving QoS in Internet, DiffServ and IntServ Architectures, RSVP.

Unit-III

Distributed Systems: Naming, DNS, DDNS, Paradigms for Communication in Internet, Caching, Issues of Scaling in Internet and Distributed Systems, Caching Techniques forWeb, Protocols to Support Streaming Media, Multimedia Transport Protocols, Content Delivery Networks, Overlay and P2P Networks.

Unit-IV

Applications and Other Networking Technologies: RTP, RTSP, SIP, VoIP, Security Systems, SSH, PGP, TLS; IPSEC, DDoS Attack, Mitigation in Internet, Security in MPLS; Introduction to Cellular, Satellite and Ad hoc Networks.

References:

- Behrouz A. Forouzan, Data Communications and Networking, Fourth Ed., Tata McGraw Hill, 2006.
- Larry L. Peterson and Bruce S. Davie, Computer Networks: A Systems Approach, Fourth Ed., Morgan Kaufmann, 2007.
- Jean Walrand and PravinVaraiya, High Performance Communication Networks, 2nd Ed., Morgan Kauffman, 1999.
- Markus Hoffmann and Leland R. Beaumont, Content Networking: Architecture, Protocols, and Practice, Morgan Kauffman, 2005.

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MT-FT-22 Object Oriented Analysis Design Using UML

L/T	P	Credit	Int	Ext
4	-	4	30	70

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Unit-1

Review of the traditional methodologies: advantages of object oriented over traditional methodologies, classes, objects, encapsulation, association, aggregation, inheritance, polymorphism, states and transitions.

Introduction to Objectory Software Development Process: Introduction, benefits, phases and iterations, elaboration stage, construction stage, transition stage.

Creating Use Case Diagrams: Actors and use cases, use case relationships, types of relationship, use case diagram, additional use case diagram in rational rose, activity diagram, transition, decision points, swimlanes.

Unit-2

Visual modeling using Unified Modeling Language (UML): Object Oriented Modeling. Introduction to Unified Modeling Language: History of UML, Overview of UML-Capabilities, Usage of UML. Introduction to Rational Rose CASE tool: Introduction, Importance of Rational rose, Capabilities of Rational Rose Case Tool.

Unit-3

Object Oriented Themes, Impact of an Object Oriented Approach, Object Model: Objects and Classes Links and Associations, Generalization and Inheritance as Restriction, Abstract Classes, Meta data and Constraints. Dynamic modeling: Events and States, Operations, Nested State Diagrams, Concurrency, Synchronization of concurrent activities. Functional modeling: Data flow diagrams, Specifying operations, Constraints Relation of Functional to Object and Dynamic models.

Unit-4

Object Oriented Methodology, Analysis, System Design, Object Design, Comparison of Methodology-Structured Analysis/Structured Design, Jackson Structured Design.

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- Rumbaugh, J.et.al., Object-Oriented modeling and Design
- UML User Guide, Grady Booch, James .Rambaugh, Ivar Jacobsan, 2000,Addision Wesley.
- Visual Modeling with Rational Rose 2000 and UML by Terry Quatranui Foreward by Grady Booch,2000
- The Objectory Software Development process, Ivar Jacobsan, Grady Booch, James Rambaugh,1999, Addision Wesley.

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4	-	4	30	70

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UNIT – I

DISTRIBUTED OPERATING SYSTEMS: Introduction, Issues, Communication Primitives, Inherent Limitations, Lamport's Logical Clock; Vector Clock; Causal Ordering; Global State; Cuts; Termination Detection. Distributed Mutual Exclusion, Non Token Based Algorithms, Lamport's Algorithm, Token Based Algorithms. Suzuki Kasami'sBroadcast Algorithm, Distributed Deadlock Detection Issues, Centralized Deadlock Detection Algorithms, Distributed Deadlock Detection Algorithms, Agreement Protocols Classification, Solutions, Applications.

UNIT – II

DISTRIBUTED RESOURCE MANAGEMENT : Distributed File Systems, Design Issues, Distributed Shared Memory, Algorithms for Implementing Distributed Shared memory, Issues in Load Distributing, Scheduling Algorithms, Synchronous and Asynchronous Check Pointing and Recovery.

UNIT – III

REAL TIME AND MOBILE OPERATING SYSTEMS : Basic Model of Real Time Systems, Characteristics, Applications of Real Time Systems, Real Time Task Scheduling, Handling Resource Sharing, Mobile Operating Systems, Micro Kernel Design, Client Server Resource Access, Processes and Threads, Memory Management.

UNIT – IV

INTRODUCTION TO ANDROID: Android Application package (APK), Working with Eclipse and Android, Application Design, Controls and User Interface, Basic Graphics ad View class, Using Google Maps in applications, Applications with multiple screens, Adding Menus and popup menus in applications, Working with images, working with text files, tables and XML, Building client server applications, Publishing your application.

References:

- MukeshSinghal and Niranjan G. Shivaratri, Advanced Concepts in Operating Systems - Distributed, Database, and Multiprocessor Operating Systems, Tata McGraw Hill.
- Abraham Silberschatz; Peter Baer Galvin; Greg Gagne, "Operating System Concepts", Wiley India Pvt. Ltd.
- Rajib Mall, "Real Time Systems: Theory and Practice", Pearson Education India.
- James C.S. "Android Application development", CENGAGE Learning.
- Gargenta M., Nakamura M., "Learning Android", OREILLY Publishers.

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UNIT - I

Introduction: Mathematical nations and terminology of sets, functions and relations, graph, string and language classification, Boolean logic properties and representation.

Finite state system: Finite Automata and its type, Two way finite Automata: Interconversion of automata and minimization. Regular expression, Arden's theorem, Pumping Lemma and its application, closure properties of regular sets.

UNIT - II

Context Free Language: Context free Grammars and Language, Simplification of context free grammars, Normal form, Pumping Lemma & its applications, closure properties of CFL's, pushdown automata, equivalence of PDA and CFG. Top down parsing, Bottom up Parsing.

UNIT -III

Turing Machine: Turing Machine, extended and restricted turing machine, time and space complexity in TM, construction of TM, computational complexity and non-computational complexity, TMs and computers, Context sensitive Language, Linear bounded automata.

UNIT - IV

Intractable Problem

Decidability: Decidable Languages, Decidable problems with CFL and regular Language undecidable problem, Halting Problem, computability: Primitive recursive functions, examples, P & NP classes, NP - complex problem.

References:

- Introduction to Automata Theory, Language & Computation by J.E. Hopcroft and J.D. Ullman, PEARSON Education 2nd Edition.
- Introduction to Language & Theory of computation, third edition, John C. Martin. MC Grow Hill.
- Theory of Computer Science, K.L.P. Mishra, PHI

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4	-	4	30	70

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Unit-I

Computer Security Concepts, Introduction, What is Security, security trends,, Components of Information System, OSI security architecture, Security Attacks, Goals for Security , security mechanisms. Integrity policies and Hybrid policies.

Unit-II

Cryptography: Concepts and Techniques, symmetric and asymmetric key cryptography
Symmetric key Ciphers: Classical encryption techniques, Block cipher design principles, DES, Advanced encryption standard, AES structure, Analysis of AES, Block cipher operations, principles of pseudorandom number generation and stream ciphers.
Asymmetric key Ciphers: Principles of public key cryptosystems, RSA algorithm, Analysis of RSA, Diffie-Hellman Key exchange.

Unit-III

Security services, Message confidentiality, message integrity, message authentication, key management, Message Authentication and Hash Functions:Authentication requirements and functions, MAC and Hash Functions, MAC Algorithms: Secure Hash Algorithm, Digital signatures, Key management and distribution, Intruders, Virus and Firewalls, Intruders, Intrusion detection, password management, Virus and related threats, Virus Countermeasures, Denial of service attacks, Firewall design principles, Types of firewalls.

Unit-IV

Security at layers(Network, Transport, Application),IPSec, Secure Socket Layer(SSL), Transport Layer Security(TLS), Secure Electronic Transaction(SET), Electronic Mail security: Pretty Good Privacy(PGP),S/MIME, Steganography & its application, watermarking & its application.

References:

- William Stallings, "Cryptography and Network Security: Principles and Practices", Third Edition, Pearson Education, 2006.
- Matt Bishop, Computer Security art and science, Second Edition, Pearson Education, 2002.
- Wade Trappe and Lawrence C. Washington, Introduction to Cryptography with Coding Theory 2e, Pearson Education, 2007.
- Jonathan Katz, and Yehuda Lindell, Introduction to Modern Cryptography, CRC Press, 2007.

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- Wenbo Mao, Modern Cryptography, Pearson Education, 2006.
- Network Security and Cryptography, Menezes Bernard, Cengage Learning, New Delhi, 2011.

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UNIT – I

Basic concepts of neuro-computing: Artificial Neural Network (ANN) and their biological roots and motivations, Mathematical Models of Neurons, ANN architecture, Learning rules, Learning Paradigms Supervised, Unsupervised and reinforcement Learning, ANN training Algorithms-perceptions, Training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model, Applications of Artificial Neural Networks, Competitive learning networks, Kohonenself organizing networks, Hebbian learning; Hopfield Networks, Associative Memories, The boltzman machine; Applications.

UNIT – II

Introduction to Fuzzy Logic: Classical and Fuzzy Sets: Overview of Classical Sets, Membership Function, Fuzzy rule generation. Operations on Fuzzy Sets: Compliment, Intersections, Unions, Combinations of Operations, Aggregation Operations. Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. Fuzzy Logic: Classical Logic.

UNIT – III

Genetic Algorithm (GA): Evolutionary computing, conditions for evolution, Simple Genetic Algorithm (SGA), different types of operators: Selection, Crossover, mutation and replacement, optimization problems and traditional optimization methods, differences between GA & traditional methods, Holland's schemata theorem, encoding schemes.

UNIT – IV

Random Optimization, Simulated Annealing, Tabu Search, Ant Colony Optimization, Particle Swarm Optimization, Memetic Algorithms.

References:

- S. N. Sivanandam & S. N. Deepa, Principles of Soft Computing, Wiley India Pvt. Ltd..
- Goldberg D. E., Genetic Algorithms in Search, Optimization, and Machine Learning. Pearson Education.
- Jang, Sun, Mizutani, Neuro-Fuzzy and Soft computing, Pearson Education.
- Haykin, Neural networks: A comprehensive foundation, Pearson Education.
- Mitchell M., An Introduction to Genetic Algorithms, Prentice-Hall.
- Klir G.J. & Yuan B., Fuzzy Sets & Fuzzy Logic, PHI.

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MT-FT-25(iii) High Performance Networks

L/T	P	Credit	Int	Ext
4	-	4	30	70

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UNIT – I

History of Networking and Internet; Need for Speed and Quality of Service; Advanced TCP/IP and ATM Networks; Internet Services; Internet Architecture; Backbone Networks; High Performance Networks; TCP Services; TCP format and connection management; SCTP; Encapsulation in IP; UDP Services, Format and Encapsulation in IP; IP Services; Header format and addressing; Fragmentation and reassembly; classless and subnet address extensions; subnetting and supernetting; CIDR; IPv6

UNIT – II

Congestion Control and Quality of Service: Data traffic; Network performance; Effects of Congestion; Congestion Control; Congestion control in TCP and Frame Relay; Link-Level Flow and Error Control; TCP flow control; Quality of Service(QoS): Flow Characteristics, Flow Classes; Techniques to improve QoS; Traffic Engineering; Integrated Services; Differentiated Services; QoS in Frame Relay and ATM; Protocols for QoS Support: Resource Reservation-RSVP; Multiprotocol Label Switching; Real-Time Transport Protocol

UNIT – III

High Speed Networks: Frame Relay Networks; Asynchronous Transfer Mode (ATM); ATM protocol Architecture; ATM logical connections; ATM cells; ATM Service categories; ATM Adaptation Layer; ATM Switching and Signaling; Optical Networks: SONET networks; SONET architecture; High-Speed LANs: Bridged and Switched Ethernet; Fast Ethernet; Gigabit Ethernet; Wireless LANs: IEEE 802.11, Bluetooth; Introduction to HIPERLAN; WIMAX; RFID, Sensor Networks; Vehicular Networks; Cellular Telephony; Generations; Cellular Technologies in different generations; GSM, CDMA; Satellite Networks

UNIT – IV

Internet Routing: Interior and Exterior gateway Routing Protocols; RIP; OSPF; BGP; IDRP; Multicasting; IGMP; MOSPF; DVMRP, ; Routing in Ad Hoc Networks; AODV, DSR; Routing in ATM: Private Network-Network Interface; Mobile IP and Wireless Application Protocol; Error and Control Messages: ICMP; Error reporting vs Error Correction; ICMP message format and Delivery; Types of messages; Address Resolution: ARP, BOOTP; DHCP; Network Management and SNMP;

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Pearson Education.
- B. Muthukumaran, "Introduction to High Performance
- James F. Kurose, Keith W. Ross, "Computer Networking, A Top-Down Approach Featuring the Internet", Pearson Education.
- Behrouz A. Forouzan, "Data Communications and Networking", McGraw Hill.
- Mahbub Hassan, Raj Jain, "High Performance TCP/IP Networking, Concepts, Issues, and Solutions", Pearson Education.
- William Stallings, "Wireless Communications & Networks", Pearson Education
- Asoke K Talukder, Hasan Ahmed, Roopa R Yavagal, "Mobile Computing", TATA McGraw Hill. 6. Larry L. Peterson, Bruce S. Davie, "Computer Networks", Elsevier India.

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