MATHEMATICS

Course Structure

Units	Topics	Marks
I	Relations and Functions	10
II	Algebra	13
III	Calculus	44
IV	Vectors and 3-D Geometry	17
V	Linear Programming	6
VI	Probability	10
Total		**100**

Course Syllabus

Unit I: Relations and Functions

Chapter 1: Relations and Functions

- Types of relations:
  - Reflexive
  - Symmetric
  - transitive and equivalence relations
  - One to one and onto functions
  - composite functions
  - inverse of a function
  - Binary operations

Chapter 2: Inverse Trigonometric Functions

- Definition, range, domain, principal value branch
- Graphs of inverse trigonometric functions

- Elementary properties of inverse trigonometric functions

Unit II: Algebra

Chapter 1: Matrices

- Concept, notation, order, equality, types of matrices, zero and identity matrix, transpose of a matrix, symmetric and skew symmetric matrices.
- Operation on matrices: Addition and multiplication and multiplication with a scalar
- Simple properties of addition, multiplication and scalar multiplication
- Noncommutativity of multiplication of matrices and existence of non-zero matrices whose product is the zero matrix (restrict to square matrices of order 2)
- Concept of elementary row and column operations
- Invertible matrices and proof of the uniqueness of inverse, if it exists; (Here all matrices will have real entries).

Chapter 2: Determinants

- Determinant of a square matrix (up to 3 x 3 matrices), properties of determinants, minors, co-factors and applications of determinants in finding the area of a triangle
- Ad joint and inverse of a square matrix
- Consistency, inconsistency and number of solutions of system of linear equations by examples, solving system of linear equations in two or three variables (having unique solution) using inverse of a matrix

Unit III: Calculus

Chapter 1: Continuity and Differentiability

- Continuity and differentiability, derivative of composite functions, chain rule, derivatives of inverse trigonometric functions, derivative of implicit functions
- Concept of exponential and logarithmic functions.
- Derivatives of logarithmic and exponential functions
- Logarithmic differentiation, derivative of functions expressed in parametric forms. Second order derivatives
- Rolle's and Lagrange's Mean Value Theorems (without proof) and their geometric interpretation

Chapter 2: Applications of Derivatives

- Applications of derivatives: rate of change of bodies, increasing/decreasing functions, tangents and normal, use of derivatives in approximation, maxima and minima (first derivative test motivated geometrically and second derivative test given as a provable tool)
- Simple problems (that illustrate basic principles and understanding of the subject as well as real-life situations)

Chapter 3: Integrals

- Integration as inverse process of differentiation
- Integration of a variety of functions by substitution, by partial fractions and by parts
- Evaluation of simple integrals of the following types and problems based on them

$\int \frac{dx}{x^2 \pm a^2}, \int \frac{dx}{\sqrt{x^2 \pm a^2}}, \int \frac{dx}{\sqrt{a^2 - x^2}}, \int \frac{dx}{ax^2+bx+c}, \int \frac{dx}{\sqrt{ax^2+bx+c}}$

$\int \frac{px+q}{ax^2+bx+c} dx, \int \frac{px+q}{\sqrt{ax^2+bx+c}} dx, \int \sqrt{a^2 \pm x^2}\, dx, \int \sqrt{x^2 - a^2}\, dx$

$\int \sqrt{ax^2 + bx + c}\, dx, \int (px + q)\sqrt{ax^2 + bx + c}\, dx$

- Definite integrals as a limit of a sum, Fundamental Theorem of Calculus (without proof)
- Basic properties of definite integrals and evaluation of definite integrals

Chapter 4: Applications of the Integrals

- Applications in finding the area under simple curves, especially lines, circles/parabolas/ellipses (in standard form only)
- Area between any of the two above said curves (the region should be clearly identifiable)

Chapter 5: Differential Equations

- Definition, order and degree, general and particular solutions of a differential equation
- Formation of differential equation whose general solution is given
- Solution of differential equations by method of separation of variables solutions of homogeneous differential equations of first order and first degree
- Solutions of linear differential equation of the type:
    - dy/dx + py = q, where p and q are functions of x or constants
    - dx/dy + px = q, where p and q are functions of y or constants

Unit IV: Vectors and Three-Dimensional Geometry

Chapter 1: Vectors

- Vectors and scalars, magnitude and direction of a vector

- Direction cosines and direction ratios of a vector
- Types of vectors (equal, unit, zero, parallel and collinear vectors), position vector of a point, negative of a vector, components of a vector, addition of vectors, multiplication of a vector by a scalar, position vector of a point dividing a line segment in a given ratio
- Definition, Geometrical Interpretation, properties and application of scalar (dot) product of vectors, vector (cross) product of vectors, scalar triple product of vectors

Chapter 2: Three - dimensional Geometry

- Direction cosines and direction ratios of a line joining two points
- Cartesian equation and vector equation of a line, coplanar and skew lines, shortest distance between two lines
- Cartesian and vector equation of a plane
- Angle between:
  - Two lines
  - Two planes
  - A line and a plane
- Distance of a point from a plane

Unit V: Linear Programming

Chapter 1: Linear Programming

- Introduction
- Related terminology such as:
  - Constraints
  - Objective function
  - Optimization
  - Different types of linear programming (L.P.) Problems
  - Mathematical formulation of L.P. Problems
  - Graphical method of solution for problems in two variables

- Feasible and infeasible regions (bounded and unbounded)
- Feasible and infeasible solutions
- Optimal feasible solutions (up to three non-trivial constraints)

Unit VI: Probability

Chapter 1: Probability

- Conditional probability
- Multiplication theorem on probability
- Independent events, total probability
- Baye's theorem
- Random variable and its probability distribution
- Mean and variance of random variable
- Repeated independent (Bernoulli) trials and Binomial distribution