DEPARTMENT OF MATHEMATICS
NATIONAL INSTITUTE OF TECHNOLOGY SRINAGAR

SYALLABUS FOR PH. D ENTRANCE EXAMINTION

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, derivative as a linear transformation.

Metric spaces, compactness, connectedness. Normed Linear Spaces. Spaces of Continuous functions as examples , Hilbert spaces.

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

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, Mobinus transformations.

Algebra: Permutations, combinations, pigeon-hole principle, inclusion-exclusion principle, derangements. Fundamental theorem of arithmetic, divisibility in Z-congruence's, Chinese Remainder Theorem, Euler's Ø- function, primitive roots. Groups, subgroups, normal subgroups, quotient groups, homeomorphisms, cyclic groups, permutation groups, Cayley's theorem, class equations, Sylow's 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.

Ordinary Differential Equations (ODEs) & Partial Differential Equations (PDEs):

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, 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.

Operations Research:
Simple way of simplex computations, Artificial variables technique, Two-phase method, Big M Method, Duality theorems, Computational procedure of dual simplex method, Transportation problems, theory of games, Moments, Probability theory, Probability distributions(discrete and continuous), sampling, statistical inference, non-linear programming, unconstraint optimization techniques, constraint optimization techniques

Differential Geometry:
Curves in R^3: Representation of curves, unit and arbitrary speed curves, Frenet-frame, curvature and torsion, Serret - Frenet formula, Helix, directional derivative and covariant derivative, Frame field, altitude matrix and connection Forms.
Surfaces in R^3: Definition and examples of a smooth surface, differentiable functions on surfaces, tangent plane and unit surface normal, Surface of revolution, first fundamental form and its properties, second fundamental form, tangential intersection of two surfaces, normal curvature, principal curvature. Meusnier's theorem, Euler's theorem, Umbilical surface, Helicoidal surface, Shape operator and its properties, Gaussian and mean curvature, minimal surface, ruled surface, line of curvature, Rodriguez formula, geodesic of a surface and geodesic equation, Gauss and Weingarten equations, Mainardi-Codazzi equations, geodesic curvature, Liouville's formula, Gauss-Bonnet theorem.