DEPARTMENT OF MATHEMATICS

Syllabus for Ph. D. Entrance Test

1. Real Analysis:

Definition, Examples and properties of Metric Spaces, Numerical Sequences and Series, Limit and Continuity of functions, Sequences and Series of functions. Limit and Continuity of functions of several variables and Derivatives of higher order. Definition, Existence and Properties of Riemann-Stieltjes integral.

2. Abstract Algebra:

Definition, Examples and Properties of Group (finite and infinite), Group of Permutations, Subgroup and Cyclic group, Normal subgroup, Centre of a group, Conjugate subgroup, Quotient groups, Homomorphism and Isomorphism and Commutator subgroup of a group. Composition series of a group, Solvable group, Nilpotent groups, Direct products, Cauchy's theorem and Sylow's theorem. Definition, Examples and Properties Ring, Field and Integral Domain. Ideals, Ring homomorphism, Field of Quotients and Polynomial rings.

3. Linear Algebra:

Definition Examples and Properties of Vector space, subspaces, linear combination of vectors, linear dependence and independence of vectors, basis and dimension of a vector space. Linear transformations, Direct sum of spaces. Dual spaces and dual basis. Algebra of matrices, Elementary transformations, Echelon form and canonical form of matrices, rank and nullity of matrices, row and column vectors, linear dependence and independence of row and column vectors, row rank and column rank of matrices. System of linear and non-linear equations. Matrix polynomials, Eigenvalues and Eigenvectors of a matrix, Characteristic polynomial and characteristic equation of a matrix, Cayley Hamilton theorem. Inner product of two vectors, orthogonal vectors, unitary and orthogonal matrices, Quadratic forms, matrix representation of linear transformations. Change of basis. Reduction of a real quadratic form, canonical or normal form of a real quadratic form.

4. Complex Analysis:

Definition and examples of Analytical functions, Cauchy-Reimann equations. Definition and examples of Conformal mapping, Bilinear transformations, their properties and classification. Complex Integration, Singularities and Poles, Calculus of Residues and Power series.

5. Topology:

Definition, Examples and Properties of topological spaces, Induced topology, Compactness and Connectedness of a topological space. Separation axioms and Axioms of Countability. Finite Intersection Properties and Product spaces.

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6. Functional Analysis:

Definition, Examples and Properties of Normed linear spaces and Banach spaces. Inner product spaces. Hilbert spaces. Orthonormal Sets. Bessel's inequality. Complete orthonormal sets and Parseval's identity. Projection theorem. Rietz-representation theorem Adjoint of an operator on a Hilbert space. Reflexivity of Hilbert spaces. Self-adjoint operators. Linear transformation & Linear functionals.

7. Partial Differential Equations:

Lagrange and Charpit methods for solving first order partial differential equations, Cauchy problems 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.

8. Differential Geometry:

Space curve: curvature and torsion, Serret-Frenet formula, Helix, Osculating plane and Bertrand curves. Parametric curves: Fundamental magnitude, Normal section, Lines of curvature, Rodrigue's formula. Dupin's theorem, theorem of Euler, Conjugate directions and Asymptotic lines. Developable associated with space curves. Geodesics.

9. Fluid Dynamics:

Kinematics: Equation of continuity in different coordinate system, Boundary surfaces. Stream lines, Path lines and streak lines. Velocity potential, Irrotational and rotational motions. Vortex lines. Equations of Motion: Lagrange's and Euler's equations of motion, Bernoulli's theorem. Complex velocity potential. Sources, sinks doublets and their images in two dimensions. Conformal mapping. Milne-Thomson circle theorem.

10. Classical Mechanics:

Generalized coordinates, Lagrange's equations, Hamilton's canonical equations, Hamilton's principle and principle of least action. Two directional motion of rigid bodies, Euler's dynamical equations for motion of a rigid body about an axis, Theory of small oscillations.

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