UPSC CSE Mathematics Syllabus 2024

The UPSC Mathematics syllabus 2024 covers a wide range of topics including abstract algebra, real analysis, complex analysis, linear algebra, analytical geometry, differential equations, probability theory, numerical analysis, mechanics, and statistics. Candidates will need to have a strong grasp of mathematical concepts and their applications to real-world problems.

UPSC CSE Mathematics Syllabus 2024 Paper 1

1. 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 and similarity
- Rank of a matrix
- Inverse of a matrix
- Solution of system of linear equations
- Eigenvalues and eigenvectors
- Characteristic polynomial
- Cayley-Hamilton theorem
- Symmetric, skew-symmetric, Hermitian, skew-Hermitian, orthogonal, and unitary matrices and their eigenvalues.

2. 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
- Partial derivatives
- Lagrange's method of multipliers
- Jacobian
- Riemann's definition of definite integrals
- Indefinite integrals
- Infinite and improper integrals
- Double and triple integrals (evaluation techniques only)
- Areas, surface, and volumes.

3. 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 and their properties.

4. Ordinary Differential Equations:

- Formulation of differential equations
- Equations of first order and first degree
- Integrating factor
- Orthogonal trajectory
- Clairaut's equation
- Singular solution
- Second and higher-order linear equations with constant coefficients
- Second-order linear equations with variable coefficients
- Euler-Cauchy equation
- Laplace and inverse Laplace transforms and their properties
- Application to initial value problems for 2nd order linear equations with constant coefficients.

5. 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
- Equilibrium of a system of particles
- Friction
- Common catenary
- Principle of virtual work
- Stability of equilibrium
- Equilibrium of forces in three dimensions.

6. 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
- Application to geometry: curves in space, curvature, and torsion
- Serret-Frenet's formulae

- Gauss and Stokes' theorems
- Green's identities.

UPSC CSE Mathematics Syllabus 2024 Paper 2

1. 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
- Integral domains, principal ideal domains, Euclidean domains, and unique factorization domains
- Fields, quotient fields

2. 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, absolute and conditional convergence
- Continuity and uniform continuity of functions
- Properties of continuous functions on compact sets
- Riemann integral, improper integrals
- Fundamental theorems of integral calculus
- Uniform convergence, continuity, differentiability, and integrability for sequences and series of functions
- Partial derivatives of functions of several variables
- Maxima and minima

3. 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
- Contour integration

4. Linear Programming:

- Linear programming problems
- Basic solution, basic feasible solution, and optimal solution
- Graphical method and simplex method of solutions

- Duality
- Transportation and assignment problems

5. 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
- Linear partial differential equations of the second order with constant coefficients
- Canonical form
- Equation of a vibrating string, heat equation, Laplace equation and their solutions

6. Numerical Analysis and Computer Programming:

- Solution of algebraic and transcendental equations of one variable
- Solution of system of linear equations
- Interpolation methods
- Numerical integration methods
- Numerical solution of ordinary differential equations
- Computer Programming: Binary system, Arithmetic and logical operations, Conversion systems, Algorithms, and flow charts

7. 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
- Potential flow
- Navier-Stokes equation for a viscous fluid