MDC

Multidisciplinary Courses (MDC)

offered by

Department of Mathematics

(wef 2025-26)

Central University of Haryana, Mahendergarh

Index

Title: **Introduction To Calculus**

Code: **MAT 110 MD 40**

LTPC: 3104

Objectives*: To understand basic concepts and applications of Calculus: understand concepts of limit, continuity, differentiability, and integration. To develop a basic level of competency in modern mathematical skills.*

Outcomes: *After going through this course the students will be able to*

- *Calculate the limit and examine the continuity of a function at a point.*
- *Understand the consequences of various mean value theorems for differentiable functions.*
- *Sketch curves in Cartesian and polar coordinate systems.*
- *Apply integration and differential equations in social sciences, physical sciences, life sciences and a host of other disciplines.*

Contents:

Unit-I: Functions and Limits (14)

- **Functions:** Introduction to functions, their graphs, and different types of functions.
- **Limits:** Understanding limits of functions, left and right-hand limits, and limits at infinity.
- **Continuity:** Definition of continuity, properties of continuous functions, and the Intermediate Value Theorem

Unit-II: Differentiability (16)

- **Definition of Derivative:** Introduction to the concept of a derivative as the rate of change of a function.
- **Basic Differentiation Rules:** Power rule, product rule, quotient rule, and chain rule for differentiation.
- **Applications of Derivatives:** Finding maximum and minimum values of functions, Rolle's theorem, and the Mean Value Theorem

Unit-III: Integration (16)

- **Indefinite Integrals:** Introduction to the concept of indefinite integrals and their properties.
- **Definite Integrals:** Understanding definite integrals and their relationship to area under a curve.
- **Fundamental Theorem of Calculus:** Connecting differentiation and integration through the Fundamental Theorem of Calculus.
- **Integration Techniques:** Substitution, integration by parts, and trigonometric substitutions

Unit-IV: Applications of Calculus (14)

- **Area and Volume:** Calculating areas between curves and volumes of solids of revolution.
- **Curve Sketching:** Using derivatives to analyze the behavior of functions and sketch their graphs.
- **Optimization Problems:** Solving optimization problems using calculus.
- **Differential Equations:** Introduction to differential equations and methods for solving simple differential equations.

References:

1.George B. Thomas Jr., R L Finney. Calculus and Analytical Geometry (14th ed.). Pearson **(Textbook**).

2. Howard Anton, I. Bivens & Stephan Davis (2016). Calculus (10th ed.). Wiley, India

3. Gabriel Klambauer (1986). Aspects of Calculus. Springer-Verlag.

4. Wieslaw Krawcewicz & Bindhyachal Rai (2003). Calculus with Maple Labs. Narosa.

Title: **Introduction To Numerical Methods**
Code: **MAT 120 MD 40**
LTPC**: 3104**

Objectives: The course objective is to acquaint the students with a wide range of numerical methods to solve algebraic and transcendental equations, linear system of equations, interpolation and curve fitting problems, numerical integration, initial and boundary value problems, etc.

Outcomes: After completing this course, students will be able to:
- Measure computational errors including absolute, relative, and round-off errors.
- Apply numerical methods to find approximate solutions for complex mathematical problems.
- Solve nonlinear equations, systems of linear equations, interpolation problems.
- Analyze the convergence, advantages, and limitations of various numerical techniques.

Contents:

Unit I (16)
Errors in approximation: absolute, relative, and percentage errors, round-off error. Solution of algebraic and transcendental equations: Bisection method, Regula Falsi method, Secant method, Method of Iteration, Newton-Raphson method, order of convergence. Systems of simultaneous equations: Gauss elimination method, Gauss-Jordan method, LU decomposition method, Iterative methods: Jacobi method and Gauss-Seidel method.

Unit II (14)
Finite differences, Interpolation techniques for equal intervals: Newton forward and backward, Gauss forward and backward, Stirling, and Bessel formulas, Interpolation with unequal intervals: Newton's divided difference method, Lagrange method, Hermite interpolation, Power method for solving eigenvalue problems.

Unit III (16)
Numerical differentiation using Newton forward and backward formulae, Numerical integration: Newton-Cotes formulas, Trapezoidal rule, Simpson's rule, Gauss-Legendre and Gauss-Chebyshev formulas, Romberg's integration, Curve fitting: straight line fitting, parabolic fitting, exponential curve fitting, and other curve models, Cubic splines.

Unit IV (14)
Solution of ordinary differential equations: Taylor series method, Picard's method, Euler method, Modified Euler method, Runge–Kutta methods, Milne's and Adam's predictor-corrector methods. Finite difference methods for boundary value problems.

References:

1. Gupta, R. K. *Numerical Methods: Fundamentals and Applications.* 1st edition, Cambridge University Press, 2019.
2. Thangaraj, P. *Computer Oriented Numerical Methods*. PHI Learning Pvt. Ltd, 2013.
3. Jain, M. K., Iyengar, S. R. K. and Jain, R. K. *Numerical Methods for Scientific & Engineering Computation*. New Age International, 2012.
4. Burden R.L. and Faires J. D. *Numerical Analysis*. 9th Edition, Cengage Learning, 2011.
5. Chapra, S. C. and Canale, R. P. *Numerical Methods for Engineers*. McGraw Hill, International Edition, 1998.
6. Mathews, J. H. *Numerical Methods for Mathematics, Science and Engineering*. Prentice- Hall, International Editions, 1992.

Title: **Basic Mathematics For Social Sciences**
Code**: MAT 130 MD 40**
LTPC**: 3104**

Objectives: The main objective is to develop a working knowledge of the basic Mathematics for social sciences and will present some of the ideas that form the foundation of quantitative work in the social sciences. In particular, topics from logarithm, set theory, matrix theory and calculus will be discussed with emphasis on the understanding of concepts and the development of intuition.

Outcomes: After completing this course, students are expected to learn the following:

- Explain the fundamental concepts of indices, logarithms, and antilogarithms and their role in basic mathematics for social science.
- Demonstrate the efficient use of set theory and Venn diagrams.
- Understand and use terms such as function, relation and permutations and combinations.
- Understand the concepts and properties of limits, continuity, differentiation, logical reasoning.

Contents:

Unit I (15):

Binary numbers, indices, logarithms and antilogarithms, laws and properties of logarithms, simple applications of logarithms and antilogarithms, numerical problems on averages, calendar, clock, time, work and distance, mensuration, seating arrangement, sets, types of sets, Venn diagrams, De Morgan's laws, problem solving using Venn diagrams, relations and types of relations.

Unit II (15):

Introduction to sequences, series, arithmetic and geometric progression, relationship between AM and GM. Basic concepts of permutations and combinations, standard results of permutations and combinations. Introduction to functions – domain and range of a function, types of functions (polynomial, rational, logarithmic, exponential, modulus, greatest integer, signum functions), graphical representation of functions.

Unit III (15):

Concept of limits and continuity of a function, instantaneous rates of change, differentiation as a process of finding derivatives, derivatives of algebraic functions using the chain rule. Mathematically acceptable statements, connecting words/phrases in mathematical statements consolidating the understanding of "if and only if" (necessary and sufficient condition), "implies", "and/or", "implied by", "there exists" and their use through real-life and mathematical examples. Logical reasoning problems (coding-decoding, odd man out, blood relations, syllogism, etc.).

Unit IV (15):

Random experiment, sample space, events, mutually exclusive events, independent and dependent events, law of total probability, Bayes' Theorem. Data on various scales (nominal, ordinal, interval, and ratio scale), data representation and visualization, data interpretation (dispersion, deviation, variance, skewness, and kurtosis), percentile rank and quartile rank, correlation (Pearson and Spearman methods of correlation), applications of descriptive statistics using real-time data.

References:

1. Gill J. *Essential Mathematics for Political and Social Research*, Cambridge University Press, 2016.
2. Haeussler E., Paul R. and Wood R. *Introductory Mathematical Analysis for Business, Economics, and the Life and Social Sciences*, 15th edition. Prentice-Hall, 2015.
3. Goldstein L., Lay D., and Schneider D. *Calculus and Its Applications*, 14th Edition. Prentice Hall, 2014.
4. Hagle T. *Basic Math for Social Scientists*: Problems and Solutions, 1996.
5. Kleppner D. and Ramsey N. *Quick Calculus*. Wiley, 1995
6. Namboodiri K. *Matrix Algebra: An Introduction*. Sage Publications # 38, 1994.

Title: **Introduction To Mathematical Analysis**
Code: **MAT 140 MD 40**
LTPC: **3104**

Objectives: The course will develop a deep and rigorous understanding of sets and functions, and defining terms to prove the results on convergence of sequences and series, defining limit, continuity, differentiability and their geometrical representation. These concepts have wide range of applications in real life.

Outcomes: After completing this course, students are expected to:

- Understand properties of sets and relations, including finite and countable sets.
- Define and classify functions (algebraic, transcendental, even/odd, periodic) and interpret them geometrically.
- Define sequences and understand their convergence, including working with series.
- Recognize and interpret limit, continuity, and differentiability both analytically and geometrically.

Contents:

Unit I (15):

Sets – finite and infinite sets, countability, relations – void, universal, reflexive, symmetric, transitive, equivalence relations; complex numbers – graphic representation, properties, polar form, de Moivre's theorem.

Unit II (15):

Functions – domain, co-domain, range; classification of real functions – algebraic and transcendental; even, odd, and periodic functions; graphs of important functions.

Unit III (15):

Sequences and convergence; series and convergence; quadratic equations – roots and nature of roots.

Unit IV (15):

Limits – definitions, fundamental theorems, evaluating limits, left/right-hand limits; continuity – at a point and on intervals; differentiability – at a point and on intervals; geometric interpretation.

References:

1. Walter, R. *Principles of Mathematical Analysis*. 3rd edition, McGraw-Hill, 2017.
2. Ram, B. *Discrete Mathematics*. Pearson Education, 2012.
3. Malik, S. C. and Arora, S. *Mathematical Analysis*. 2nd edition, New Age International Publishers, 2005.
4. Somasundram, D. and Chaudhary, B. *A First Course in Mathematical Analysis*. Narosa Publishing House, 1996.
5. Royden, H. L. *Real Analysis*. 4th edition, Macmillan Publishing Co., New York, 1993.

Title: **Introductory Linear Algebra**
Code: **MAT 210 MD 40**
LTPC: **3104**

Objectives: To give a brief introduction of vector spaces, matrix algebra and determinant, which can be used for further applications in various fields of interest.

Outcomes: After completing this course, students would be able to

- Use the concept of system of linear equations and find its solutions
- Understand the notion of Matrix operations (addition, multiplication), Transpose, symmetric matrices
- Describe the concepts of the terms basis, dimension, and apply these concepts to various vector spaces and subspaces
- Compute Eigenvalues and Eigenvectors

Contents:

Unit I (15): Matrix Algebra and Determinant
Matrix operations (addition, multiplication), Transpose, symmetric matrices, Identity and inverse of a matrix, Elementary matrices, Invertibility and its conditions, Partitioned matrices. Definition and properties, Cofactor expansion, Determinants and invertibility, Cramer's Rule, Applications of determinants

Unit II (15): Systems of Linear Equations
Systems of equations and augmented matrices, Gaussian elimination, Row echelon form and reduced row echelon form (RREF), Solutions to homogeneous and non-homogeneous systems, Rank and existence of solutions

Unit III (15): Vectors and Vector Spaces
Vectors in R^n, Vector operations (addition, scalar multiplication), Linear combinations, Span and linear dependence/independence, Subspaces, Basis and dimension, Row space, column space, null space.

Unit IV (15): Eigenvalues and Eigenvectors
Eigenvalues and Eigenvectors, Definitions and geometric interpretation, Characteristic equation, Diagonalization of matrices, Similar matrices, Applications in systems of differential equations

References:

1. Hoffman, K. and Kunze, R. *Linear Algebra*. 2nd edition, Pearson India, 2015.
2. Axler, S. *Linear Algebra Done Right*. 2nd edition, Springer-Verlag, 2014.
3. Lang, S. *Linear Algebra*. 3rd edition, Springer-Verlag, New York, 2013.
4. Lipschutz, S. and Lipson, M. *Linear Algebra*. 3rd edition, Tata McGraw-Hill, 2005.
5. Friedberg, S. H., Insel, A. J. and Spence, L. E. *Linear Algebra*. 4th edition, 2002.
6. David C. Lay *"Linear Algebra and Its Applications"*. Pearson, 2022
7. Gilbert Strang *"Introduction to Linear Algebra"*. Wellesley-Cambridge Press, 2016