Mathematics
Syllabus

Algebra: Groups, Normal subgroups, homomorphisms and automorphisms; Group actions, Sylow's theorems and their applications; Euclidean domains, Principle ideal domains and Unique factorization domains. Prime ideals and maximal ideals in Commutative Rings; Fields.

Topology: Basic concepts of topology, Product topology, Connectedness, Compactness, Countability and Separation axioms, Urysohn's Lemma.

Real Analysis: Sequences and series of functions, Uniform convergence, Power series, Fourier series, Functions of several variables, Maxima, Minima; Riemann integration, Multiple integrals, Line, Surface and Volume integrals, Theorems of Green, Stokes and Gauss; Metric spaces, Completeness, Weierstrass approximation theorem, Compactness; Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, Dominated convergence theorem.

Linear Algebra: Finite dimensional vector spaces; Linear transformations and their matrix representations, rank; Systems of linear equations, Eigen values and Eigen vectors, Cayley-Hamilton Theroem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices; Finite dimensional inner product spaces, Gram-Schmidt orthonormalization process, Self-adjoint operators.

Complex Analysis: Analytic functions, Conformal mappings, Bilinear transformations; Complex integration: Cauchy's integral theorem and formula; Liouville's theorem, Maximum modulus principle; Taylor's and Laurent's series; Residue theorem and applications for evaluating real integrals.

Functional Analysis: Banach spaces, Hahn-Banach extension theorem, open mapping and closed graph theorems, Principle of uniform boundedness; Hilbert spaces, Orthonormal bases, Riesz representation theorem, bounded linear operators.

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: Linear and quasilinear first order partial differential equations, Method of characteristics; Second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems; Solutions of Laplace, Wave and Diffusion equations in two variables; Fourier series and Fourier transform and Laplace transform methods of solutions for the above equations.

Probability and Statistics: Probability space, Conditional probability, Bayes theorem, Independence, Random variables, Joint and Conditional distributions, Standard probability distributions and their properties, Expectation, Conditional expectation, Moments; Weak and strong law of large numbers, Central limit theorem; Sampling distributions, Maximum likelihood estimators, Testing of hypotheses, Standard parametric tests based on Normal, Chi-square , t, F – distributions; Linear regression; Interval estimation.

Numerical Analysis: Numerical solution of algebraic and transcendental equations: Bisection method, Secant method, Newton-Raphson method, Fixed point iteration; Interpolation: Error of polynomial interpolation, Lagrange and Newton interpolations; Numerical differentiation; Numerical integration: Trapezoidal and Simpson's rules, Gauss Legendre quadrature, Method of undetermined parameters; Least square polynomial approximation; Numerical solution of systems of linear equations: Direct methods (Gauss elimination, LU decomposition); Iterative methods (Jacobi and Gauss-Seidel); Matrix Eigen value problems: Power method, Numerical solutions of ordinary differential equations: initial value problems: Taylor series method, Euler's method, Runge-Kutta methods.

Linear programming: Linear programming problem and its formulation, Convex sets and their properties, Graphical method, Basic feasible solutions, Simplex method, Big-M and two phase methods; Infeasible and unbounded LPP's, Alternate optima; Dual problem and duality theorems, Dual Simplex method and its application in post optimality analysis; Transportation problems, Assignment problems

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.

Linear Integral Equations: Linear integral equation of the first and second kind of Fredholm and Volterra type, Solutions with separable kernels. Characteristic numbers and Eigen functions, Resolvent kernel.

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