MATHEMATICS

Sets and Logic

Set: Representing sets in different ways. Subsets. Different types of sets e.g. universal set, finite or infinite sets, intervals in real line. Various operations on sets. Properties of various operations on sets. Venn diagram. Ordered pairs. Cartesian products.

Relations & functions: Type of relations. Equivalence relation. Functions. Types of functions. Composition of functions, inverse of a function. Real valued functions: algebraic operations of real valued functions, different types of real valued functions (e.g. polynomial, rational, modules, signum, etc), graphical representation of real valued functions.

Basic counting techniques

Permutations and Combinations: Fundamental principles of counting. Factorial n. Permutations and combinations- derivation of formulae and their connections. Applications.

Binomial Theorem: Binomial theorem for positive integral indices. Pascal's triangle. General and middle term in binomial expansion. Applications.

Complex numbers, linear and quadratic equations

Complex Numbers: Motivation for complex numbers. Representation of complex numbers in the plane as a pair of real numbers and their representation of the form a+ib. Polar representation and the Argand plane. Algebra of complex numbers. Modulus and conjugate of a complex number. Statement of the Fundamental Theorem of Algebra.

Quadratic Equations: Quadratic equations and their solutions. Relation between roots and the coefficients of quadratic equations.

Linear Inequalities: Inequalities, Algebraic solution of linear inequalities in one variable and their graphical representation.

Trigonometric functions

Measures of angles and their conversions. Trigonometric functions, identities, and their geometric interpretations. Applications of trigonometric equations. Inverse trigonometric functions and properties. Graphs of trigonometric functions.

Vectors

Vectors and scalars. Magnitude and direction of a vector. Direction cosines/ ratios. Types of vectors. Position vector. Negative and components of a vector. Addition of vectors. Multiplication of a vector by a scalar. Position vector of a point dividing a line segment in the given ratio. Dot and cross products of vectors. Projection of a vector on another vector/ line.

Matrices & determinants

Matrices: Concept, notation, order, equality, transpose of a matrix, types of matrices, simple properties of addition, multiplication, scalar multiplication, and multiplication of matrices. Concept of elementary row and column operations. Invertible matrices and proof of the uniqueness of inverse, if it exists. Applications of matrices.

Determinants: Determinant of a square matrix (up to 3 X 3 matrices), properties of determinants, minors, cofactors, and applications of determinants in finding the area of a triangle. Adjoint and inverse of a square matrix. Applications of determinants.

Coordinate geometry

Cartesian system of rectangular coordinates in a plane. Shifting of origin.

Straight Lines: Slope of a line and angle between two lines. Various forms of equations of a line. General equation of a line. Distance of a point from a line.

Conic Sections: Sections of a cone: Circles, ellipse, parabola, hyperbola, a point, a straight line, and a pair of intersecting lines as a degenerated case of a conic section. Standard equations and simple properties of parabola, ellipse, and hyperbola. Standard equation of a circle, the general form of the equation of a circle.

Three-dimensional geometry

Coordinate axes and planes. Distance between points. Section formula. Direction cosines and direction ratios of a line. Various forms of the equation of a line. Angle between two lines and two planes. Shortest distance between two lines in three-dimensional space. Coplanar and skew line. Cartesian and vector equation of a plane. Distance of a point from a plane.

Sequences & series

Arithmetic and Geometric progressions. Sums of finite and infinite geometric series. Sums of finite terms in arithmetic series. Arithmetic mean (A.M.) and geometric mean (G.M.). Relation between A.M and G.M. Sums of first n-terms of the special series, for example, $\sum n$, $\sum n^2$ and $\sum n^3$.

Limit & continuity

Limits. Continuity. Algebraic properties of limits. Algebraic properties of continuous functions. Limits and continuity of real valued functions, polynomials, rational functions, trigonometric functions, exponential functions, and inverse functions.

Differentiation

Differentiation: Definition of derivative and relating it to slope of tangent of the curve. Derivative of sum, difference, product, and quotient of functions. Derivative of some standard functions e.g. polynomial, trigonometric, inverse trigonometric, exponential, and logarithmic functions. Derivative of composite functions via chain rule. Derivative of implicit functions and functions in parametric forms. Logarithmic derivative. Second order derivatives.

Application of Derivatives: Rate of change, increasing/decreasing functions, tangents and normals maxima and minima.

Integration

Integration: Integration as inverse process of differentiation. Integrals involving algebraic, trigonometric, exponential, and logarithmic functions. Integration of a variety of functions by substitution, by partial fractions, by parts and using trigonometric identities. Evaluation of integrals of some standard types. Fundamental theorem of calculus. Basic properties and evaluation of definite integrals.

Applications of Integration: Finding the area of region under simple curves. Finding the area of the region between two simple curves.

Differential equations

Definition, order, degree. Formation of a differential equation. Solution by separation of variables. Homogeneous differential equation of first order and degree. Solution of the equations dy/dx +P y=Q where P and Q are functions of x or constant and similarly for dx/dy +P x=Q where P and Q are functions of y or constant.

Statistics, Probability & Linear Programming

Statistics: Measure of dispersion; mean deviation, variance, and standard deviation of ungrouped/grouped data.

Probability: Random experiments: outcomes, sample spaces (set representation). Events: Occurrence of events, ‘not’, ‘and’ & ‘or’ events, exhaustive events, mutually exclusive events. Axiomatic (set theoretic) probability. Probability of an event, probability of ‘not’, ‘and’, & ‘or’ events. Multiplication theorem on probability. Conditional probability, independent events, total probability, Baye’s theorem.