

Paper No :	Paper Name
<b>Paper 1 :</b>	<b>Calculus</b>
CO1:	<ul style="list-style-type: none"> <li>• Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>• Apply derivatives in Optimization, Social sciences, Physics and Life sciences etc.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>• Compute area of surfaces of revolution and the volume of solids by integrating over cross-sectional areas.</li> </ul>
<b>Paper 2:</b>	<b>Algebra</b>
CO1:	<ul style="list-style-type: none"> <li>• Employ De Moivre's theorem in a number of applications to solve numerical problems.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>• Apply Euclid's algorithm and backwards substitution to find greatest common divisor.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>• Recognize consistent and inconsistent systems of linear equations by the row echelon form of the augmented matrix, using rank.</li> </ul>
CO4:	<ul style="list-style-type: none"> <li>• Find eigenvalues and corresponding eigenvectors for a square matrix.</li> </ul>
<b>Paper 3:</b>	<b>Real Analysis</b>
CO1:	<ul style="list-style-type: none"> <li>• Understand many properties of the real line <math>\mathbb{R}</math> and learn to define sequence in terms of functions from <math>\mathbb{N}</math> to a subset of <math>\mathbb{R}</math>.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>• Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate their limit superior, limit inferior, and the limit of a bounded sequence.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>• Apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.</li> </ul>
<b>Paper 4:</b>	<b>Differential Equations</b>
CO1:	<ul style="list-style-type: none"> <li>• Formulate Differential Equations for various Mathematical models.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>• Solve first order non-linear differential equation and linear differential equations of higher order using various techniques.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>• Apply these techniques to solve and analyze various mathematical models.</li> </ul>

<b>Paper 5:</b>	<b>Theory of Real Functions</b>
CO1:	<ul style="list-style-type: none"> <li>To have a rigorous understanding of the concept of limit of a function.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>The geometrical properties of continuous functions on closed and bounded intervals.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>The applications of mean value theorem and Taylor's theorem.</li> </ul>
<b>Paper 6:</b>	<b>Group Theory-I</b>
CO1:	<ul style="list-style-type: none"> <li>Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, etc;</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>Link the fundamental concepts of Groups and symmetrical figures;</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>Analyze the subgroups of cyclic groups;</li> </ul>
CO4:	<ul style="list-style-type: none"> <li>Explain the significance of the notion of cosets, normal subgroups, and factor groups.</li> </ul>
<b>Paper 7:</b>	<b>Multivariate Calculus</b>
CO1:	<ul style="list-style-type: none"> <li>The conceptual variations when advancing in calculus from one variable to multivariable discussions.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>Inter-relationship amongst the line integral, double and triple integral formulations.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>Applications of multi variable calculus tools in physics, economics, optimization, and understanding the architecture of curves and surfaces in plane and space etc.</li> </ul>
<b>Paper 8:</b>	<b>Skill Enhancement Paper SEC-1: LaTeX and HTML</b>
CO1:	<ul style="list-style-type: none"> <li>Typeset mathematical formulas, use nested list, tabular &amp; array environments.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>Create or import graphics.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>Use beamer to create presentation and HTML to create a web page.</li> </ul>
<b>Paper 9:</b>	<b>Partial Differential Equations</b>
CO1:	<ul style="list-style-type: none"> <li>Formulate, classify and transform partial differential equations into canonical form.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>Solve linear and non-linear partial differential equations using various methods; and apply these methods in solving some physical problems.</li> </ul>
<b>Paper 10:</b>	<b>Riemann Integration &amp; Series of Functions</b>

CO1:	<ul style="list-style-type: none"> <li>Some of the families and properties of Riemann integrable functions, and the applications of the fundamental theorems of integration.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>Beta and Gamma functions and their properties.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>The valid situations for the inter-changeability of differentiability and integrability with infinite sum, and approximation of transcendental functions in terms of power series.</li> </ul>
<b>Paper 11:</b>	<b>Ring Theory &amp; Linear Algebra-I</b>
CO1:	<ul style="list-style-type: none"> <li>The fundamental concept of Rings, Fields, subrings, integral domains and the corresponding morphisms.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>The concept of linear independence of vectors over a field, the idea of a finite dimensional vector space, basis of a vector space and the dimension of a vector space.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>Basic concepts of linear transformations, the Rank-Nullity Theorem, matrix of a linear transformation, algebra of transformations and the change of basis.</li> </ul>
<b>Paper 12:</b>	<b>Skill Enhancement Paper SEC-2: Computer Algebra Systems and Related Software</b>
CO1:	<ul style="list-style-type: none"> <li>Use CAS as a calculator, for plotting functions, animations and various applications of matrices.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>Understand the use of the software <b>R</b> for entry, summary calculation, pictorial representation of data and exploring relationship between data.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>Analyze, test, and interpret technical arguments on the basis of geometry.</li> </ul>
<b>Paper 13:</b>	<b>Metric Spaces</b>
CO1:	<ul style="list-style-type: none"> <li>Understand the basic concepts of metric spaces;</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>Correlate these concepts to their counter parts in real analysis;</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>Appreciate the abstractness of the concepts such as open balls, closed balls, compactness, connectedness etc. beyond their geometrical imaginations.</li> </ul>
<b>Paper 14:</b>	<b>Group Theory-II</b>
CO1:	<ul style="list-style-type: none"> <li>Automorphisms for constructing new groups from the given group.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>External direct product <math>Z_2 + Z_2</math> applies to data security and electric circuits.</li> </ul>

CO3:	<ul style="list-style-type: none"> <li>Group actions, Sylow theorems and their applications to check nonsimplicity.</li> </ul>
<b>Paper 15:</b>	<b>Numerical Analysis</b>
CO1:	<ul style="list-style-type: none"> <li>Some numerical methods to find the zeroes of nonlinear functions of a single variable and solution of a system of linear equations, up to a certain given level of precision.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>Interpolation techniques to compute the values for a tabulated function at points not in the table.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>Applications of numerical differentiation and integration to convert differential equations into difference equations for numerical solutions.</li> </ul>
<b>Paper 16:</b>	<b>Mathematical Modeling and Graph Theory</b>
CO1:	<ul style="list-style-type: none"> <li>The use of mathematics software to observe the implementations of the above mentioned methods efficiently, and to enhance the problem solving skills.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>To solve physical problems using differential equations.</li> </ul>
<b>Paper 17:</b>	<b>C++ Programming for Mathematics</b>
CO1:	<ul style="list-style-type: none"> <li>Understand and apply the programming concepts of C++ which is important to mathematical investigation and problem solving.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>Use mathematical libraries for computational objectives.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>Represent the outputs of programs visually in terms of well formatted text and plots.</li> </ul>
<b>Paper 18:</b>	<b>Probability Theory and Statistics</b>
CO1:	<ul style="list-style-type: none"> <li>Distributions to study the joint behavior of two random variables.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>To establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>Central limit theorem, which helps to understand the remarkable fact that: the empirical frequencies of so many natural populations, exhibit a bell shaped curve.</li> </ul>
<b>Paper 19:</b>	<b>Discrete Mathematics</b>
CO1:	<ul style="list-style-type: none"> <li>Lattices and their types;</li> </ul>

CO2:	<ul style="list-style-type: none"> <li>• Boolean algebra, switching circuits and their applications;</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>• Graphs, their types and its applications in study of shortest path algorithms.</li> </ul>
<b>Paper 20:</b>	<b>Cryptography and Network Security</b>
CO1:	<ul style="list-style-type: none"> <li>• Understand the fundamentals of Cryptography and Network Security, including data and advanced encryption standard (DES &amp; AES), RSA and elliptic curve cryptography.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>• Encrypt and decrypt messages using block ciphers, sign and verify messages using well known signature generation and verification algorithms.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>• Acquire knowledge of standard algorithms that can be used to provide confidentiality, integrity and authentication of data.</li> </ul>
<b>Paper 21:</b>	<b>Complex Analysis</b>
CO1:	<ul style="list-style-type: none"> <li>• Understand the significance of differentiability of complex functions leading to the understanding of Cauchy-Riemann equations.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>• Evaluate the contour integrals and understand the role of Cauchy-Goursat theorem and the Cauchy integral formula.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>• Expand some simple functions as their Taylor and Laurent series, classify the nature of singularities, find residues and apply Cauchy Residue theorem to evaluate integrals.</li> </ul>
<b>Paper 22:</b>	<b>Ring Theory and Linear Algebra-II</b>
CO1:	<ul style="list-style-type: none"> <li>• Appreciate the significance of unique factorization in rings and integral domains.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>• Compute with the characteristic polynomial, eigenvalues, eigenvectors, and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and apply the basic diagonalization result.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>• Compute inner products and determine orthogonality on vector spaces, including Gram-Schmidt orthogonalization to obtain orthonormal basis.</li> </ul>
<b>Paper 22:</b>	<b>Mathematical Finance</b>
CO1:	<ul style="list-style-type: none"> <li>• Financial markets and derivatives including options and futures.</li> </ul>

CO2:	<ul style="list-style-type: none"> <li>• Pricing and hedging of options, interest rate swaps and no-Arbitrage pricing concept.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>• Stochastic analysis (Ito formula and Ito integration) and the Black-Scholes model.</li> </ul>
<b>Paper 23:</b>	<b>Introduction to Information Theory and Coding</b>
CO1:	<ul style="list-style-type: none"> <li>• The output of the channel, a received signal is observed.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>• The detection &amp; correction of errors while transmission.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>• Representation of a linear code by matrices and its encoding and decoding.</li> </ul>
<b>Paper 24:</b>	<b>Biomathematics</b>
CO1:	<ul style="list-style-type: none"> <li>• Learn the development, analysis and interpretation of bio mathematical models.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>• Reinforce the skills in mathematical modeling.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>• Appreciate the theory of bifurcation and chaos.</li> </ul>
CO4:	<ul style="list-style-type: none"> <li>• Learn to apply the basic concepts of probability to molecular evolution and genetics.</li> </ul>
<b>Paper 25:</b>	<b>Number Theory</b>
CO1:	<ul style="list-style-type: none"> <li>• Some of the open problems related to prime numbers, viz., Goldbach conjecture etc.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>• About number theoretic functions and modular arithmetic.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>• Public crypto systems, in particular, RSA.</li> </ul>
<b>Paper 26:</b>	<b>Linear Programming and Applications</b>
CO1:	<ul style="list-style-type: none"> <li>• Analyze and solve linear programming models of real life situations.</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>• The graphical solution of LPP with only two variables, and illustrate the concept of convex set and extreme points. The theory of the simplex method is developed.</li> </ul>
CO3:	<ul style="list-style-type: none"> <li>• The relationships between the primal and dual problems and their solutions with applications to transportation, assignment and two-person zero-sum game problem.</li> </ul>
<b>Paper 27:</b>	<b>Mechanics</b>
CO1:	<ul style="list-style-type: none"> <li>• The significance of mathematics involved in physical quantities and their uses;</li> </ul>
CO2:	<ul style="list-style-type: none"> <li>• To study and to learn the cause-effect related to these; and</li> </ul>

CO3:

- The applications in observing and relating real situations/structures.