UNIVERSITY OF LUCKNOW

DEPARTMENT OF MATHEMATICS & ASTRONOMY

YEAR WISE SYLLABUS OF FOUR YEAR U.G. PROGRAM IN MATHEMATICS

UNDER

NATIONAL EDUCATION POLICY 2020

(EFFECTIVE FROM SESSION 2024-25 ONWARDS)

Paper 1: Differential Calculus

Credit: 4   **T: 04**

Course Outcomes:

1. Know the concepts of calculus, namely, limits, continuity, differentiability of functions of one and two variables and their applications in the form of mean value theorem and Taylor's theorem.
2. Sketch curves in a plane using its mathematical properties in the different coordinate systems of reference.
3. Get knowledge of curvature, asymptotes, envelopes and evolutes.

UNIT I

Limit, continuity and differentiability of function of single variable, Cauchy's definition, Heine's definition, Uniform continuity, Borel's theorem, boundedness theorem, Bolzano's theorem, Intermediate value theorem, extreme value theorem, Darboux's intermediate value theorem for derivatives, Chain rule, indeterminate forms.

UNIT II

Rolle's theorem, Lagrange and Cauchy Mean value theorems, mean value theorems of higher order, Taylor's theorem with various forms of remainders, Successive differentiation, Leibnitz theorem, Maclaurin's and Taylor's series,

Limit and Continuity of functions of two variables, Differentiation of function of two variables, Necessary and sufficient condition for differentiability of functions two variables.

UNIT III

Partial differentiation, Euler's theorem on homogeneous function, Schwarz's and Young theorem, Taylor's theorem for functions of two variables with examples, Maxima and minima for functions of two variables, Lagrange multiplier method, Jacobians, Inverse function theorem and implicit function theorem.

UNIT IV

Tangents and normals, Asymptotes, Curvature, Envelops and evolutes, Tests for concavity and convexity, Points of inflexion, Multiple points, Parametric representation of curves and tracing of parametric curves, Tracing of curves in Cartesian and Polar forms.

References:

Text Books:

1. T.M. Apostol, Calculus Vol. I, John Wiley & Sons Inc.
2. S. Balachandra Rao, C. K. Shantha, Differential Calculus, New Age Publication.

Suggested Reading:

1. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc.,2002.
2. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.

Web References:
1. Digital platforms web links: NPTEL/SWAYAM/ MOOCS/Openstax.org
2. https://openlearninglibrary.mit/edu/courses
3. http://heecontent.upsdc.gov.in/SearchContent.aspx
4. https://www.lkouniv.ac.in/en/article/e-content-faculty-of-science

Paper 2: Matrices and Algebra

Credit: 4   **T:04**

Course Outcomes:

1. Find the rank and eigen values of matrices.
2. Study the system of linear homogeneous and non-homogeneous equations.
3. Recognize the mathematical objects that are groups, and classify them as abelian, cyclic and permutation groups, etc.
4. Link the fundamental concepts of Groups and symmetrical figures.
5. Analyze the subgroups of cyclic groups.
6. Explain the significance of the notion of cosets, normal subgroups, and factor group.
7. Understand the concepts of rings, subrings and fields.

UNIT I

Elementary operations on matrices, Rank of a matrix, Echelon and normal form of a matrix, Inverse of a matrix by elementary operations, System of linear homogeneous and non-homogeneous equations, Theorems on consistency of a system of linear equations. Eigen values, Eigen vectors and characteristic equation of a matrix, Cayley-Hamilton theorem and its use in finding inverse of a matrix.

UNIT II

Equivalence relations and partitions, Congruence modulo n, Definition of a group with examples and simple properties, Subgroups, Generators of a group, Cyclic groups, Coset decomposition, Lagrange's theorem and its consequences, Fermat and Euler theorems. Normal subgroups, Quotient groups.

UNIT III

Homomorphism and isomorphism, Fundamental theorem of homomorphism, Theorems on isomorphism, Permutation groups, Even and odd permutations, The alternating group, Cayley's theorem, Direct products.

UNIT IV

Rings, types of rings (commutative rings, rings with unity, division rings, Integral domains and fields) with examples, basic properties, sub-rings, Characteristic of a ring, Ideals and quotient rings, Ring homomorphism, Isomorphism theorems, Field of quotient of an integral domain, polynomial rings.

References:

Text Books:

1. Linear Algebra by K. Hoffman and R. Kunze.
2. V. Sahai and V. Bist, Algebra, Narosa

Suggested Readings:

1. J.B. Fraleigh, A First Course in Abstract Algebra, Pearson
2. I.N. Herstein, Topics in Algebra, John Wiley & Sons

Web References:
1. Digital platforms web links: NPTEL/SWAYAM/ MOOCS/Openstax.org
2. https://openlearninglibrary.mit/edu/courses
3. http://heecontent.upsdc.gov.in/SearchContent.aspx
4. https://www.lkouniv.ac.in/en/article/e-content-faculty-of-science

Paper Q1: Applicable Mathematics– I

Credit: 2   **T:02**

Course Outcomes:

1. To compute the rank of a matrix and its applications in finding solutions of system of equations, computing Eigen values and Eigen vectors and their applications.

2. To Know the concepts of calculus, namely, limits, continuity, differentiability of functions and their applications in the form of mean value theorem and Taylor's theorem.

UNIT I

Types of matrices, elementary operations on matrices, rank of a matrix, echelon and normal forms of a matrix, inverse of a matrix by elementary operations, systems of linear homogeneous and non - homogeneous equations, consistency of linear system of equations.

UNIT II

Eigenvalues, eigenvectors and characteristic equation of a square matrix, Cayley-Hamilton theorem and its application in finding the inverse of a matrix.

UNIT III

Limit, continuity and differentiability of functions of single variable, successivedifferentiation, Leibnitz's theorem, Rolle's theorem, Lagrange's and Cauchy's mean value theorems, Taylor's and Maclaurins's series.

UNIT IV

Limit, continuity and differentiability of functions of two variables, partial derivatives, Euler's theorem for homogeneous functions, Jacobian.

References:

Textbooks
1. Linear Algebra by K. Hoffman and R. Kunze.
2. Calculus, Volumes I & II by T. M. Apostol.
3. Mathematical Analysis by S.C. Malik and S. Arora, New Age International Limited, New Delhi.

Suggested Books
1. R. R. Goldberg : Methods of Real Analysis, Oxford & IBH Pub. Co. Pvt. Ltd.
2. R. G. Bartle, The Elements of Real Analysis, Wiley International Edition.

Co-Curricular Course in Mathematics

Paper CC-1: Elementary Number Theory
(Pre-requisites: Mathematics in Class 12)

Credit: 2   **T:02**

Course Objectives:

1. To introduce the student to basic concepts of number theory.
2. To identify and apply various properties of and relating to the integers.
3. To apply number theoretic algorithms in cryptography.

Course Outcomes:

At the end of this course students will be able to:

1. Solve problems in elementary number theory.
2. Study certain number theoretic functions and their properties.
3. Understand the concept of congruence and related theorems.
4. Apply linear congruences in cryptography.

UNIT I

GCD, Euclid algorithm for finding GCD, Extended Euclid algorithm, Prime numbers and their properties, Prime number theorem.

UNIT II

Congruence and its properties, Linear Congruence, Chinese Remainder theorem, Fermat's theorem, Euler's theorem, Wilson's theorem,

UNIT III

Primality testing algorithm, Discrete logarithm, Some factorization algorithms.

UNIT IV

Some algebraic structure: Group, Ring and Field, Finite fields and their construction.

Recommended Books:

1. Elementary Number Theory, Burton, Mc Graw Hill.