

## Syllabus for Ph.D Entrance Examination: 2021-2022

### Group A: General Mathematics

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

**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.

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

**Elementary Probability:** Basic definitions, random variables, distributions, discrete random variables: Bernoulli, binomial, and Poisson distributions; continuous random variables: properties of uniform, normal and exponential distributions; expectation, conditional probability and Bayes' theorem.

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

### Group B: Technical Topics in Computer Science

**Graph theory:** Paths and cycles, connected components, tree, digraphs, planar graphs, Eulerian graphs, Hamiltonian paths.

**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, stack, queue, linked list, binary tree, heap, AVL tree, B-tree.

**Design and Analysis of Algorithms:** Asymptotic notation, searching, sorting, selection, graph algorithms.

**Digital circuits and systems:** 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.

**Real Analysis:** Sequences and series, Continuity and differentiability of real valued functions of one and two real variables and applications, uniform convergence, Riemann integration.

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

**Probability Theory:** Combinatorial probability, Conditional probability, Bayes theorem, Standard discrete distributions (uniform, binomial, Poisson, geometric, hypergeometric). Expectation, Variance and moments.

**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.