

Syllabus for Ph.D. Entrance Examination 2024: Ph.D in Engineering

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, differentiation 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: Breadth First Search, Depth First Search, Shortest Path

Circuits and systems: Analysis of elementary high school level circuits involving resistance, capacitance and inductance; analog electronic circuits involving transistors, Boolean algebra, Minimization of Boolean functions, Gates and logic circuits, Combinational and sequential circuits; Signals and systems, Convolution, Fourier transform, and z -transform.

Formal Languages and Automata Theory: Finite automata and regular languages. Pushdown automata and context-free languages. Turing machines and recursively enumerable languages. Undecidability

Group C: Physics and Engineering Aspects of Physics

Quantum mechanics: Basic linear algebra relevant to quantum mechanics (for example: vector spaces, direct sum, tensor product, hermitian and unitary operators, etc), postulates of quantum mechanics, Schrodinger equation and its applications, quantum harmonic oscillator, symmetries, angular momentum, variational principle, and approximation methods.

Electronics: Basic electronics, digital electronics, analog and digital modulation, microcontroller and processor.

Condensed matter: Symmetry in Solids, X-ray Diffraction Methods, Free Electron Theory of Metals, Thermal Conductivity of Metals, Theory of Specific Heat, Lattice Vibrations, Dielectrics, Magnetism, Superconductivity: Type I and Type II Superconductors, BCS Theory, Josephson Tunneling, Energy Bands in Solids, Semiconductors, Defects in Solids.

Entrance Examination Guidelines

There will be a total of 16 questions divided into three groups (4 + 6 + 6 = 16). Each question will carry 20 marks. A candidate is required to answer 5 questions, with a minimum of 2 questions from Group A and the remaining from Group B or Group C.