Syllabus and Sample Questions for
M.Tech in Computer Science
and
M.Tech in Crypology and Security

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Contents

The Selection Test

The selection test for M.Tech. in Computer Science and M.Tech. in Cryptology and Security will consist of two parts.

- Test **PCA** (objective type) in the forenoon session.

- Test **PCB** (short answer type) in the afternoon session:

The detailed syllabi and sample questions are given in the subsequent pages. A model PCB paper to illustrate the structure of the question paper is also provided.

Syllabus for PCA (First Half, MCQ Type)

The PCA test will consist of 30 multiple-choice questions from the following topics (however, the number of questions from each topic may not be the same):

- Analytical Reasoning.

- Elementary Number Theory: Divisibility, Congruence, Primality.

- Elementary Algebra: Arithmetic, Geometric and Harmonic Progression, Inequalities involving Arithmetic, Geometric and Harmonic Mean. Binomial Theorem and Multinomial Theorem, Theory of Polynomials.

- Linear Algebra: Matrices, Determinants, Rank and Inverse, Properties of Symmetric and Idempotent Matrices, Vectors, Eigenvalues and Eigenvectors, Quadratic Forms. System of Linear Equations.

- Euclidean and Coordinate Geometry: Straight Lines, Circle, Triangles.

- Calculus: Sequences and their Properties, Series, Power Series, Taylor Series and Maclaurin Series, Convergence, Limits, Continuity, Differentiation and Integration of Functions, Rolle's Theorem and Mean Value Theorem, Maxima and Minima.

- Discrete Mathematics: Elementary Set Theory, Permutations and Combinations, Functions and Relations, Recurrences.

- Basic Graph Theory: Paths and Cycles, Connected Components, Trees, Digraphs.

- Elementary Discrete Probability Theory: Combinatorial Probability, Conditional Probability, Bayes Theorem.

- Mathematical Logic: Boolean Algebra, Propositional Logic, Predicate Logic.

- Basic Automata Theory: Strings, Languages, Finite State Automata, Regular Expressions.

- Basic Algorithmic Concepts: Interpreting Simple Pseudocodes Written with Sequential, Conditional, Iterative, Recursive Constructs.

Syllabus for PCB (Second Half, Short Answer Type) CS Group

The students will have to answer one question of 20 marks on *Programming and algorithmic thinking*, and any 5 questions, of 16 marks each, from the following topics.

- Logical Reasoning, Functions and Relations, Divisibility, Congruences, Primality, Permutations and Combinations, Binomial / Multinomial Theorem, Recurrence Relations.

- Design and Analysis of Algorithms: Asymptotic Notation, Searching, Sorting, Graph Traversal, Minimum Spanning Tree, Shortest Path Algorithms.

- Data Structures: Array, Stack, Queue, Linked List, Binary Tree, Heap, AVL Tree, B-tree.

- Graph Theory: Graphs, Adjacency Matrix and Adjacency List representation of Graphs, Subgraphs, Paths and Cycles, Trees and their Properties, Connectivity, Digraphs, Vertex Colouring, Planar Graphs.

- Formal Languages and Automata Theory: Finite Automata and Regular Expressions, Pumping Lemma for Regular Languages, Pushdown Automata, Context-free Grammar, Turing Machine, Elements of Undecidability.

- Switching Theory and Logic Design: Boolean expressions and their minimization, Techniques such as Karnaugh Maps and Quine-McCluskey Method. Adders (Half and Full), Subtractors, Encoders and Decoders, Multiplexers and Demultiplexers, Read-Only Memory (ROM). Flip-Flops (SR, JK, D, T), Counters (Asynchronous and Synchronous), Registers (Shift Registers and Storage Registers). Design and Synthesis of Finite-State Machines (FSM), Practical implementation of various digital circuits.

- Computer Organization and Architecture: Number Representation, Computer Arithmetic, Memory Organization, I/O Organization, Processor Organization, Pipelining.

- Operating Systems: Memory Management, Processor Management, Critical Section Problem, Deadlocks, Device Management, File Systems.

- Database Management Systems: Relational Model, Relational Algebra, SQL, Functional Dependency, Normalisation (2NF, 3NF and BCNF).

- Computer Networks: OSI, LAN Technology - Bus / Tree, Ring, Star; MAC Protocols; WAN Technology - Circuit Switching, Packet Switching; Data Communications - Data Encoding/Decoding, Flow Control, Error Detection/Correction.

Syllabus for PCB (Second Half, Short Answer Type) Non-CS Group

The students will have to answer one question of 20 marks on *Programming and algorithmic thinking*, and any 5 questions, of 16 marks each, from the following topics.

Topics in Mathematics

- Logical Reasoning, Functions and Relations, Divisibility, Congruences, Primality. Permutations and Combinations, Binomial / Multinomial Theorem, Recurrence Relations.

- Design and Analysis of Algorithms: Asymptotic Notation, Searching, Sorting, Graph Traversal, Minimum Spanning Tree, Shortest Path Algorithms.

- Linear Algebra: System of Linear Equations, Determinant, Rank and Inverse of a Matrix, Vector Space and Linear Transformation, Eigenvalues and Eigenvectors of Matrices, Properties of Symmetric and Idempotent Matrices.

- Polynomials: Polynomials of a Single Variable and Multiple Variables.

- Discrete Probability Theory: Combinatorial Probability, Conditional Probability, and Bayes Theorem. Discrete Random Variables. Expectation and Variance of Discrete Random Variables.

- Graphs, Adjacency Matrix and Adjacency List representation of Graphs, Subgraphs, Paths and Cycles, Trees and their Properties, Connectivity, Digraphs, Vertex Colouring, Planar Graphs.

- Calculus: Sequences and their Properties. Series, Power Series, Convergence, Limits, Continuity, Differentiation and Integration of Functions, Maxima and Minima, Functions of Several Variables.

- Formal Languages and Automata Theory: Finite Automata and Regular Expressions, Pumping Lemma for Regular Languages, Pushdown Automata, Context-free Grammar, Turing Machine, Elements of Undecidability.

Topics in Engineering Sciences

- Elementary Circuit Theory: Node and Mesh Analysis, Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL), Superposition Theorem, Thevenin's and Norton's Theorems, Maximum Power Transfer Theorem.

- Switching Theory and Logic Design: Boolean expressions and their minimization, Techniques such as Karnaugh Maps and Quine-McCluskey Method. Adders (Half and Full), Subtractors, Encoders and Decoders, Multiplexers and Demultiplexers, Read-Only Memory (ROM). Flip-Flops (SR, JK, D, T), Counters (Asynchronous

and Synchronous), Registers (Shift Registers and Storage Registers). Design and Synthesis of Finite-State Machines (FSM), Practical implementation of various digital circuits.

- Mechanics: Gravitation, Moments of Inertia and applications, Particle Dynamics and Laws of Motion, Elasticity and Friction, Strength of Materials and their mechanical properties.

- Thermodynamics: Laws of Thermodynamics (First, Second, and Third Laws), Heat Engines, Efficiency, and Carnot Cycle, Applications of Thermodynamic Principles in Engineering.