UPSC Maths Optional Syllabus 2026: Get the Complete Details, PDF & Preparation Tips

UPSC aspirants with strong mathematical expertise and having extreme passion for the subject can choose mathematics as an optional for their CSE Mains. Selecting the optional subject is crucial since it carries 500 marks (Paper 1 & Paper 2) out of 1750 marks in UPSC Mains exam. UPSC Maths optional syllabus consists of two papers covering topics like algebra, calculus, vector analysis, fluid dynamics, etc. Ensuring to master the important mathematics concepts and topics combined with strong practice can lead to better results. In this blog, you can get the complete details of UPSC mathematics optional syllabus, downloadable UPSC maths optional syllabus PDF and the key preparation tips to crack the mathematical optional paper.

UPSC Mathematics Optional Syllabus: A Brief Overview

UPSC mathematics optional syllabus is a comprehensive, deep and graduate-level curriculum dealing with complex mathematical concepts, computational techniques and abstract theories. It is divided into two papers, as we already discussed, covering the range of topics from algebra to mechanics and fluid dynamics. These two papers in combination test the candidates ability to handle both rigorous proofs and intricate numerical problem solving. Here is the brief details on two UPSC mathematics question papers:

- **UPSC Mathematics Question Paper 1 (250 marks):** It deals with foundational topics like Linear Algebra, Calculus, Analytic Geometry, Ordinary Differential Equations (ODEs), etc
- **UPSC Mathematics Question Paper 2 (250 marks):** It focuses on Algebra, Real Analysis, Complex Analysis, Linear Programming, etc.

UPSC Maths Optional Syllabus Paper 1

Paper 1 of the UPSC Maths Optional Syllabus focuses on the foundation aspects of mathematics and application-based physics,

Section A

- **Linear Algebra:** Vector spaces over $\mathbb{R}$ and $\mathbb{C}$, 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, determinants, solutions of systems of linear equations; Characteristic roots and vectors, Cayley-Hamilton theorem. Algebra of complex numbers, complex plane, modulus and

argument, geometric representation of complex numbers, conjugate, triangle inequality, De Moivre's theorem, elementary properties of complex numbers.

- **Calculus:** Real numbers, functions, limits, continuity, differentiability, mean value theorems, Taylor's theorem with remainders, indeterminate forms, maxima and minima, asymptotes; Curve tracing; Functions of two or three variables: limits, continuity, partial derivatives, maxima and minima, Lagrange's method of multipliers, Jacobian, Hessian, differentiability, tangent planes and normal lines; Double and triple integrals and their applications.
- **Analytic Geometry:** Cartesian and polar coordinates in two and 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.

Section B

- **Ordinary Differential Equations:** First order ordinary differential equations; Exact equations, integrating factors; Methods of linear equations, Bernoulli, exact, homogeneous, linear, orthogonal trajectories; Second and higher order differential equations; Euler-Cauchy equation; Legendre's equation; Method of Laplace transforms for solving ordinary differential equations.
- **Dynamics and Statics:** Rectilinear motion; Simple harmonic motion; Motion in a plane; Projectiles; Constrained motion; Work and energy; Keel's theorem; Collision of elastic bodies, conservation of linear and angular momentum; Statics: Forces and their equilibrium; Virtual work; Forces acting at a point; Equilibrium of coplanar forces.
- **Vector Analysis:** Scalar and vector fields; Gradient, divergence, curl; Line, surface and volume integrals; Theorem of Green, Stokes and Gauss; Orthogonal curvilinear coordinates.

UPSC Maths Optional Syllabus Paper 2

Paper 2 of the Mathematics optional UPSC deals with more abstract and computationally intensive mathematical calculations and operations:

Section A

- **Algebra:** Groups; subgroups, normal subgroups, quotient groups, homomorphisms, cyclic groups, permutation groups, Cayley's theorem, Lagrange's theorem, Sylow theorems; Rings, subrings and ideals, homomorphisms, integral domains, principal ideal domains, unique factorization domains and Euclidean domains; Fields; Galois theory.
- **Real Analysis:** Real number system as an ordered field with the least upper bound property; Sequences, limit of a sequence, Cauchy sequence, completeness of real line;

Series and tests of convergence including comparison test, ratio test, root test, integral test with applications; Rearrangement of series; Uniform convergence; Continuity, properties of continuous functions on compact sets; Riemann integral and its definition and properties; Improper integrals; Fundamental theorems of integral calculus.

- **Complex Analysis:** Analytic functions, Cauchy-Riemann equations; Cauchy's theorem, Cauchy's integral formula, powers of an analytic function; Liouville's theorem; Maximum modulus principle; Taylor series; singularities, classification of singularities; Residue theorem; Application to real integrals; elementary properties of entire functions.

Section B

- **Partial differential equations:** Variable separable method, Laplace equation, rectangular Cartesian and polar coordinates; Solutions of one dimensional wave equation and two-dimensional Laplace equation by separation of variables.
- **Numerical Analysis and Computer programming:** Numerical methods: Solution of algebraic and transcendental equations of one variable by bisection, Regula-Falsi and Newton-Raphson methods; Solution of systems of linear equations by Gaussian elimination and House-Holder (QR) transformation; Numerical integration: Trapezoidal rule, Simpson's 1/3rd rule, Gaussian quadrature formula; Numerical solution of ordinary differential equations: Least square polynomials and other methods; Difference equations; Discrete dynamical systems and applications.
- **Computer Programming:** Binary system; Arithmetic and logical operation on numbers; Octal and Hexadecimal systems; Conversion to and from decimal systems; Algebra of binary numbers; Elements of computer systems and concept of memory; Basic logic gates and truth tables, Boolean algebra, normal forms; Representation of unsigned integers, signed integers and reals, double precision reals and long integers; Algorithms and flow charts for solving numerical analysis problems.
- **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; Stream-lines, path of a particle; Potential flow; Two-dimensional and axisymmetric motion; Sources and sinks, vortex motion; Navier-Stokes equation for a viscous fluid

*Download **UPSC maths optional syllabus PDF** to keep it in handy and refer to it whenever you want to go through the syllabus of mathematics optional UPSC!*

Preparation Strategy to Deal with Mathematics Optional UPSC

Use the following preparation strategy and tips to study the mathematics options UPSC with ease:

- **Master the Syllabus:** Go through the entire syllabus, understand it and categorise the topics like easy/medium/hard, which allows us to prioritize your time and energy properly.
- **Form the Conceptual Clarity:** More than rote memorization, build a deeper understanding of the formulas, first principles and logical development of the topic.
- **Maintain Separate Notebook:** While you are studying, make your own notes by consolidating theorems, proofs, formulas, examples, facts and even counterexamples. This set of notes can help you during the revision process as well.
- **Practice Past Year Question (PYQ):** For each topic, devote the time to practice the past year questions (PYQs) till you feel comfortable in handling the different varieties of problems.
- **Revise the Notes:** If you maintain the separate notebook for UPSC maths optional syllabus, this step will be easier. Just go through all the notes and errors you listed while solving the problems to practice recalling and strengthening the learning.

Recommended UPSC Mathematics Optional Books

Below, we have given the list of UPSC mathematics optional books for the UPSC candidates who opted maths as an optional to excel in the Mains examination:

- Linear Algebra by Hoffman and Kunze
- Mathematical Analysis by S.C. Malik and Savita Arora
- Analytical Solid Geometry by Shanti Narayan and P.K. Mittal
- Ordinary and Partial Differential Equations by M.D. Raisinghania
- Statics and Dynamics by Krishna Series
- Vector Analysis by Schaum's Outline Series (Murray Spiegel)
- Contemporary Abstract Algebra by Joseph Gallian
- Real Analysis by H.L. Royden or Shanti Narayan
- Complex Variables by Schaum's Outline Series (Murray Spiegel)
- Operations Research (Linear Programming) by Kanti Swarup or S.D. Sharma
- Numerical Methods by Jain, Iyengar, and Jain
- Fluid Dynamics by M.D. Raisinghania
- Classical Mechanics by Herbert Goldstein or Gupta, Kumar, and Sharma