

Syllabus for entrance examination for Ph.D. in Mathematics

Section-A

Research methodology:

- * Meaning, nature, significance and types of research.
- * End to end process of research, research proposal, synopsis, hypothesis, data collection, literature survey, sampling, interviewing, questionnaire, data processing, interpretation, report writing, bibliography.
- * Thesis/Dissertation writing.
- * Role and use of computers in research.

Section-B

Algebra: Groups, subgroups, normal subgroups, quotient groups, homomorphism's, 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.~~

Linear Algebra: Vector spaces, subspaces, linear dependence, basis and dimension, linear transformation, null space, rank and nullity, range space, Matrix representation of linear transformation. Change of basis, Eigen values and eigenvectors, Inner product, orthogonality, Gram-Schmidt process, orthogonal expansion, Quadratic forms, reduction to normal form

Analysis:

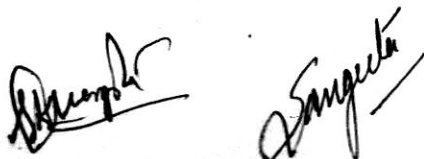
Elementary set theory, finite, countable and uncountable sets Real number system as a complete ordered field, Archimedean property, supremum, infimum. Sequences and series, convergence, limsup, liminf. Bolzano Weierstrass theorem, Heine Borel theorem. Continuity, uniform continuity, differentiability, mean value theorem.

Sequences and series of functions, uniform convergence. Riemann sums and Riemann integral, Improper Integrals. Monotonic functions, types of discontinuity, functions of bounded variation, Lebesgue measure, Lebesgue integral.

Functions of several variables, directional derivative, partial derivative, and derivative as a linear transformation, inverse and implicit function theorems.

Metric spaces, compactness, connectedness. Normed linear Spaces. Spaces of continuous functions as examples.

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



Complex Analysis: Algebra of complex numbers, the complex plane, polynomials, power series, transcendental functions such as exponential, trigonometric and hyperbolic functions. 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. Taylor series, Laurent series, calculus of residues. Conformal mappings, Mobius transformations.

Ordinary Differential Equations (ODEs):

Existence and uniqueness of solutions of initial value problems for first order ordinary differential equations, singular solutions of first order ODEs, system of first order ODEs. General theory of homogenous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, Green's function.

Partial Differential Equations (PDEs):

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.

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's and Hermite interpolation, Numerical differentiation and integration, Numerical solution of ODEs using Picard, Euler, Modified Euler and Runge-Kutta methods.

Operation Research: Linear programming problems, convex set, convex functions, Simplex method and its variants, duality, sensitivity analysis, Transportation problems, initial basic feasible solution and optimal solution, degeneracy, Assignment problems, application of TP and AP

Fuzzy Logic: Crisp set and fuzzy set basic concepts of fuzzy sets, membership functions. Basic operations on fuzzy sets, properties of fuzzy sets, Fuzzy relations. Propositional logic and predicate logic, fuzzy If-Then rules, fuzzy mapping rules and fuzzy implication functions, applications.

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