

# Ph.D. Qualifying Examination

The questions in the written exam will be from the following subjects which are detailed in below:

1. Data Structures
2. Algorithms
3. Operating Systems
4. Database Systems
5. Software Engineering
6. Programming Languages and Automata Theory
7. Discrete Mathematics
8. Computer Networks
9. Computer Architecture
10. Digital Design

## 1. Data Structures

### Topics:

- Overview of ADT.
- Algorithm analysis for data structures
- Lists, stacks, queues.
- Trees.
- Hashing.
- Priority queues (heaps).
- Graphs.

### Texts:

- Mark Allen Weiss, Data Structures and Algorithm Analysis in Java/C++.
- Data Abstraction and Problem Solving with C++, Frank Carrano, Addison Wesley.

## 2. Algorithms

### Topics:

- Analysis of Algorithms
- Sorting
- Searching & Data Structures
- Graph Algorithms
- Greedy Algorithms
- Divide and Conquer Algorithms
- Dynamic Programming
- String Processing
- Complexity Classes, NP Completeness

**Texts:**

- Introduction to Algorithms by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Cliff Stein, Mc Graw-Hill.
- Algorithms, S. Dasgupta, C. H. Papadimitriou, U. V. Vazirani, New York: McGraw-Hill.

### 3. Operating Systems

**Topics:**

- Operating Systems Overview
- Processes and Threads.
- Process Scheduling
- Interprocess Communication.
- CPU Scheduling.
- Synchronization.
- Deadlocks.
- Memory Management.
- Virtual Memory.
- File Systems (Interface and Implementation).
- Mass Storage Structure.
- Input/Output and I/O Systems.

**Texts:**

- Modern Operating Systems, A.S. Tanenbaum, Prentice-Hall.
- Operating System Concepts, A. Silberschatz, P.B. Galvin, Addison-Wesley.
- Design and Implementation of the 4.3BSD Operating System, S.J. Leffler, M.K. McKusick, M.J. Karels, J.S. Quarterman, Addison-Wesley.

### 4. Database Systems

**Topics:**

- Data Models
- Physical Data Organization
- Relational Database Design Concepts (Entity/Relationship Model, Relational Model, Relational Algebra)
- Relational Query Languages
- Functional Dependency Theory and Normalization
- Indexing
- Query Processing and Optimization Techniques
- Transaction Processing and Management
- Recoverability
- Concurrency Control Protocols

**Texts:**

- Database Management Systems, Raghu Ramakrishnan, McGraw-Hill.
- Database System Concepts, Silberschatz & Korth, McGraw-Hill.
- Principles of Database and Knowledge-Base Systems, Volume 1, Ullman, Computer Science Press.

## 5. Software Engineering

**Topics:**

- Software Development Lifecycles
- Software Development process models
- Software Project Management
- Requirements Specification and Modeling Techniques
- Traditional, object oriented and component based approaches
- Software metrics
- Software quality
- Testing
- Integration methods
- Maintenance
- Understanding the OO Worldview.
- OO Analysis.
- OO System and Object Design.
- Design Patterns and Architectural Styles.
- OO Software Testing.
- Visual Modeling with Unified Modeling Language (UML).

**Texts:**

- Software Engineering: A Practitioners Approach, R.S. Pressman, McGraw-Hill.
- Software Engineering, Sommerville, Addison-Wesley
- Object-Oriented Software Engineering Using UML Patterns, and Java, Bernd Bruegge and Allen H. Dutoit, Prentice-Hall.
- Object-Oriented Software Engineering, Timothy C. Lethbridge and Robert Laganriere, McGraw-Hill.

## 6. Programming Languages and Automata Theory

**Topics:**

- Finite Automata, DFA, NFA, Equivalences
- Regular expressions, properties of regular sets.
- Context-free grammars, properties of context-free languages.
- Pushdown automata.
- Turing machines.
- Complexity, NP-Completeness.

- Universal Turing Machine
- Halting Problem
- Storage Structures
- Control Structures
- Type Systems
- Names, Scopes, and Bindings.
- Data Types and Type Checking.
- Lexical and syntactic description of languages
- Object-oriented programming languages
- Logic Programming languages
- Functional Programming Languages

**Texts:**

- Programming Language Concepts and Paradigms, D.A. Watt, Prentice-Hall.
- Programming Language Pragmatics, Michael L. Scott, Morgan Kaufmann.
- Elements of the Theory of Computation, H.R. Lewis, C.H. Papadimitriou, Prentice-Hall.
- Introduction to the Theory of Computation, M. Sipser, Course Technology.
- Introduction to Automata Theory, Languages, and Computation, J. E. Hopcroft, R. Motwani and J. D. Ullman, Addison-Wesley.

## 7. Discrete Mathematics

**Topics:**

- Propositional Logic
- Predicate Logic
- Sets and Functions
- Growth of Functions, Complexity of Algorithms
- Integers, Division, and Algorithms
- Induction and Recursion
- Sequences and Summations, Mathematical Induction, Recursive Definitions and Structural Induction,
- Recursive Algorithms
- Permutations and Combinations
- Recurrence Relations and Generating Functions
- Inclusion and Exclusion
- Relations
- Equivalence Relations, Partial Orderings
- Graphs
- Trees

**Texts:**

- Discrete Mathematics and its Applications, K.H. Rosen, McGraw-Hill.
- Logic and Discrete Mathematics: A Computer Science Perspective , W.K. Grassmann and J.P. Tremblay, Prentice Hall.
- Discrete and Combinatorial Mathematics, An Applied Introduction, Ralph P. Grimaldi, Addison-Wesley.

## 8. Computer Networks

**Topics:**

- Principles and techniques employed in computer and wireless Networks
- Data link layer issues
- Network layer issues
- Transport layer issues
- Network programming
- Performance evaluation of computer networks
- Security of computer networks
- Wireless networks

**Texts:**

- Computer Networks, A.S. Tanenbaum, Prentice Hall.
- Computer Networking: A Top Down approach, J.F. Kurose, K.W. Ross, Addison-Wesley.
- Cryptography and Network Security: Principles and Practice, W. Stallings, Prentice Hall.

## 9. Computer Architecture

**Topics:**

- Review of Technology, Role of Performance
- Assembly / Machine Language
- Review of MIPS ISA
- Arithmetic
- The Processing Unit, Data Path and Control Sequencing
- Pipelining
- Graphical Processing Units
- Memory and Memory Hierarchy
- I/O Organization
- Interfacing Processors and Peripherals
- Multiprocessor Systems

**Texts:**

- Computer Organization and Design, D.A. Patterson, J.L. Hennessy, Morgan-Kaufmann.
- Computer Architecture: A Quantitative Approach, J. L. Hennessy and D. A. Patterson.

## 10. Digital Design

### Topics:

- Combinational Circuits
- Combinational Circuit Minimization: Algebraic and Karnaugh-map minimization
- Synchronous Sequential Circuits
- Registers, Counters
- RAM, ROM, PLA, and PAL
- Arithmetic Logic Unit, Multiplication and Division, Floating Point operations

### Texts:

- Digital Design, M. Mano, Prentice-Hall.
- Digital Design Principles and Practices, John F. Wakerly.