Creative Learning System
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UPSC CIVIL SERVICES EXAMINATION

Official Optional Subject Syllabus

Mathematics

The Mathematics optional tests a candidate's conceptual clarity and problem-solving abilities across pure and applied mathematics branches.

Paper I

Linear Algebra and Calculus

- **Linear Algebra:** Vector spaces over R and C, linear dependence and independence, subspaces, bases, dimension; Linear transformations, rank and nullity, matrix of a linear transformation. Algebra of Matrices; Row and column reduction, Echelon form, congruence's and similarity; Rank of a matrix; Inverse of a matrix.
- **Calculus:** Real numbers, functions of a real variable, limits, continuity, differentiability, mean value theorem, Taylor's theorem with remainders, indeterminate forms, maxima and minima, asymptotes; Curve tracing; Functions of two or three variables: limits, continuity, partial derivatives.

Analytic Geometry and Ordinary Differential Equations

- **Analytic Geometry:** Cartesian and polar coordinates in three dimensions, second degree equations in three variables, reduction to canonical forms, straight lines, shortest distance between two skew lines; Plane, sphere, cone, cylinder, paraboloid, ellipsoid, hyperboloid of one and two sheets.
- **Ordinary Differential Equations:** Formulation of differential equations; Equations of first order and first degree, integrating factor; Orthogonal trajectory; Equations of first order but not of first degree, Clairaut's equation. Second and higher order linear equations with constant coefficients.

Dynamics, Statics and Vector Analysis

- **Dynamics & Statics:** Rectilinear motion, simple harmonic motion, motion in a plane, projectiles; constrained motion; Work and energy, conservation of energy; Kepler's laws, orbits under central forces.

- **Vector Analysis:** Scalar and vector fields, differentiation of vector field of a scalar variable; Gradient, divergence and curl in cartesian and cylindrical coordinates; Higher order derivatives; Vector identities and vector equations.

Paper II

Algebra and Real Analysis

- **Algebra:** Groups, subgroups, cyclic groups, cosets, Lagrange's Theorem, normal subgroups, quotient groups, homomorphism of groups, basic isomorphism theorems, permutation groups, Cayley's theorem. Rings, subrings and ideals, homomorphisms of rings.
- **Real Analysis:** Real number system as an ordered field with least upper bound property; Sequences, limit of a sequence, Cauchy sequence, completeness of real line; Series and its convergence.

Complex Analysis and Linear Programming

- **Complex Analysis:** Analytic functions, Cauchy-Riemann equations, Cauchy's theorem, Cauchy's integral formula, power series representation of an analytic function, Taylor's series; Singularities; Laurent's series; Cauchy's residue theorem.
- **Linear Programming:** Linear programming problems, basic solution, basic feasible solution and optimal solution; Graphical method and simplex method of solutions; Duality.

Partial Differential Equations & Mechanics

- **Partial Differential Equations:** Family of surfaces in three dimensions and formulation of partial differential equations; Solution of quasilinear partial differential equations of the first order, Cauchy's method of characteristics.
- **Numerical Analysis and Computer Programming:** Numerical methods: solution of algebraic and transcendental equations of one variable by bisection, Regula-Falsi and Newton-Raphson methods.
- **Mechanics and Fluid Dynamics:** Generalized coordinates; D' Alembert's principle and Lagrange's equations; Hamilton equations; Moment of inertia; Motion of rigid bodies in two dimensions. Equation of continuity; Euler's equation of motion for inviscid flow.