

## Computer Science

Discrete Mathematics
<p>Principles of Counting, Recurrence Relations, Sets, Functions, Relations, Propositional Logic and Predicate Logic, Strings and Languages.</p> <p><b>Reference books:</b></p> <p>Mott, Kandel, and Baker. Discrete Mathematics for Computer Scientists &amp; Mathematicians, PHI 2003.</p> <p>Harry Lewis and Christos Papadimitriou. Elements of the Theory of Computation 2<sup>nd</sup> Edition, Pearson Education.</p>

## Theory of Computation

Regular Languages, Regular Expressions, Finite Automata (deterministic and non-deterministic), Grammar, Context Free Grammar, Context Free Languages, Push Down Automata (deterministic and non-deterministic), Proving languages to be regular vs. not-regular and context free vs. not-context free, Turing Machines, Universal Turing Machine, Recursive and Recursively Enumerable Languages, Decidability and Un-decidability.

### Reference books:

Harry R. Lewis and Christos H. Papadimitriou. Elements of the Theory of Computation 2nd Edition, Pearson Education.

## Data Structures & Algorithms

Abstract Data Types and Data Structures. Algorithm Analysis and Order Notation.

Sorting and Searching – Algorithms and Complexity; Design and Implementation Techniques.

Linear Data Structures – Lists and Representation; Access-Restricted Lists; Queries, Design, and Implementation.

Dictionary Data Type: Lists, Hash Tables, Search Trees – Height Balancing; Queries, Design, and Implementation.

Non-linear Data Structures and Partially Ordered Data: Trees – Representation, Applications, and Traversal; Graphs – Representation, Connectivity, Traversal, and Paths; Design and Implementation

### Reference Books:

Michael T. Goodrich, Roberto Tamassia. Algorithm Design. Wiley Student Edition.

Cormen T.H., Leiserson, C.E., Rivest, R.L., and C. Stein. Introduction to Algorithms, MIT Press, 2<sup>nd</sup> Ed.

## Design & Analysis of Algorithms

Algorithm Design Techniques: Top-Down Design (Divide-and-Conquer, Greedy); Bottom-Up Design(Dynamic Programming); Randomization.

Analysis and Complexity: Analysis of Algorithms; Complexity of Problems – Lower Bound Analysis; Non-deterministic Algorithms, Complexity Classes and Reductions, NP-completeness / NP-hardness.

Handling Hard Problems: Search – Backtracking, Branch-and-Bound; Introduction to Approximation Algorithms.

### Reference Books:

Cormen T.H., Leiserson, C.E., Rivest, R.L., and C. Stein. Introduction to Algorithms, MIT Press, 2<sup>nd</sup> Edition.

## Digital Electronics and Microprocessors

Combinational Logic Design, Adders, Multiplexers, De-Multiplexers, Encoders, Decoders. Sequential Logic Design, Counters, Registers., Programmable Logic Devices and Logic Families., 8085, 8086 architecture and assembly programming, Memory interfacing, Programmable peripheral devices and Interfacing (8253, 8255, 8259, 8251).

### Reference books:

Digital Design by M. Morris Mano, 5<sup>th</sup> edition, Pearson Education, Delhi, 2012. The Intel Microprocessors by Barry B Brey, 8<sup>th</sup> edition, PHI, 2014.

## Operating Systems

Tasks, Processes, and Threads, Process States & Transitions, Process organization, Process Scheduling. Concurrency, Mutual Exclusion, Process synchronization, Deadlock and Deadlock handling, Memory allocation, Paging and Segmentation, Locality, Virtual memory, Frame allocation and Page replacement algorithms. Thrashing, File systems - Interface, Structure and Implementation, I/O system, Secondary Storage and Mass Storage Structure.

**Reference books:**

Silberschatz, A and Galvin, P.B. “Operating System Concepts”, 9th edition, Addison Wesley, 2012.

**Computer Organization and Architecture**

Instruction Set Architecture - RISC & CISC processors, Computer Arithmetic & Control Unit., Cache Memory & Main Memory, I/O, Secondary Memory, RAID System, Bus & Interconnections., Pipelining, and Instruction-Level Parallelism.

**Reference books:**

Hennessey & Patterson: Computer Organization & Design: Hardware-Software Interface, 5<sup>th</sup> edition, MK/Elsevier, NY, 2013.

**Computer Networks**

Concept of autonomous computing nodes in Computer Networks, Concept of Services, Interfaces & Protocols in Network Architectures; Classification of Networks: LAN MAN, WAN, SAN, PAN, Network Topologies: Bus, Star, Ring, Tree etc., The IEEE 802 Workgroup and select standards: IEEE 802.1, IEEE 802.2, IEEE 802.3 (& Variants): Ethernet, Error Control, Flow Control, Bridges, Basics of Wi-Fi & IEEE 802.11 (WLAN), Protocols at the Network / Internet Layer: IPv4, IPv6, ICMP(v4), IGMP (v4), ICMPv6, IP Addressing Schemes, IP Sub-netting: FLSM, VLSM, Unicast Routing Algorithms &

Protocols: Distance Vector Routing (RIP), Link-State Routing (OSPF), Multicast Routing: PIM-SM, PIM-DM, MOSPF, DVMRP, Path-Vector Routing (BGP), Mobile IP(v4) and Mobile IPv6, Transport Layer Protocols: TCP, UDP, Ports, Sockets, Flow Control, Congestion Control & Avoidance, Application Layer Protocols: HTTP, FTP, DNS, DHCP, SMTP, POP, IMAP, Elementary aspects of Network Security: Integrity, Privacy, Confidentiality, Protection, Authentication, Role of Cryptography, Non-Repudiation, Digital Signatures & Certificates, Intrusion Detection Systems, Firewalls

**Reference Books:**

1. James F. Kurose & Keith W. Ross: Computer Networking: A Top-Down Approach, 7<sup>th</sup> Edition, Pearson Education Inc. Boston, 2016.

2. Larry L. Peterson & Bruce S. Davie: Computer Networks: A Systems Approach, 5th Edition, MorganKaufmann / Elsevier, New Delhi, 2012, reprint 2016.

3. Andrew S. Tanenbaum & David J. Wetherall: Computer Networks, 5<sup>th</sup> Edition, Pearson, New Delhi, 2014.

**Database Systems**

Data Modeling – ER Model, Relational Model, Object-oriented Model, Object-relational Model, Query Languages – Relational Algebra, Relational Calculus, & SQL, Normalization & Indexing – Functional Dependencies (FDs), Closure of set of FDs, Attribute Closure, Canonical Cover, Normal forms up to

4NF. Primary, Clustering, & Secondary Indices, Tree-based and Hash-based Indexing, Multi-Dimensional Indexing, Query Evaluation & Optimization: Algorithms for evaluation of relational operators, Cost-based & heuristic query optimization techniques, Transaction Management – Concurrency: Locking & Timestamping & Crash Recovery: Log-based & Shadow Paging.

**Reference books:**

1. Silberschatz, Korth & Sudarshan. Database System Concepts – 3<sup>rd</sup> edn, Mc-Graw Hill, 2011
2. Garcia-Molina, Ullman, Widom, The Complete Book - Database Systems, 2<sup>nd</sup> edn, Pearson Education, 2009

**Compiler Construction**

Overview of Compiler, phases of compiler, Lexical Analysis, Parsing (Top-down and Bottom-up Parsing), Abstract Syntax tree, Symbol Tables, Semantic Analysis. Types inferencing and Type Checking. Syntax Directed Translation. Intermediate Code, Code Generation – Basic Blocks and Flow Graphs, Register Allocation and Assignment, Code Generation Techniques.

**Reference books:**

1. Aho, A. V., Sethi, R., and Ullman, J. D., Compilers - Principles, Techniques and Tools, Addison-Wesley, 1988. (Indian reprint 2000).
2. Sethi, R., Programming Languages - Concepts & Constructs, 2<sup>nd</sup> Ed., Addison-Wesley, 1996. (Indian reprint 1999).