Miranda House

Department of Mathematics

DEPARTMENT OF MATHEMATICS

Generic Elective offered by the Department

Generic Elective papers offered for students enrolled in various Honours courses

Semester	Paper Name
I	Calculus
II	Linear Algebra
III	Differential equations (with practical)/Linear programming and game theory
IV	Numerical Methods(with practical)/Elements of analysis

Generic Elective papers for B.A. Programme

Semester	Paper Name
V	General Mathematics-1
VI	General mathematics-2

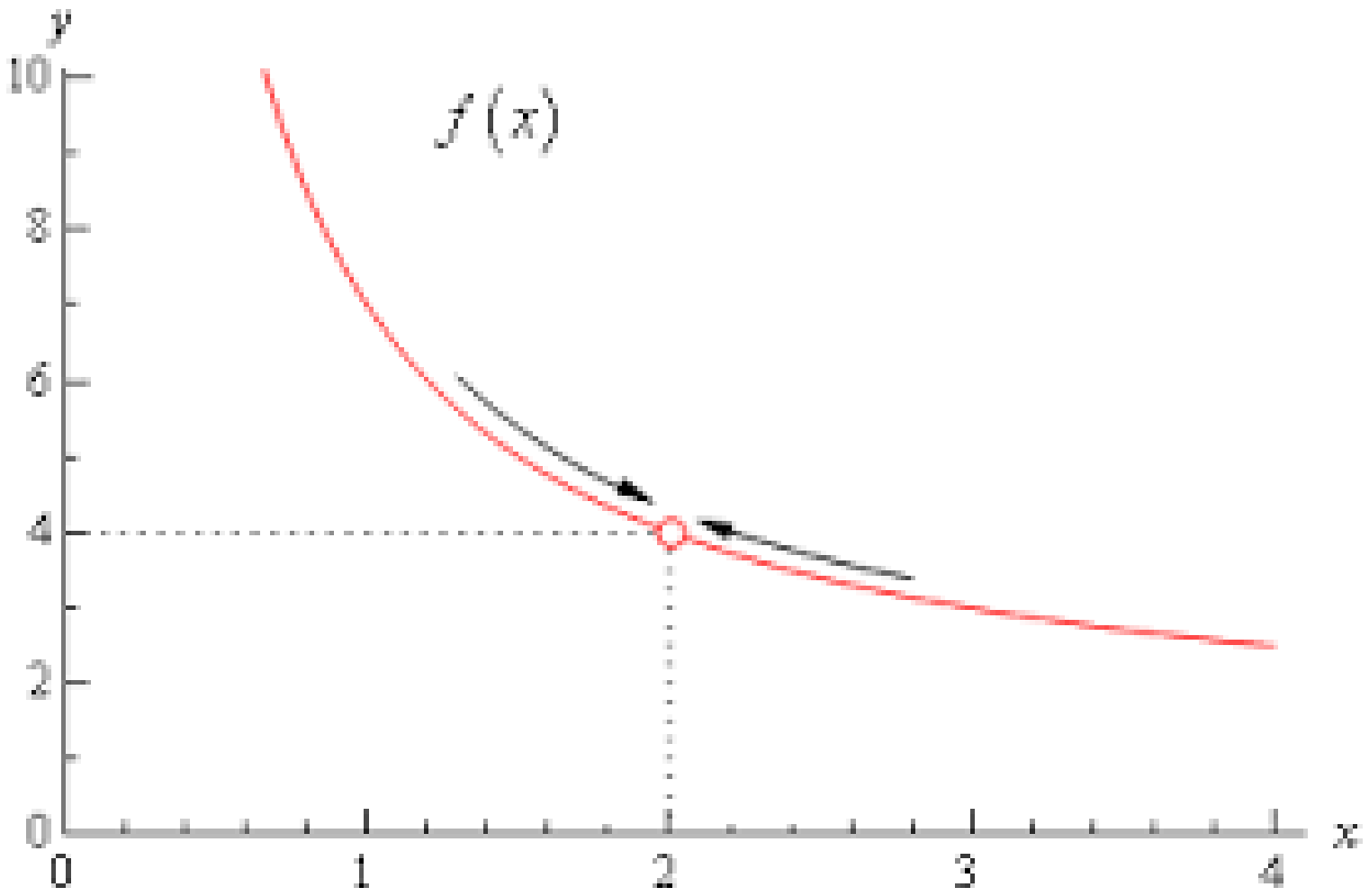
For any query contact

Dr. Daulti Verma

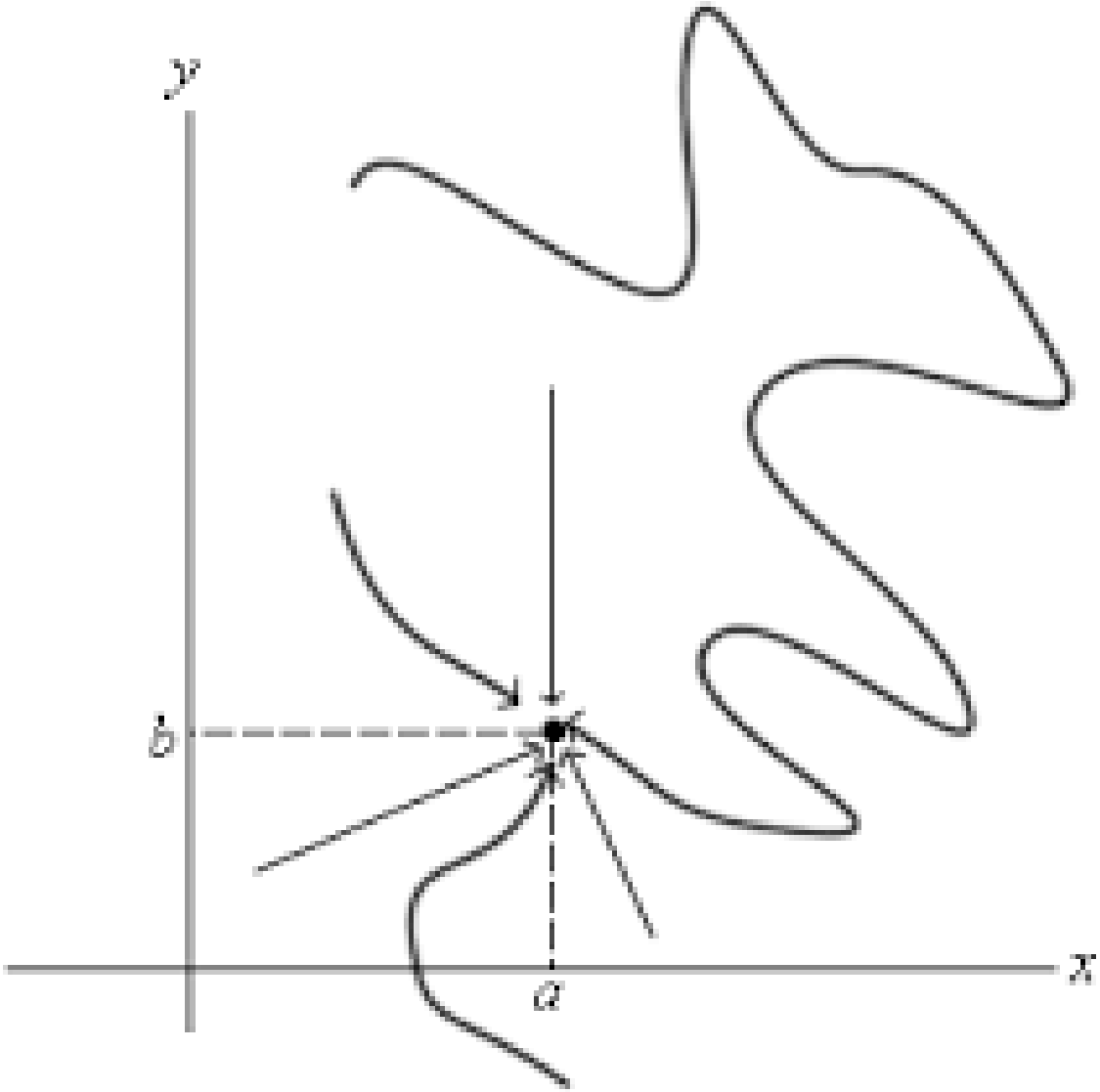
Phone No. :9910712722

Email ID : daulti.verma@mirandahouse.ac.in

Limit in one variable



Limit in two variables



Unit 1: Applications of Derivatives and Limits

The first derivative test, Concavity and inflection points, Second derivative test, Curve sketching using first and second derivative test; Limits at infinity, Horizontal asymptotes, Vertical asymptotes, Graphs with asymptotes; L'Hôpital's rule.

Unit 2: Applications of Definite Integrals

Volumes by slicing, Volumes of solids of revolution by the disk method, Volumes of solids of revolution by the washer method, Volume by cylindrical shells, Length of plane curves, Arc length of parametric curve, Area of surface of revolution.

Unit 3: Conics, Vector-Valued Functions and Partial Derivatives

Techniques of sketching conics, Reflection properties of conics; Polar coordinates, graphing in polar coordinates; Vector-valued functions: Limits, Continuity, Derivatives, Integrals, Arc length, Unit tangent vector, Curvature, Unit normal vector; Functions of several variables: Graphs and level curves, Limits and continuity, Partial derivatives and differentiability, The chain rule, Directional derivatives and gradient vectors, Tangent plane and normal line, Extreme values and saddle points.

Unit 1: Euclidean space Rn and Matrices

Fundamental operation with vectors in Euclidean space Rn , Linear combination of vectors, Dot product and their properties, Cauchy–Schwarz inequality, Triangle inequality, Projection vectors, Some elementary results on vectors in Rn, Matrices: Gauss–Jordan row reduction, Reduced row echelon form, Row equivalence, Rank, Linear combination of vectors, Row space, Eigenvalues, Eigenvectors, Eigenspace, Characteristic polynomials, Diagonalization of matrices; Definition and examples of vector spaces, Some elementary properties of vector spaces, Subspace, Span, Spanning set for an eigenspace, Linear independence and linear dependence of vectors, Basis and dimension of a vector space, Maximal linearly independent sets, Minimal spanning sets; Application of rank: Homogenous and non-homogenous systems of linear equations; Coordinates of a vector in ordered basis, Transition matrix.

Unit 2: Linear Transformations and Computer Graphics

Linear transformations: Definition and examples, Elementary properties, The matrix of a linear transformation, Linear operator and similarity; Application: Computer graphics, Fundamental movements in a plane, Homogenous coordinates, Composition of movements; Kernel and range of a linear transformation, Dimension theorem, One to one and onto linear transformations, Invertible linear transformations, Isomorphism, Isomorphic vector spaces to Rn .

Unit 3: Orthogonality and Least Square Solutions

Orthogonal and orthonormal vectors, Orthogonal and orthonormal bases, Orthogonal complement, Projection theorem, Orthogonal projection onto a subspace; Application: Least square solutions for inconsistent systems, Non-unique least square solutions.

Unit 1: Ordinary Differential Equations and Applications
First order exact differential equations, Integrating factors and rules to find integrating factors, Linear equations and Bernoulli equations, Orthogonal trajectories and oblique trajectories, Basic theory of higher order linear differential equations, Wronskian and its properties; Solving differential equation by reducing its order.

Unit 2. Explicit Methods of Solving Higher-Order Linear Differential Equations
Linear homogenous equations with constant coefficients, Linear non-homogenous equations, Method of undetermined coefficients, Method of variation of parameters, CauchyEuler equations; Simultaneous differential equations.

Unit 3. First and Second Order Partial Differential Equations
Partial differential equations: Basic concepts and definitions. Mathematical problems; First order equations: Classification, Construction, Geometrical interpretation; Method of characteristics, General solutions of first order partial differential equations; Canonical forms and method of separation of variables for first order partial differential equations; Classification of second order partial differential equations; Reduction to canonical forms; Second order partial differential equations with constant coefficients, General solutions.

Unit 1. Linear Programming Problem, Simplex Method and Duality

Graphical method of solution, Basic feasible solutions, Linear programming and convexity; Introduction to the simplex method: Theory of the simplex method, Optimality and unboundedness; Simplex tableau and examples, Artificial variables; Introduction to duality, Formulation of the dual problem with examples and interpretations, Duality theorem.

Unit 2. Transportation and Assignment Problems Definition and mathematical formulation of transportation problems, Methods of finding initial basic feasible solutions, North West corner rule, Least-cost method, Vogel's approximation method, Algorithm for solving transportation problems; Mathematical formulation and Hungarian method of solving assignment problems.

Unit 3. Two-Person, Zero-Sum Games

Introduction to game theory, Formulation of two-person zero-sum rectangular game, Solution of rectangular games with saddle points, Mixed strategies, Dominance principle, Rectangular games without saddle points, Graphical and linear programming solution of rectangular games.

Unit 1: Errors and Roots of Transcendental and Polynomial Equations Floating point representation and computer arithmetic, Significant digits; Errors: Roundoff error, Local truncation error, Global truncation error; Order of a method, Convergence and terminal conditions; Bisection method, Secant method, RegulaFalsi method, NewtonRaphson method.

Unit 2: Algebraic Linear Systems and Interpolation Gaussian elimination method (with row pivoting), GaussJordan method; Iterative methods: Jacobi method, GaussSeidel method; Interpolation: Lagrange form, Newton form, Finite difference operators, GregoryNewton forward and backward difference interpolations, Piecewise polynomial interpolation (linear and quadratic).

Unit 3:Numerical Differentiation, Integration and ODE

Numerical differentiation: First and second order derivatives, Richardson extrapolation method; Numerical integration: Trapezoidal rule, Simpson's rule; Ordinary differential equation: Euler's method, Modified Euler's methods (Heun's and midpoint)

Unit 1. Real umbers and Sequences Finite and infinite sets, Examples of countable and uncountable sets; Absolute value and the Real line, Bounded sets, Suprema and infima, The completeness property of , Archimedean property of ; Real sequences, Convergence, sum and product of convergent sequences, Order preservation and squeeze theorem; Monotone sequences and their convergence; Proof of convergence of some simple sequences. Subsequences and the BolzanoWeierstrass theorem; Limit superior and limit inferior of a bounded sequence; Cauchy sequences, Cauchy convergence criterion for sequences.

Unit 2. Infinite Series of Real numbers Definition and a necessary condition for convergence of an infinite series, Geometric series, Cauchy convergence criterion for series; Positive term series, Integral test, Convergence of pseries, Comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's root test; Alternating series, Leibniz test; Absolute and conditional convergence.

Unit 3. Power Series and Elementary Functions Definition of power series, Radius and interval of convergence, CauchyHadamard theorem, Statement and illustration of term-by-term differentiation, Integration of power series, and Abel's theorem, Power series expansions for ^{x} , $sinx$, $cosx$, $log(1+x)$ and their properties.

Generic Elective Papers for BA Prog.

Unit 1: Biographies of Ancient Indian Mathematicians

A brief introduction to the lives and information on the works of the following mathematicians: Aryabhata, Varahamihira, Brahmagupta, Bhaskara I & II, Mahavira, Madhava, and Paramesvara.

Unit 2: Number Systems

An overview of number systems, Algebraic and transcedental numbers with some historical background, Fundamental arithmetic operations, Rules of divisibility, Hierarchy of operations and Modular arithmetic, Euclidean algorithm, Prime numbers, The sieve of Eratosthenes, Fundamental theorem of arithmetic, Euclid's lemma, Fermat numbers, Mersenne numbers and Mersenne primes, prime testing method of Fermat, Statement and significance of the prime number theorem, Goldbach conjuctures, Twin primes, Uses of prime numbers, Perfect and amicable numbers, Pythagoreans triplets and its properties, Statement and historic background of Fermat's last theorem, Multiplication principle, Permutation and combinations, Latin squares and magic squares.

Unit 3: Matrices and Determinants

Matrices, Basic concepts and algebraic operations, Types of matrices, Transpose of a matrix, Symmetric and skew-symmetric matrices, Matrix multiplication and its properties, Powers of square matrices, Inverse square matrix and its properties, Determinant and its properties, Expansion by rows and columns, Cofactors, Matrix singularity, Adjoint matrix and calculation of inverse, Cramer's rule.

Unit 1: Biographies of Remarkable Mathematicians

A brief introduction to the lives and information on the works of the following mathematicians: Euler, Lagrange, Gauss, Cauchy, Abel, Galois, Riemann, Hardy, Noether, Ramanujan, von Neumann, Wiles, and Bhargava.

Unit 2: Functions, Perspective Geometry, Symmetry and Fractals

Basics of graph theory, Königsberg bridge problem, Four-color map problem, Möbius strip, Klein bottle. Introduction of functions, Graphs of functions, Increasing and decreasing functions, Even and odd functions, Location of points of extrema, Inflection, Periodic functions – all via graphs. Perspective and Projection, Perspective geometry: Lines and points in 2D and 3D, Fundamental trigonometric functions, Use of perspective in drawing, Historic background, Common tools adopted by artists for such representations, Analysis of some paintings to spot uses of perspective and projection techniques. Types of symmetry, Concrete examples of symmetry groups, Study of symmetry and patterns by looking at monuments/buildings/ornamental art, Fibonacci sequences in nature, Golden ratio, Golden triangle. Shapes and solids, Basic tilings, The regular polyhedron, Importance of Platonic solids and mystical significance to the ancient Greeks; Fractals in nature, Snowflake curves, Sierpinski triangle.

Unit 3: Solving Systems of Linear Equations using Matrices
Solving systems of linear equations, Gaussian elimination method and row operations, Consistent and inconsistent system, GaussJordon row reduction and reduced row echelon form, Homogenous system, Equivalent systems and row equivalence of matrices, Rank of a matrix, Relation between homogenous system and rank.

Thank You