SRM UNIVERSITY AP
Andhra Pradesh

Syllabus of Mathematics for PhD Entrance Exam

Analysis: Elementary set theory, finite, countable, and uncountable sets. Real number system as a complete ordered field, Archimedean property, supremum, infimum. Sequences and series, convergence, limsup, liminf. Continuity, uniform continuity, differentiability, mean value theorem. Riemann sums and Riemann integral, Improper Integrals. Functions of several variables, directional derivative, partial derivative, derivative as a linear transformation, inverse and implicit function theorems. Metric spaces, compactness, connectedness.

Linear Algebra: Vector spaces, subspaces, linear dependence, basis, dimension, algebra of linear transformations.Eigenvalues and eigenvectors, Cayley-Hamilton theorem. Matrix representation of linear transformations. Change of basis, canonical forms, diagonal forms, triangular forms, Jordan forms. Quadratic forms, reduction and classification of quadratic forms.

Complex Analysis: Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions (exponential, trigonometric, hyperbolic). Analytic functions, Cauchy-Riemann equations. Contour integral, Cauchy's theorem, Cauchy's integral formula, Liouville's theorem, Maximum modulus principle, Schwarz lemma, Open mapping theorem.
Conformal mappings, Mobius transformations.

Algebra: Permutations, combinations, pigeon-hole principle, inclusion-exclusion principle, derangements. 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 domain, principal ideal domain, Euclidean domain. Polynomial rings and irreducibility criteria. Fields, finite fields, field extensions, Galois Theory.

Topology: Basis, dense sets, subspace and product topology, separation axioms, connectedness, compactness.

Ordinary Differential Equations (ODEs): Existence and uniqueness of solutions of initial value problems for first-order ODEs. Singular solutions of first-order ODEs, system of first-order ODEs. General theory of homogeneous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green's function.

Partial Differential Equations (PDEs): Lagrange and Charpit methods, Cauchy problem.
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.

Numerical Analysis: Numerical solutions of algebraic equations, Method of iteration and 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.

Calculus of Variations: Variation of a functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema. Variational methods for boundary value problems in ordinary and partial differential equations.

Probability and Statistics: Statistics: Population, sample, variables. Types of data: qualitative and quantitative. Measures of central tendency: mean, median, mode. Measures of dispersion: range, variance, standard deviation. Creating and interpreting frequency distributions. Basic probability concepts. Probability rules and laws. Probability distribution, sampling methods, central Limit Theorem, confidence intervals. Hypothesis testing, types of errors in hypothesis testing. One-sample and two-sample t-tests,. Correlation and causation, scatterplots, and correlation coefficients. Introduction to Regression Analysis.