Mukesh Patel School of Technology Management & Engineering, Mumbai

Department of Basic Science and Humanities

Syllabus for PhD Entrance Test (Applied Mathematics)

Effective from May, 2026

SECTION- A

Section A will include 25 compulsory objective-type questions, each carrying 2 marks. It will be focused on research aptitude. The section will be general in nature and aims to evaluate the candidate's research aptitude, with emphasis on reasoning ability, data interpretation, and quantitative skills.

SECTION-B

Section B will comprise 25 compulsory objective-type questions, each carrying 2 marks, based on the following syllabus:

UNIT I -ANALYSIS

Elementary set theory, finite, countable and uncountable sets, real number system as a complete ordered field, Archimedean property, supremum and infimum, sequences and series, convergence, limit superior (lim sup) and limit inferior (lim inf), Bolzano–Weierstrass theorem, Heine–Borel theorem, continuity, uniform continuity, differentiability, Mean Value Theorem, sequences and series of functions, uniform convergence, Riemann sums and Riemann integral, improper integrals, monotonic functions, types of discontinuities, functions of bounded variation, Lebesgue measure and Lebesgue integral, functions of several variables, partial derivatives, directional derivatives, derivative as a linear transformation, inverse function theorem and implicit function theorem, metric spaces, compactness and connectedness, normed linear spaces, spaces of continuous functions as examples

UNIT II - LINEAR ALGEBRA

Vector spaces, subspaces, linear dependence and independence, basis and dimension, algebra of linear transformations, matrices, rank and determinant, systems of linear equations, eigenvalues and eigenvectors, Cayley–Hamilton theorem, matrix representation of linear transformations, change of basis, canonical forms including diagonal, triangular and Jordan forms, inner product spaces, orthonormal basis, quadratic forms, reduction and classification of quadratic forms

UNIT III - COMPLEX ANALYSIS

Algebra of complex numbers, complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions, analytic functions, Cauchy–Riemann equations, contour integration, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, maximum modulus principle, Schwarz lemma, open mapping theorem, Taylor series, Laurent series, calculus of residues, conformal mappings, Möbius transformations

UNIT IV - ALGEBRA

Permutations, combinations, pigeonhole principle, inclusion–exclusion principle, derangements, fundamental theorem of arithmetic, divisibility in $\mathbb{Z}$, congruences, Chinese Remainder Theorem, Euler's φ-function, primitive roots, groups, subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley's theorem, class equations, Sylow theorems, rings, ideals, prime and maximal ideals, quotient rings, unique factorization domains, principal ideal domains, Euclidean domains, polynomial rings, irreducibility criteria, fields, finite fields, field extensions, Galois theory

UNIT V - ORDINARY & PARTIAL DIFFERENTIAL EQUATIONS

Existence and uniqueness of solutions of initial value problems for first-order ordinary differential equations, singular solutions of first-order ODEs, systems of first-order ODEs, general theory of homogeneous and non-homogeneous linear ODEs, variation of parameters, Sturm–Liouville boundary value problems, Green's functions.Lagrange and Charpit methods for solving first-order PDEs, Cauchy problem for first-order PDEs, classification of second-order PDEs, general solution of higher-order PDEs with constant coefficients, method of separation of variables for Laplace, Heat and Wave equations

UNIT-VI NUMERICAL ANALYSIS

Numerical solutions of algebraic equations, method of iteration, Newton–Raphson method, rate of convergence, solution of systems of linear algebraic equations using Gauss elimination and Gauss–Seidel methods, finite differences, Lagrange, Hermite and spline interpolation, numerical differentiation and integration, numerical solutions of ODEs using Picard, Euler, modified Euler and Runge–Kutta methods

UNIT VII - CLASSICAL MECHANICS

Generalized coordinates, Lagrange's equations, Hamilton's canonical equations, Hamilton's principle, principle of least action, two-dimensional motion of rigid bodies, Euler's dynamical equations for motion of a rigid body about an axis, theory of small oscillations

UNIT VIII - PROBABILITY THEORY, STATISTICS AND STOCHASTIC PROCESSES

Probability theory including random variables, probability distributions (discrete and continuous), expectation, variance, joint distributions, conditional probability, limit theorems, basic statistical inference including estimation and hypothesis testing, stochastic processes including discrete-time

and continuous-time processes, Markov chains, transition probability matrices, steady-state behaviour, Poisson processes and their properties