Mathematics
(12 Core + 3 Optional = 15x4Cr = 60Cr)

Majors in Mathematics are offered with an objective of preparing the students to take up higher studies in Mathematics in international reputed institutes including IITs, IISc, Delhi University, Central Universities, JNU etc. in India. This course will develop the ability to think logically, critically and analytically in dealing with real life situations. After doing this course, the students will also be able to choose carrier in mathematics related fields in education, government/corporate sectors, finance and insurance sectors etc.

A set of twelve core courses will be offered to the students who are opting this major in II and II years of their Bachelor’s program. Four courses per semester will be offered in first three semester and in fourth semester, student will be asked to choose at least three courses from the basket of six to seven courses.

In first semester of Majors, four foundational courses (Calculus, Algebra, Differential Equations and Real Analysis) will be offered. During this semester, student will learn to solve complicated system of equations, modeling of physical phenomena, and understanding of real number system. Second semester of Majors (Group Theory, Metric spaces, Mathematical methods and Linear Algebra) will provide in depth knowledge of pure mathematical courses and prepare students for learning mathematical methods like Laplace and Fourier transforms etc. and it will also introduce the definition of space and dimensions in mathematical terms. In third semester of Majors, in addition to pure mathematics courses, student will learn some numerical techniques (using MATLAB) to solve the problems which are not solvable analytically. A course on complex analysis having wide range applications in string and quantum field theory will also be introduced. In fourth semester, the elective courses from various applied fields like Mechanics, Optimization, Graph theory, Probability and Statistics will be offered and students will be asked to three elective courses. Certain course will include computational lab components also.

In brief, the above program covers broad range of topics related to pure and applied mathematics: Linear algebra, Metric spaces, Group and Ring theory, Numerical analysis, Calculus along with relevant applicable computational laboratory components (using MATLAB, Mathematics SPSS etc.)
## Course Scheme

12 Core Courses + 3 Electives = 15 Courses

<table>
<thead>
<tr>
<th>Semester</th>
<th>Course</th>
<th>Credit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Introduction to Mathematical Thinking</td>
<td>2 (Foundation Course)</td>
</tr>
<tr>
<td>3</td>
<td>Calculus</td>
<td>4 (Core Courses until Sem 5)</td>
</tr>
<tr>
<td></td>
<td>Algebra</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Differential Equations</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Real Analysis</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Group Theory</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Metric Spaces</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Mathematical Methods</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Linear Algebra</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Ring Theory</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Complex Analysis</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Partial Differential Equations</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Numerical Analysis</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td><strong>Electives (Any 3)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Optimization Techniques</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Mechanics</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Discrete Mathematics</td>
<td>4</td>
</tr>
</tbody>
</table>
Course Objectives: The primary objective of this course is to introduce the basic tools of theory of equations, complex numbers, number theory and matrices to understand their linkage to the real-world problems.


Theory of Equations: The Fundamental theorem of algebra, Relations between the roots and the coefficients of polynomial equations in one variable, solution of polynomial equations having conditions on roots, common roots and multiple roots, Transformation of equations, Nature of the roots of an equation, Descartes’ rule of signs, Solutions of cubic equations (Cardon’s method), Biquadratic equations and their solutions.

Complex Numbers: Review of complex numbers, Transcendental functions, hyperbolic functions, Polar representation of complex numbers, Imaginary roots, the $n$th roots of unity, De Moivre’s theorem and its applications.

Recommended Books:


CALCULUS
Course-II

L T P Cr.
4 0 0 4.0

Course objectives: The primary objective of this course is to introduce the basic tools of calculus and geometric properties of different conic sections which are helpful in understanding their applications in planetary motion.

Derivatives and Applications: Review of Limits, Continuity of functions, differentiability, the first-derivative test for relative extrema, concavity and inflection points, second-derivative test for relative extrema, Curve tracing using first and second derivative test, limits to infinity and infinite limits.

Sketching and Tracing of Curves: Asymptotes in Cartesian coordinates, intersection of curve and its asymptotes, asymptotes in polar coordinates, Curvature, radius of curvature for Cartesian curves, parametric curves, polar curves, Newton’s method, radius of curvature for pedal curves, Tangential polar equations, centre of curvature, circle of curvature, chord of curvature, evolutes, multiple points, Cusp, nodes, conjugate points, types of cusps.

Multivariable Functions: Limits and continuity for functions of several variables, partial derivatives, the chain rule, directional derivatives, gradient vectors, tangent planes, extreme values and saddle points.

Multiple Integrals and Applications: Double integrals, triple integrals, Jacobian, substitutions in multiple integrals, Green’s theorem, Stoke’s theorem and the divergence’s theorem, Quadrature (area) section area, area bounded by closed curves, Volume and surfaces of Revolution, Hyperbolic functions, Reduction formulas.

Recommended Books:

Differential Equations
Course-III

L T P Cr

4 0 0 4.0

Course Objectives: The main objectives of this course are to introduce the students to the exciting world of Differential Equations, exhibit the techniques for obtaining solutions to ordinary differential equations and the basic ideas and theory behind those techniques.


Second and Higher order Differential Equations: Higher-Order Linear Differential Equations: Basic Existence Theorem, The Homogeneous Equation, Wronskian, its properties and applications, reduction of order, the non-homogeneous equation, the homogeneous linear equation with constant coefficients, initial-value problem, the Cauchy-Euler equation, theorems on the second-order homogeneous linear equation, the method of undetermined coefficients, method of variation of parameters.

Power Series solution of Differential Equations: Ordinary points and singular points, power series solution about an ordinary point, power series solution about singular points, the method of Frobenius.

Recommended Books:


Real Analysis
Course-IV

L T P Cr.

4 0 0  4.0

Course Objectives: The course will develop a deep and rigorous understanding of real line and of defining terms to prove the results about convergence and divergence of sequences and series of real numbers. These concepts have wide range of applications in real life scenario.

Real Number System $\mathbb{R}$ and its properties: Algebraic and order properties of $\mathbb{R}$, Absolute value of a real number; Bounded above and bounded below sets, Supremum and infimum of a nonempty subset of $\mathbb{R}$, The completeness property of $\mathbb{R}$, Archimedean property, Density of rational numbers in $\mathbb{R}$, Definition and types of intervals, Nested intervals property, Neighborhood of a point in $\mathbb{R}$, Open and closed sets in $\mathbb{R}$.

Sequences in $\mathbb{R}$: Convergent sequence, Limit of a sequence, Bounded sequence, Limit theorems, Monotone sequences, Monotone convergence theorem, divergent sequence, Subsequences, Bolzano-Weierstrass theorem for sequences, Limit superior and limit inferior for bounded sequence, Cauchy sequence, Cauchy’s convergence criterion.

Infinite Series: Convergence and divergence of infinite series of real numbers, Necessary condition for convergence, Cauchy criterion for convergence; Tests for convergence of positive term series: Integral test, comparison test, D’Alembert’s ratio test, Cauchy’s $n$th root test; Alternating series, Leibniz test, Absolute and conditional convergence.

Recommended Books:


