

Syllabus for Ph.D. Entrance Examination 2024: Mathematical and Information Science (MIS)

Group A: General Mathematics

Basic Algebra: Theory of Equations, Complex Numbers, Basic understanding of Group Theory.

Elementary Linear Algebra: Determinants and their properties, Cramer's Rule, Systems of linear equations, Rank, matrices and matrix algebra, Eigen values and Eigen vectors, orthogonal bases, vector spaces, inner products, Gram-Schmidt procedure.

Basic Statistics: Mean, median, mode, standard deviation, skewness and kurtosis, moment, correlation and regression.

Discrete Mathematics: Basics of set theory, functions and relations, basic combinatorics (basic counting, inclusion-exclusion principle, pigeonhole principle), permutation and combination, recurrence relations, generating functions.

Elementary Probability: Basic definitions, random variables, distributions, Standard discrete distributions (uniform, binomial, Poisson, geometric, hypergeometric); Expectation, Variance and moments; Conditional probability and Bayes' theorem.

Basic Number Theory: Divisibility, GCD, Modular arithmetic, Chinese Remainder Theorem.

Elementary High School Level Calculus: Limit, continuity, differentiability and integration.

Group B: Technical Topics in Computer Science

Graph theory: Paths and cycles, Connected components, Tree, Digraphs, Eulerian trails, Hamiltonian paths, Planar graphs, Graph coloring.

Elements of computing: Basics of programming (using pseudo-code and any one of the languages from C, C++, Java, Python), Procedure call and parameter passing.

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

Design and Analysis of Algorithms: Asymptotic notation, Searching, Sorting, Selection, Graph algorithms.

Circuits and systems: Analysis of elementary high school level circuits involving resistance, capacitance and inductance; Boolean algebra, Minimization of Boolean functions, Gates and logic circuits, Combinational and sequential circuits.

Group C: Technical Topics in Mathematics

Basic Topology: Topological spaces, Continuous functions, Connectedness, Compactness, Separation axioms. Product spaces. Complete metric spaces. Uniform continuity, Basic notions of homotopy, Fundamental Groups.

Analysis: Sequences and series, Continuity and differentiability of real valued functions of one and two real variables and applications, uniform convergence, Riemann integration, Ordinary differential equations, Basics of complex analysis.

Linear Algebra: Vector spaces, linear transformations, characteristic roots and characteristic vectors, systems of linear equations, inner product spaces, diagonalization of symmetric and Hermitian matrices.

Abstract Algebra: Groups, homomorphisms, normal subgroups and quotients, isomorphism theorems, finite groups, symmetric and alternating groups, direct product, structure of finite Abelian groups, Sylow theorems. Rings and ideals, quotients, homomorphism and isomorphism theorems, maximal ideals, prime ideals, integral domains, field of fractions; Euclidean rings, principal ideal domains, unique factorisation domains, polynomial rings. Fields, characteristic of a field, algebraic extensions, roots of polynomials, separable and normal extensions, finite fields.

Written Test Guidelines

There will be a total 16 questions in three groups ($4+6+6 = 16$). Each question will be of 20 marks. A candidate have to answer 5 questions with at least 2 questions from Group A and remaining questions from Group B or Group C.