

# Syllabus of the Ph.D. Qualifier Test

## Paper I

### Part A: Data Structures, Algorithms and Programming

Linked lists, Stacks, Queues, Trees, Binary search tree – height balanced tree, AVL tree, red-black tree, Hash table, Graphs – representations.

Asymptotic notation and complexity analysis; Recurrence relations – solving by iterative method.

Searching algorithms: Linear search, Binary search, Hashing.

Sorting algorithms: Bubble sort, Insertion sort, Merge sort, Quick sort, Heap sort.

Basic notions of algorithm design techniques: Greedy, Divide-and-conquer, Dynamic programming.

Graph Algorithms: BFS, DFS, Minimum spanning trees, Single-source shortest path.

Basics of C Programming: Input/Output, Control flows, Functions, Arrays, Structures, Pointers, Recursive functions. Programming to solve basic data structures.

#### Books:

1. Classic Data Structures (2<sup>nd</sup> Edition), Prentice Hall of India
2. Introduction to Algorithms (3rd Edition), Prentice Hall of India.
3. Programming in C, Kernighan and Ritchie, Prentice Hall of India.

### Part B: Computer Organization and Architecture

Instruction set architecture: Instruction types, Representations, Addressing modes.

Arithmetic: Representation of fixed and floating-point numbers, 2's complement arithmetic.

Control unit: Organization of a CPU, Register-transfer level specifications.

Memory system: Memory organization, Concept of memory hierarchy, Cache memory, Page table, TLB, Virtual memory.

Input-output systems: Interrupt-driven I/O, Polling and Vectored interrupt, Basic concept of DMA transfer.

**Books:**

1. Computer Architecture and Organization; J P Hayes, McGraw Hill
2. Computer Organization and Architecture, William Stallings, Prentice Hall of India

**Part C: Operating Systems**

Basic components of operating system.

Hardware requirements: Privileged mode and privileged instructions, Handling of hardware and software interrupts.

Processes and IPC: Basic concepts, Process state transition diagram, Context switch, Mutual exclusion problem, Semaphores - definition and implementation.

Process scheduling: Preemptive and non-preemptive, FCFS, SJF and Round-robin.

Memory management: Logical and physical addresses, Paging and virtual memory, Page fault handling.

**Book:**

1. Operating system concepts, A. Silberschatz, P.B. Galvin and G. Gane, McGraw Hill.

## **Paper II (Option A)**

### **Part A: Information System Development**

Software process and process models.

Requirements analysis and specification

Software design processes: Function-oriented design with data flow diagrams, Object-oriented modeling with the Unified Modeling Language (UML).

Software testing: Black box, white box and grey box testing strategy. Testing techniques: Unit testing, Integration testing and System testing.

Software project management: People management, Process improvement – GQM, CMMI, Software cost estimation – COCOMO.

Books:

1. Ian Sommerville, Software Engineering, 8th Edn., 2007, Addison Wesley.
2. M. Fowler and K. Scott, UML Distilled, 2000, Addison Wesley.

### **Part B: Database Management Systems**

Entity relationship diagrams; Integrity constraints; Relational algebra, Normalization – 1NF, 2NF, 3NF and BCNF.

SQL queries, Fundamentals of Indexing: B-Tree and B+ Tree. Fundamentals of Transactions – ACID property, Degree of consistency, Recovery, Concurrency control – Serializable schedule.

**Book:**

1. Database System Concepts (5<sup>th</sup> Edition), Avi Silberschatz, Henry F. Korth, S. Sudarshan, McGraw-Hill.

## **Paper II (Option B)**

### **Networking and Internet Technology**

Basics of data communication: Spectrum and Bandwidth of signals, Attenuation and Noise, Nyquist rate, Bit rate, Capacity of a channel - Nyquist and Shannon limits.

Encoding techniques: NRZ, NRZ-L, Manchester, Differential Manchester, Multiplexing techniques (TDM and FDM), Synchronous and Asynchronous communications.

Flow control: Stop-and-wait, Sliding window, ARQ techniques - Stop-and-wait, Go-back-N, Selective-Repeat.

Data link layer issues: Framing, Contention protocols – CSMA, CSMA/CD, CSMA/CA, Ethernet.

Network layer issues: Routing protocols - Flooding, Random routing, Distance vector and link state protocols, IPv4 - addressing, fragmentation.

ARP, Subnetting.

Transport layer issues - TCP (basic operation), Flow control, Congestion control, UDP (basic operation), Socket.

Configuration and management protocols: DHCP (sequence of commands), SNMP (commands, MIB).

Application layer protocols: Telnet, SMTP, POP3, HTTP

DNS, Concepts of proxy and firewall, Security – Basic cryptographic concepts, IPSec, SSL.

Basic topics on HTML.

### **Books:**

1. Data Communication and Networking, W. Stalling, Pearson Education
2. Computer Networking: Forouzan, Addison Wesley