

SEMESTER-I

COURSE 1: DIFFERENTIAL EQUATIONS

Theory M-MA1-1301(4) Credits: 4

5 hrs/week

Course Objectives

1. To introduce the concepts and methods for solving first-order differential equations, including exact, linear, and Bernoulli equations.
2. To understand special types of first-order differential equations such as Clairaut's equations and those solvable for p , x or y .
3. To develop techniques for solving higher-order linear differential equations with constant coefficients.
4. To apply the operator method for finding particular integrals of non-homogeneous differential equations with various types of right-hand side functions.
5. To learn the method of variation of parameters for solving non-homogeneous differential equations.

Course Outcomes

After successful completion of the course, the student will be able to

1. Solve exact differential equations, linear equations, Bernoulli's equations, and equations reducible to exact form using integrating factors.
2. Analyze and solve first-order differential equations that are solvable for p , x , and y , including Clairaut's equations.
3. Solve homogeneous and non-homogeneous linear differential equations of higher order with constant coefficients using operator methods.
4. Compute particular integrals for non-homogeneous equations when the right-hand side is a polynomial, exponential, or trigonometric function.
5. Solve non-homogeneous differential equations using the method of variation of parameters and other applicable techniques.

Unit – 1

Exact Differential Equations - Integrating factors - Equations reducible to Exact Equations by

Integrating Factors (i) $\frac{1}{Mx + Ny}$ (ii) $\frac{1}{Mx - Ny}$ - Linear Differential Equations – Bernoulli's

Equations

Unit – 2

Equations solvable for p , Equations solvable for y , Equations solvable for x – Clairaut's equation

Unit – 3

Solutions of homogeneous linear differential equations of second and higher order with constant coefficients $f(D)y = 0$ - Solutions of non-homogeneous linear differential equations $f(D)y = Q(x)$ of second order with constant coefficients by means of polynomial operators (i) $Q(x) = b e^{ax}$ where b is a real constant - (ii) $Q(x) = \sin ax$ (or) $\cos ax$ where a is a real constant.

Unit – 4

Solution to a non-homogeneous linear differential equations of second order with constant coefficients by means of polynomial operators $Q(x) = b x^k$, $Q(x) = e^{ax} V$, where V is a function of x .

Unit – 5

Solution of the non-homogeneous linear differential equations of second order with constant coefficients by means of polynomial operators $Q(x) = x V$, where V is a function of x – Problems on Method of Variation of parameters to find solutions of linear differential equations with variable coefficients.

Activities

The activities planned throughout the Differential Equations course include a variety of interactive and evaluative methods such as quizzes, assignments, seminars, and student presentations. Students will also engage in a mini project, prepare concept flowcharts, and participate in operator method chart activities. Peer teaching sessions, LMS-based online quizzes, and board work challenges will foster collaborative and digital learning. Additionally, poster presentations on applications and visual aids like chalk talks will be incorporated to support diverse learning styles and deepen conceptual clarity.

Text Book

Differential Equations and Their Applications by Zafar Ahsan, published by Prentice-Hall of India Pvt. Ltd, New Delhi-Second edition.

Reference Books

1. Ordinary and Partial Differential Equations by Dr. M.D. Raisinghanian, published by S. Chand & Company, New Delhi.
2. Differential Equations with applications and programs – S. Balachandra Rao & HR Anuradha- Universities Press.
3. Differential Equations -Srinivas Vangala & Madhu Rajesh, published by Spectrum University

SEMESTER-I

COURSE 2: SOLID GEOMETRY

Theory M-MA2-1301(3) Credits: 4

5 hrs/week

Course Objectives

1. To introduce fundamental concepts of planes, lines, and spheres in 3D geometry.
2. To develop analytical skills for deriving equations of planes, lines, and spheres in different forms.
3. To analyze geometric relationships, including angles, distances, and intersections between lines, planes, and spheres.
4. To study advanced properties of spheres, such as tangents, polar planes, and orthogonality conditions.
5. To apply geometric principles to solve problems involving coplanarity, shortest distances, and sphere-line/plane interactions.

Course Outcomes

After completing this course, students will be able to

1. Derive and interpret equations of planes and lines in various forms.
2. Compute angles, distances, and intersection conditions between geometric elements (lines, planes, spheres).
3. Determine coplanarity of lines and solve problems involving shortest distances in 3D space.
4. Analyse sphere-related problems, including tangents, intersections, and circle equations in 3D.
5. Apply advanced concepts like polar planes, conjugate points, and orthogonality conditions of spheres.

Course Content

Unit – 1

Equation of plane in terms of its intercepts on the axis - Equations of the plane through the given points - Length of the perpendicular from a given point to a given plane - Bisectors of angles between two planes - Combined equation of two planes

Unit – 2

Equation of a line in various forms - Angle between a line and a plane - The condition that a given line may lie in a given plane - The condition that two given lines are coplanar - Number of arbitrary constants in the equations of straight line - Sets of conditions which determine a line

Unit – 3

The shortest distance between two skew lines - The length and equations of the line of shortest distance between two skew lines - Length of the perpendicular from a given point to a given line.

Unit – 4

Definition and equation of the sphere - Equation of the sphere through four given points - Plane sections of a sphere - Intersection of two spheres - Equation of a circle - Sphere through a given circle - Intersection of a sphere and a line

Unit – 5

Power of a point - Tangent plane - Plane of contact; Polar plane - Pole of a Plane - Conjugate points - Conjugate planes - Angle of intersection of two spheres - Conditions for two spheres to be orthogonal - Radical Plane – Coaxial system of spheres-Limiting Points.

Activities

The activities include quizzes, assignments, seminars, and student presentations. Additional tasks involve mini projects, concept flowcharts, operator method charts, peer teaching, LMS-based quizzes, board work challenges, poster presentations, and visual aids like chalk talks to enhance learning and engagement.

Text Book

Analytical Solid Geometry by Shanti Narayan and P.K. Mittal, published by S. Chand & Company Ltd. 7th Edition.

Reference Books

1. A text Book of Analytical Geometry of Three Dimensions, by P.K. Jain and Khaleel Ahmed, published by Wiley Eastern Ltd., 1999.
2. Co-ordinate Geometry of two and three dimensions by P. Balasubrahmanyam, K.Y. Subrahmanyam, G.R. Venkataraman published by Tata McGraw - Hill Publishers.
3. Solid Geometry by B. Rama Bhupal Reddy, published by Spectrum University Press.

Course Objectives

1. To introduce students to the foundational concepts of algebraic structures with a focus on groups.
2. To develop an understanding of subgroups, cosets, and their relevance in group theory.
3. To explore the properties and significance of normal subgroups and their role in constructing quotient groups.
4. To study and apply the concepts of group homomorphisms, isomorphisms, and the fundamental theorem of homomorphism.
5. To examine the structure and properties of permutation and cyclic groups, including their role in group classification.

Course Outcomes

After successful completion of this course, the student will be able to

1. Understand the definition and basic properties of groups, including finite and infinite groups, and construct composition tables.
2. Analyze subgroups and cosets, apply Lagrange's Theorem, and understand the structure of a group through its subgroups.
3. Identify and verify normal subgroups, and understand their role in forming quotient groups.
4. Understand and apply homomorphisms and isomorphisms, including the fundamental homomorphism theorem and its applications.
5. Work with permutations, transpositions, and cyclic groups, and understand their properties and significance in group theory, including Cayley's Theorem.

Course Content**Unit – 1**

Binary Operation – Algebraic structure – Semi group - Monoid – Group definition and its elementary properties - Finite and Infinite groups – examples – order of a group - Composition tables with examples.

Unit – 2

Definition of Complex – Multiplication of two complexes- Inverse of a complex- Definition of Subgroup - examples-Criterion for a complex to be a subgroup- Criterion for the product of two subgroups to be a subgroup-Union and Intersection of subgroups – Definition of Cosets – Properties of Cosets – Index of a subgroup of a finite group – Lagrange's Theorem.

Unit – 3

Normal Subgroups - Definition of normal subgroup – Proper and improper normal subgroups – Hamilton group- Criterion for a subgroup to be a normal subgroup – Intersection of two normal subgroups - Sub group of index 2 is a normal sub group

Unit – 4

Quotient groups - Definition of homomorphism – Image of a homomorphism- Elementary properties of homomorphisms – Isomorphism – Automorphism- Definitions and elementary properties–Kernel of a homomorphism – Fundamental theorem of Homomorphism and applications.

Unit – 5

Definition of permutation –Multiplication of Permutations– Inverse of a permutation – Cyclic permutations – Transposition – Even and odd permutations – Cayley’s theorem - Cyclic Groups - Definition of cyclic group – Elementary properties

Activities

The activities include quizzes, assignments, seminars, and student presentations. Additional tasks involve mini projects, concept flowcharts, operator method charts, peer teaching, LMS-based quizzes, board work challenges, poster presentations, and visual aids like chalk talks to enhance learning and engagement.

Text Book

Modern Algebra by A.R.Vasishtha and A.K. Vasishtha, Krishna Prakashan Media Pvt. Ltd., Meerut.

Reference Books

1. Abstract Algebra by J.B. Fraleigh, Published by Narosa publishing house.
2. Modern Algebra by M.L. Khanna, Jai Prakash and Co. Printing Press, Meerut
3. Rings and Linear Algebra by Pundir & Pundir, published by Pragathi Prakashan

Course Objectives

1. To develop a strong foundation in the real number system and its axiomatic structure.
2. To introduce the concepts of order, bounds, completeness, and related foundational properties of real numbers.
3. To explore the properties of sets in real analysis, including neighborhoods, limit points, open and closed sets.
4. To build analytical skills in handling sequences, convergence criteria, and monotonicity.
5. To understand the behavior of infinite series and apply standard convergence tests effectively.

Course Outcomes

After successful completion of this course, the student will be able to

1. Understand the real number system, its axioms, and properties, including completeness, supremum, and infimum.
2. Apply the Archimedean property, denseness, and concepts of neighborhoods, limit points, and derived sets in problem-solving.
3. Analyze sequences for boundedness and convergence using definitions and the Cauchy criterion.
4. Understand the concept of subsequences, apply the Bolzano-Weierstrass theorem, and test convergence using Cauchy's general principle.
5. Determine the convergence of infinite series using various tests and solve related analytical problems.

Course Content**Unit – 1**

Real number system - Field axioms – Properties of real numbers - Order axioms – Properties of Order relation - Principle of induction - Extended real number system – Modulus of a real number – Properties of modulus – Triangle property - Aggregates – Finite and infinite aggregates – Boundedness of an aggregate – Least upper bound (supremum) and greatest lower bound (infimum) of an aggregate – Properties of boundedness – Completeness axiom – Dedekind's theorem - Theorem on Dedekind's axiom and completeness axiom.

Unit – 2

Archimedean Property - Its corollaries – Integral part of a real number - Denseness of the real number system – Intervals – Neighbourhood of a point - Limit point of an aggregate – Derived Set - Bolzano - Weierstrass theorem – Interior point of a set - Open and closed Sets – Its properties (without proofs) - Countable and uncountable sets - Properties of countable sets.

Unit – 3

Sequences – Operations of sequences - Subsequences - Range and Boundedness of Sequences - Limit of a sequence and Convergent sequence – Divergent sequence – Uniqueness of a limit – Sandwich theorem on sequences - Monotone sequences - Problems

Unit – 4

Limit Point of a Sequence - Bolzano-Weierstrass theorem on subsequences – Cauchy Sequences – Cauchy's general principle of convergence - Problems

Unit – 5

Infinite Series – Convergence and divergence of series - Cauchy's general principle of convergence for series – Series of non-negative terms - Convergence of geometric series – p series test - comparison test – D'Alembert's ratio test – Cauchy's n^{th} root test – problems.

Activities

The activities include quizzes, assignments, seminars, and student presentations. Additional tasks involve mini projects, concept flowcharts, operator method charts, peer teaching, LMS-based quizzes, board work challenges, poster presentations, and visual aids like chalk talks to enhance learning and engagement.

Text Book

An Introduction to Real Analysis by Robert G. Bartle and Donald R. Sherbert, John Wiley and sons Pvt. Ltd

Reference Books

1. Elements of Real Analysis by Shanthi Narayan and Dr. M.D. Raisinghania, S. Chand & Company Pvt. Ltd., New Delhi.
2. Principles of Mathematical Analysis by Walter Rudin, McGraw-Hill Ltd.

fundamental theorem on homomorphisms. (K3 & K4)

CO5: Define permutations and understand their multiplication, Explain the concept of cyclic permutations, Differentiate between even and odd permutations, State Cayley's theorem.

(K1 & K2)

Course Content:

Unit – 1

Groups:

Binary Operation – Algebraic structure – semi group-monoid – Group definition and elementary properties Finite and Infinite groups – examples – order of a group, Composition tables with examples.

Unit – 2:

Sub Groups

Complex Definition – Multiplication of two complexes - Inverse of a complex-Subgroup definition-examples-criterion for a complex to be a subgroups-Criterion for the product of two subgroups to be a subgroup-union and Intersection of subgroups. Coset Definition – Properties of Cosets – Index of a subgroups of a finite groups – Lagrange's Theorem.

Unit – 3:

Normal Subgroups:

Normal Subgroups: Definition of normal subgroup – proper and improper normal subgroup–Hamilton group- Criterion for a subgroup to be a normal subgroup – intersection of two normal subgroups, Sub group of index 2 is a normal sub group

Unit – 4 :

Homomorphisms:

Quotient groups, Definition of homomorphism – Image of homomorphism elementary properties of homomorphism – Isomorphism – automorphism definitions and elementary properties–kernel of a homomorphism – fundamental theorem on Homomorphism and applications.

Unit – 5:

Permutations and Cyclic Groups:

Definition of permutation – permutation multiplication – Inverse of a permutation – cyclic permutations – transposition – even and odd permutations – Cayley's theorem.

Cyclic Groups - Definition of cyclic group – elementary properties – classification of cyclic groups.

Activities:

Seminar/ Quiz/ Assignments/ Applications of Group Theory to Real life Problem /Problem Solving Sessions.

Text Book:

Modern Algebra by A.R. Vasishtha and A.K. Vasishtha, Krishna Prakashan Media Pvt. Ltd., Meerut.

Reference Books:

1. Abstract Algebra by J.B. Fraleigh, Published by Narosa publishing house.
2. Modern Algebra by M.L. Khanna, Jai Prakash and Co. Printing Press, Meerut
3. Rings and Linear Algebra by Pundir&Pundir, published by PragathiPrakashan

PRACTICAL SYLLABUS

Course Objectives: To enable the students to –

- CO1:** Recall the definition of a group and its basic properties, Explain the difference between a semigroup, a monoid, and a group, interpret composition tables to understand group operations (K1 & K2)
- CO2:** Verify whether a given subset satisfies the subgroup criteria, Determine whether the intersection or union of two subgroups is also a subgroup, Investigate the properties of cosets and their significance, Explore the implications of Lagrange's Theorem on subgroup sizes. (K3 & K4)
- CO3:** Formulate the definition of a normal subgroup, Differentiate between proper and improper normal subgroups, Assess the impact of normal subgroups on group structure, Analyse the intersection of two normal subgroups. (K5 & K6)
- CO4:** Construct examples of homomorphisms, Investigate the properties of images and kernels. Evaluate the impact of isomorphisms and automorphisms on group structures, Understand the significance of the fundamental theorem on homomorphisms. (K3 & K4)
- CO5:** Recall the definition of permutations and their basic properties, Identify cyclic permutations. Explain the significance of even and odd permutations, Understand the role of Cayley's theorem in group theory. (K1 & K2)

Course Outcomes: After successful completion of this course, the student will be able to

- CO1:** Apply theoretical / analytical /statistical knowledge gained in various courses of B.Sc to solve numerical problems based on real life situations during practical and Draw meaningful solutions to day-to-day problems
- CO2:** Define a group and explain its fundamental properties, Understand the concept of order within a group, Describe the algebraic structure of a semigroup and a monoid, Explain the composition tables for groups (K1 & K2)
- CO3:** Determine whether a given subset is a subgroup of a group, Apply the criterion for the product of two subgroups to be a subgroup, Analyse the properties of cosets and their relationship to subgroups, Calculate the index of a subgroup using Lagrange's Theorem. (K3 & K4)
- CO4:** Define a normal subgroup and distinguish between proper and improper normal subgroups, Apply the criterion for a subgroup to be normal, Evaluate the intersection of two normal

subgroups, Understand the concept of normal subgroups in group theory. (K5 & K6)

CO5: Define a homomorphism between groups, Understand the image and kernel of a Homomorphism, Explore the properties of isomorphisms and automorphisms, Apply the fundamental theorem on homomorphisms. (K3 & K4)

CO6: Define permutations and understand their multiplication, Explain the concept of cyclic permutations, Differentiate between even and odd permutations, State Cayley's theorem. (K1 & K2)

Course Content:

Unit – 1

Groups:

Binary Operation – Algebraic structure – semi group-monoid – Group definition and elementary properties Finite and Infinite groups – examples – order of a group, Composition tables with examples.

Unit – 2:

Sub Groups

Complex Definition – Multiplication of two complexes - Inverse of a complex-Subgroup definition-examples-criterion for a complex to be a subgroups-Criterion for the product of two subgroups to be a subgroup-union and Intersection of subgroups. Coset Definition – Properties of Cosets – Index of a subgroups of a finite groups – Lagrange's Theorem.

Unit – 3:

Normal Subgroups:

Normal Subgroups: Definition of normal subgroup – proper and improper normal subgroup–Hamilton group- Criterion for a subgroup to be a normal subgroup – intersection of two normal subgroups, Sub group of index 2 is a normal sub group

Unit – 4 :

Homomorphisms:

Quotient groups, Definition of homomorphism – Image of homomorphism elementary properties of homomorphism – Isomorphism – automorphism definitions and elementary properties–kernel of a homomorphism – fundamental theorem on Homomorphism and applications.

Unit – 5:

Permutations and Cyclic Groups:

Definition of permutation – permutation multiplication – Inverse of a permutation – cyclic

permutations – transposition – even and odd permutations – Cayley's theorem.

Cyclic Groups - Definition of cyclic group – elementary properties – classification of cyclic groups.

Activities:

Seminar/ Quiz/ Assignments/ Applications of Group Theory to Real life Problem /Problem Solving Sessions.

Text Book:

Modern Algebra by A.R. Vasishtha and A.K. Vasishtha, Krishna Prakashan Media Pvt. Ltd., Meerut.

Reference Books:

1. Abstract Algebra by J.B. Fraleigh, Published by Narosa publishing house.
2. Modern Algebra by M.L. Khanna, Jai Prakash and Co. Printing Press, Meerut
3. Rings and Linear Algebra by Pundir&Pundir, published by PragathiPrakashan

(Major)

Course Objectives: To enable the students to –

- CO1:** Apply the concept of finite differences to express any function value in terms of leading terms and differences, Utilize the E and D operators to manipulate finite differences, Investigate the properties of factorial notation and its role in expressing missing terms, Analyse the relations between Δ , ∇ , and E operators. (K3 & K4)
- CO2:** Derive Newton–Gregory forward and backward interpolation formulas, Solve interpolation problems with equal and unequal intervals, Explore the concept of divided differences and their significance, Understand the properties of Lagrange's interpolation. (K3 & K4)
- CO3:** Compute central difference operators such as (δ), (μ), and (σ), Apply Gauss forward formula for equal intervals, Investigate the practical implications of Stirling's and Bessel's formulas, Understand the relationship between central difference operators. (K3 & K4)
- CO4:** Determine an initial approximate value for solving algebraic and transcendental equations, Implement bisection method, Regula Falsi method, and Newton–Raphson method, Evaluate the efficiency and accuracy of different root-finding techniques, Understand the convergence behavior of iterative methods. (K3 & K4)
- CO5:** Apply least-squares curve fitting procedures, Fit data using a straight line and explore nonlinear curve fitting, Construct curve fits by combining sums of exponentials, Develop practical skills in curve fitting. (K3 & K6)

Course Outcomes: Students will be able to

- CO1:** Express function values using finite differences, Understand the fundamental theorem of difference calculus. (K3 & K4)
- CO2:** Implement Newton–Gregory interpolation techniques, Utilize divided differences and

Lagrange's method for interpolation. (K3 & K4)

CO3: Calculate central difference operators and apply them in interpolation, Utilize Gauss forward and backward formulas. (K3 & K4)

CO4: Solve given equations using bisection, Regula Falsi, and Newton–Raphson methods.(K3 & K4)

CO5: Perform least-squares fitting for various types of data. (K3)

Course Content:

Unit – I: The Calculus of Finite Differences:

The operators Δ, ∇, E - Fundamental theorem of difference calculus- properties of Δ, ∇, E and problems on them to express any value of the function in terms of the leading terms and the leading differences - relations between E and D - relation between D and Δ - problems on one or more missing terms- Factorial notation- problems on separation of symbols- problems on Factorial notation.

Unit – II: Interpolation with Equal and Unequal Intervals:

Derivations of Newton – Gregory Forward and backward interpolation and problems on them - Divided differences, Newton divided difference formula, Lagrange's and problems on them.

Unit – 3: Central Difference Interpolation formulae:

Central Difference operators δ, μ, σ and relation between them - Gauss forward formula for equal intervals - Gauss Backward formula - Stirling's formula - Bessel's formula and problems on the above formulae.

Unit – 4: Solution of Algebraic and Transcendental Equation:

Method for finding initial approximate value of the root - Bisection method - to find the solution of given equations by using (i) Regula Falsi method (ii) Iteration method (iii) Newton – Raphson's method and problems on them.

Unit – 5: Curve Fitting:

Least-squares curve fitting procedures - fitting a straight line-nonlinear curve fitting-curve fitting by a sum of exponentials

Activities:

Seminar/ Quiz/ Assignments/ Applications of Numerical methods to Real life Problem /Problem Solving Sessions.

Text Book:

Numerical Analysis by G. Shanker Rao, New Age International Publications

Reference Books:

1. Applied Numerical Analysis by Curtis F. Gerald and Patrick O. Wheatley, Pearson,(2003)
7th Edition
2. Introductory Methods of Numerical Analysis by S.S. Sastry, (6th Edition) PHI New Delhi
2012
3. Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S .R. K.
Iyengar and R. K. Jain, New Age International Publishers (2012), 6th edition.

ST. JOSEPH'S COLLEGE FOR WOMEN (AUTONOMOUS), VISAKHAPATNAM

III SEMESTER

MATHEMATICS

TIME: 2 HRS/WEEK

M-Ma2-3352(3)

NUMERICAL METHODS

MAX. MARKS: 50

w.e.f AK 2023-2024 (Admitted batch) PRACTICAL SYLLABUS

(Major)

Course Objectives: To enable the students to –

CO1: Apply the concept of finite differences to express any function value in terms of leading terms and differences, Utilize the E and D operators to manipulate finite differences, Investigate the properties of factorial notation and its role in expressing missing terms, Analyse the relations between Δ , ∇ , and E operators. (K3 & K4)

CO2: Derive Newton–Gregory forward and backward interpolation formulas, Solve interpolation problems with equal and unequal intervals, Explore the concept of divided differences and their significance, Understand the properties of Lagrange's interpolation. (K3 & K4)

CO3: Compute central difference operators such as (δ), (μ), and (σ), Apply Gauss forward formula for equal intervals, Investigate the practical implications of Stirling's and Bessel's formulas, Understand the relationship between central difference operators. (K3 & K4)

CO4: Determine an initial approximate value for solving algebraic and transcendental equations, Implement bisection method, Regula Falsi method, and Newton–Raphson method, Evaluate the efficiency and accuracy of different root-finding techniques, Understand the convergence behavior of iterative methods. (K3 & K4)

CO5: Apply least-squares curve fitting procedures, Fit data using a straight line and explore nonlinear curve fitting, Construct curve fits by combining sums of exponentials, Develop practical skills in curve fitting. (K3 & K6)

Course Outcomes: Students will be able to

CO1: Apply theoretical / analytical /statistical knowledge gained in various courses of B.Sc to solve numerical problems based on real life situations during practicals and draw meaningful solutions to day-to-day problems

CO2: Express function values using finite differences, Understand the fundamental theorem of

difference calculus. (K3 & K4)

CO3: Implement Newton–Gregory interpolation techniques, Utilize divided differences and Lagrange’s method for interpolation. (K3 & K4)

CO4: Calculate central difference operators and apply them in interpolation, Utilize Gauss forward and backward formulas. (K3 & K4)

CO5: Solve given equations using bisection, Regula Falsi, and Newton–Raphson methods. (K3 & K4)

CO6: Perform least-squares fitting for various types of data. (K3)

Course Content:

Unit – I: The Calculus of Finite Differences:

The operators Δ, ∇, E - Fundamental theorem of difference calculus- properties of Δ, ∇, E and problems on them to express any value of the function in terms of the leading terms and the leading differences - relations between E and D - relation between D and Δ - problems on one or more missing terms- Factorial notation- problems on separation of symbols- problems on Factorial notation.

Unit – II: Interpolation with Equal and Unequal Intervals:

Derivations of Newton – Gregory Forward and backward interpolation and problems on them - Divided differences, Newton divided difference formula, Lagrange’s and problems on them.

Unit – 3: Central Difference Interpolation formulae:

Central Difference operators δ, μ, σ and relation between them - Gauss forward formula for equal intervals - Gauss Backward formula - Stirling’s formula - Bessel’s formula and problems on the above formulae.

Unit – 4: Solution of Algebraic and Transcendental Equation:

Method for finding initial approximate value of the root - Bisection method - to find the solution of given equations by using (i) Regula Falsi method (ii) Iteration method (iii) Newton – Raphson’s method and problems on them.

Unit – 5: Curve Fitting:

Least-squares curve fitting procedures - fitting a straight line-nonlinear curve fitting-curve fitting by a sum of exponentials

Activities:

Seminar/ Quiz/ Assignments/ Applications of Numerical methods to Real life Problem /Problem Solving Sessions.

Text Book:

Numerical Analysis by G. Shanker Rao, New Age International Publications

Reference Books:

1. Applied Numerical Analysis by Curtis F. Gerald and Patrick O. Wheatley, Pearson,(2003) 7th Edition
2. Introductory Methods of Numerical Analysis by S.S. Sastry, (6th Edition) PHI New Delhi 2012
3. Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S .R. K. Iyengar and R. K. Jain, New Age International Publishers (2012), 6th edition.

Course Content:

Unit – I: LAPLACE TRANSFORMS – I

Definition of Laplace Transform - Linearity Property - Piecewise Continuous Function - Existence of Laplace Transform - Functions of Exponential order and of Class A.

Unit – II: LAPLACE TRANSFORMS – II

First Shifting Theorem, Second Shifting Theorem, Change of Scale Property, Laplace transform of the derivative of $f(t)$, Initial value theorem and Final value theorem.

Unit – III: LAPLACE TRANSFORM – III

Laplace Transform of Integrals - Multiplication by t , Multiplication by tn - division by t - Laplace transform of Bessel Function - Laplace Transform of Error Function - Laplace transform of Sine and Cosine integrals.

Unit – IV: INVERSE LAPLACE TRANSFORMS – I

Definition of Inverse Laplace Transform - Linearity Property - First Shifting Theorem - Second Shifting Theorem - Change of Scale property - use of partial fractions - Examples.

Unit – V: INVERSE LAPLACE TRANSFORMS – II

Inverse Laplace transforms of Derivatives - Inverse Laplace Transforms of Integrals - Multiplication by Powers of 'p' - Division by powers of 'p' - Convolution Definition - Convolution Theorem - proof and Applications - Heaviside's Expansion theorem and its applications.

Activities:

Seminar/ Quiz/ Assignments/ Applications of Laplace Transforms to Real life Problem /Problem Solving Sessions.

Text Book:

LaPlace Transforms by A. R. Vasishtha, Dr. R. K. Gupta, Krishna Prakashan Media Pvt. Ltd., Meerut.

Reference Books:

1. Introduction to Applied Mathematics by Gilbert Strang, Cambridge Press
2. Laplace and Fourier's transforms by Dr. J. K. Goyal and K.P. Gupta, Pragathi Prakashan, Meerut.

Course Objectives: To enable the students to –

- CO1:** Apply the definition of Laplace transform to transform functions from the time domain to the Laplace domain, Utilize the linearity property of Laplace transforms. **(K3)**
- CO2:** Apply the shifting theorems and change of scale property in Laplace transforms, Utilize Laplace transforms to find derivatives and evaluate initial and final values. **(K3)**
- CO3:** Compute Laplace transforms of integrals and functions involving multiplication by (t) and (t^n) , Understand the Laplace transforms of special functions such as Bessel functions, error functions, and sine/cosine integrals. **(K2 & K3)**
- CO4:** Utilize the inverse Laplace transform to transform functions back from the Laplace domain to the time domain, Apply the shifting theorems and change of scale property in inverse Laplace transforms. **(K3)**
- CO5:** Compute inverse Laplace transforms of derivatives and integrals, Understand the concept of convolution and its application in inverse Laplace transforms. **(K3)**
- Course Outcomes:** After successful completion of this course, the student will be able to
- CO1:** Apply theoretical / analytical /statistical knowledge gained in various courses of B.Sc to solve numerical problems based on real life situations during practical and draw meaningful solutions to day-to-day problems. **(K3)**
- CO2:** Compute Laplace transforms for piecewise continuous functions, Determine the existence of Laplace transforms for functions of exponential order. **(K3)**
- CO3:** Use Laplace transforms to analyse shifted and scaled functions, Apply the initial value theorem and final value theorem. **(K3 & K4)**
- CO4:** Evaluate Laplace transforms involving integrals and special functions, Apply Laplace transforms to solve problems related to Bessel functions and other special functions. **(K3 & K5)**
- CO5:** Compute inverse Laplace transforms using partial fractions and shifting theorems, solve problems related to inverse Laplace transforms **(K3)**
- CO6:** Evaluate inverse Laplace transforms involving derivatives and integrals, Apply the convolution theorem and Heaviside's expansion theorem. **(K3 & K5)**

Course Content:

Unit – I: LAPLACE TRANSFORMS – I

Definition of Laplace Transform - Linearity Property - Piecewise Continuous Function - Existence of Laplace Transform - Functions of Exponential order and of Class A.

Unit – II: LAPLACE TRANSFORMS – II

First Shifting Theorem, Second Shifting Theorem, Change of Scale Property, Laplace transform of the derivative of $f(t)$, Initial value theorem and Final value theorem.

Unit – III: LAPLACE TRANSFORMS – III

Laplace Transform of Integrals - Multiplication by t , Multiplication by tn - division by t - Laplace transform of Bessel Function - Laplace Transform of Error Function - Laplace transform of Sine and Cosine integrals.

Unit – IV: INVERSE LAPLACE TRANSFORMS – I

Definition of Inverse Laplace Transform - Linearity Property - First Shifting Theorem - Second Shifting Theorem - Change of Scale property - use of partial fractions - Examples.

Unit – V: INVERSE LAPLACE TRANSFORMS – II

Inverse Laplace transforms of Derivatives - Inverse Laplace Transforms of Integrals - Multiplication by Powers of 'p' - Division by powers of 'p' - Convolution Definition - Convolution Theorem - proof and Applications - Heaviside's Expansion theorem and its applications.

Activities:

Seminar/ Quiz/ Assignments/ Applications of Laplace Transforms to Real life Problem /Problem Solving Sessions.

Text Book:

Laplace Transforms by A. R. Vasishtha, Dr. R. K. Gupta, Krishna Prakashan Media Pvt. Ltd., Meerut.

Reference Books:

1. Introduction to Applied Mathematics by Gilbert Strang, Cambridge Press
2. Laplace and Fourier's transforms by Dr. J. K. Goyal and K.P. Gupta, Pragathi Prakashan, Meerut.

properties of Hermite Polynomials and recurrence relations.

(Unit-III: K3 & K4)

CO4: Solve Bessel equation and write the Bessel equation of first kind of order n , also find the generating function for Bessel function understand the orthogonal properties of

Bessel function. **(Unit-IV: K3 & K4)**

CO5: Find power series solutions of ordinary differential equations. **(Unit-V: K3)**

Course Syllabus

Unit-1: Beta and Gamma functions, Chebyshev polynomials

1. Euler's Integrals - Beta and Gamma Functions, Elementary properties of Gamma Functions, Transformation of Gamma Functions.
2. Another form of Beta Function, Relation between Beta and Gamma Functions.
3. Chebyshev polynomials, Orthogonal properties of Chebyshev polynomials, Recurrence relations, Generating functions for Chebyshev polynomials.

(Chapter 2.9 – 2.15 and 8.1 – 8.8)

Unit-2: Legendre polynomials

1. Definition, Solution of Legendre's equation, Legendre polynomial of degree 'n', Generating function of Legendre polynomials.
2. Definition of $P_n(x)$ and $Q_n(x)$, General solution of Legendre's Equation (derivations not required) to show that $P_n(x)$ is the coefficient of h^n , in the expansion of $(1-2xh+h^2)^{-1/2}$
3. Orthogonal properties of Legendre's polynomials, Recurrence formulas for Legendre's Polynomials, Rodrigue's formula for Legendre's Polynomials.

(Chapter 2.1 – 2.5 and 2.7, 2.8 & 2.12)

UNIT-3: Hermite Polynomials:

1. Hermite Differential Equations, Solution of Hermite Equation, Hermite polynomials, Generating function for Hermite polynomials.
2. Other forms for Hermite Polynomials, Rodrigues formula for Hermite Polynomials, to find first few Hermite Polynomials.
3. Orthogonal properties of Hermite Polynomials, Recurrence formulae for Hermite Polynomials.

(Chapter 6.1 – 6.8)

UNIT-4: Bessel's Equation:

1. Definition, Solution of Bessel's equation, Bessel's function of the first kind of

- order 'n', Bessel's function of the second kind of order 'n'.
2. Integration of Bessel's equation in series for $m=0$, Definition of $J_n(x)$, Recurrence formulae for $J_n(x)$.
 3. Generating function for $J_n(x)$, Orthogonally of Bessel's functions.

(Chapter 5.1 – 5.7)

UNIT-5: Power Series and Power Series Solutions of Ordinary Differential Equations:

1. Introduction, summary of useful results, power series, some important facts about the power series, radius of convergence
2. Introduction of power series solutions of ordinary differential equation
3. Ordinary and singular points, regular and irregular singular points, power series solution.

(Chapter 7.1 – 7.7 and 8.1 to 8.4)

II. Prescribed textbook

1. J.N.Sharma and Dr.R.K.Gupta, Special functions, Krishna Prakashan Media(P) Ltd. (Unit-1 to Unit - 4)
2. Dr.M.D.Raisinghania, Ordinary and Partial Differential Equations, S.Chand&Company Pvt. Ltd., Ram Nagar, New Delhi-110055. (Unit – 5)

Reference Books:

1. Shanti Narayan and Dr.P.K.Mittal ,Integral Calculus, S.Chand& Company Pvt.Ltd.,Ram Nagar, New Delhi-110055.
2. George F.Simmons, Differential equations with Applications and Historical Notes, Tata McGRAW-Hill Edition,1994.
3. Shepley L.Ross, Differential equations, Second Edition, JohnWilly &Sons, NewYork, 1974.
4. Web resources suggested by the teacher and college librarian including reading material.

Course Objectives:

To enable the students to

- CO1:** Understand Euler's integrals and their connection to beta and gamma functions, Explore elementary properties of gamma functions and their transformations, Investigate Chebyshev polynomials, including their orthogonal properties and recurrence relations.
- CO2:** Define Legendre polynomials and their significance, Solve Legendre's equation and compute Legendre polynomials of degree 'n', Explore the generating function of Legendre polynomials.
- CO3:** Study Hermite differential equations and their solutions, Compute Hermite polynomials and understand their generating function, Investigate the orthogonal properties and recurrence formulas for Hermite polynomials.
- CO4:** Define Bessel's equation and its solutions, Explore Bessel functions of the first and second kinds for various orders, Understand the integration of Bessel's equation in series and their recurrence formulas for Bessel functions.
- CO5:** Learn about power series and their properties, including the radius of convergence, Introduce power series solutions for ordinary differential equations, Distinguish between ordinary and singular points, regular and irregular singular points, and their impact on power series solutions.

Course Outcomes: Students after successful completion of the course will be able to:

- CO1:** Apply theoretical / analytical / statistical knowledge gained in various courses of B.Sc to solve numerical problems based on real life situations during practical and Draw meaningful solutions to day-to-day problems
- CO2:** Understand the Beta and Gamma functions, their properties and relation between These two functions, understand the orthogonal properties of Chebyshev polynomials and recurrence relations. (Unit-I: K2 & K4)
- CO3:** Solve Legendre equation and write the Legendre equation of first kind, also Find the generating function for Legendre Polynomials, understand the

Orthogonal properties of Legendre Polynomials. (Unit-II: K3 & K4)

CO4: Solve Hermite equation and write the Hermite Polynomial of order (degree) n , also find the generating function for Hermite Polynomials, study the orthogonal properties of Hermite Polynomials and recurrence relations.

(Unit-III: K3 & K4)

CO5: Solve Bessel equation and write the Bessel equation of first kind of order n , also find the generating function for Bessel function understand the orthogonal properties of Bessel function. (Unit-IV: K3 & K4)

CO6: Find power series solutions of ordinary differential equations. (Unit-V: K3)

Course Syllabus

Unit-1: Beta and Gamma functions, Chebyshev polynomials

1. Euler's Integrals - Beta and Gamma Functions, Elementary properties of Gamma Functions, Transformation of Gamma Functions.
2. Another form of Beta Function, Relation between Beta and Gamma Functions.
3. Chebyshev polynomials, Orthogonal properties of Chebyshev polynomials, Recurrence relations, Generating functions for Chebyshev polynomials.

(Chapter 2.9 – 2.15 and 8.1 – 8.8)

Unit-2: Legendre polynomials

1. Definition, Solution of Legendre's equation, Legendre polynomial of degree 'n', Generating function of Legendre polynomials.
2. Definition of $P_n(x)$ and $Q_n(x)$, General solution of Legendre's Equation (derivations not required) to show that $P_n(x)$ is the coefficient of h^n , in the expansion of $(1-2xh+h^2)^{-1/2}$
3. Orthogonal properties of Legendre's polynomials, Recurrence formulas for Legendre's Polynomials, Rodrigue's formula for Legendre's Polynomials.

(Chapter 2.1 – 2.5 and 2.7, 2.8 & 2.12)

UNIT-3: Hermite Polynomials:

1. Hermite Differential Equations, Solution of Hermite Equation, Hermite polynomials, Generating function for Hermite polynomials.
2. Other forms for Hermite Polynomials, Rodrigues formula for Hermite Polynomials, to find first few Hermite Polynomials.
3. Orthogonal properties of Hermite Polynomials, Recurrence formulae for Hermite Polynomials.

(Chapter 6.1 – 6.8)

UNIT-4: Bessel's Equation:

1. Definition, Solution of Bessel's equation, Bessel's function of the first kind of order 'n', Bessel's function of the second kind of order 'n'.
2. Integration of Bessel's equation in series for $m=0$, Definition of $J_n(x)$, Recurrence formulae for $J_n(x)$.
3. Generating function for $J_n(x)$, Orthogonally of Bessel's functions.

(Chapter 5.1 – 5.7)

UNIT-5: Power Series and Power Series Solutions of Ordinary Differential Equations:

1. Introduction, summary of useful results, power series, some important facts about the power series, radius of convergence
2. Introduction of power series solutions of ordinary differential equation
3. Ordinary and singular points, regular and irregular singular points, power series solution.

(Chapter 7.1 – 7.7 and 8.1 to 8.4)

Prescribed textbook:

1. J.N.Sharma and Dr.R.K.Gupta, Special functions, Krishna Prakashan Media(P) Ltd. **(Unit-1 to Unit - 4)**
2. Dr.M.D.Raisinghania, Ordinary and Partial Differential Equations, S.Chand &Company Pvt. Ltd., Ram Nagar, New Delhi-110055. **(Unit – 5)**

Reference Books:

1. Shanti Narayan and Dr.P.K.Mittal ,Integral Calculus, S.Chand& Company Pvt.Ltd.,Ram Nagar, New Delhi-110055.
2. George F.Simmons, Differential equations with Applications and Historical Notes, Tata McGRAW-Hill Edition,1994.
3. Shepley L.Ross, Differential equations, Second Edition, John Willy &Sons, NewYork, 1974.
4. Web resources suggested by the teacher and college librarian including reading material.

ST. JOSEPH'S COLLEGE FOR WOMEN (AUTONOMOUS), VISAKHAPATNAM
III SEMESTER

MATHEMATICS
MULTI-DISCIPLINARY COURSE
BASIC MATHEMATICS

TIME: 2Hrs/Week
Max.Marks:50

w.e.f AK 2023-2024 (Admitted Batch) **SYLLABUS**

Course Outcomes

After successful completion of this course, the student will be able to

CO1: understand the concept of sets and relations

CO2: know the method of rationalisation in surds

CO3: understand Co-ordinate system and Locus

CO4: find the Point of intersection of two straight lines

CO5: find the Rank of a matrix.

Course Content:

Unit – I:Algebra

Sets and Relations: Sets – Finite and Infinite sets – Equality of sets – Subsets – Power set – Universal set – Union and Intersection of sets – Relations – Equivalence relations – Examples.

Surds: Surd – Pure and Mixed surds – Similar surds – Monomial surds – Binomial Surds – Rationalisation.

Logarithms: Definition – Properties of Logarithms – Common Logarithms.

Unit – II:Co-ordinate Geometry

Co-ordinate system: Distance between two points – Division formula – Centroid – Areas of Triangles and Quadrilaterals.

Locus: Definition of Locus – Equation of Locus

Straight Line: Different forms – Reduction of general equation into various forms – Point of intersection of two straight lines

Unit – III:Matrices

Matrices: Types of matrices – Examples – Addition of Matrices – Subtraction of Matrices – Scalar multiple of a matrix – Multiplication of matrices – Transpose of a matrix and determinants – Minors and Cofactors – Adjoint of a matrix – Inverse of a matrix – Rank of a matrix – definition and examples.

Activities:

Seminar/ Quiz/ Assignments/ Problem Solving Sessions.

Reference Books:

1. Basic Abstract Algebra by P.B.Bhattacharya, S.K.Jain, S.R.Nagpaul, Cambridge University Press.
2. Co-ordinate Geometry by M.L.Khanna, Jai Prakash Nath Publications.
3. A Text book of Matrices by Shanti Narayan & PK Mittal, S.Chand Publications.

Course Content:

Unit – I:

Rings and Fields:

Definition of a ring and Examples – Basic properties – Boolean rings - Fields – Divisors of 0 and Cancellation Laws – Integral Domains – Division ring - The Characteristic of a Ring, Integral domain and Field – Non-commutative Rings - Matrices over a field – The Quaternion ring.

Unit – II:

Subrings and Ideals:

Definition and examples of Sub rings – Necessary and sufficient conditions for a subset to be a subring – Algebra of Subrings – Centre of a ring – left, right and two-sided ideals – Algebra of ideals – Equivalence of a field and a commutative ring without proper ideals

Unit-III:

Principal ideals and Quotient Rings:

Definition of a Principal ideal ring (Domain) – Every field is a PID – The ring of integers is a PID – Example of a ring which is not a PIR – Cosets – Algebra of cosets – Quotient rings – Construction of composition tables for finite quotient rings of the ring Z of integers and the ring Z_n of integers modulo

Unit – IV:

Homomorphism of Rings:

Homomorphism of Rings – Definition and Elementary properties – Kernel of a homomorphism – Isomorphism – Fundamental theorems of homomorphism of rings – Maximal and prime Ideals – Prime Fields

Unit – V:

Rings of Polynomials:

Polynomials in an indeterminate – The Evaluation morphism -- The Division Algorithm in $F[x]$ – Irreducible Polynomials – Ideal Structure in $F[x]$ – Uniqueness of Factorization $F[x]$.

Activities: Seminar/ Quiz/ Assignments/ Applications of ring theory concepts to Real life Problem /Problem Solving Sessions.

Text book:

Modern Algebra by A.R. Vasishta and A.K. Vasishta, Krishna Prakashan Media Pvt. Ltd.

Reference books:

1. A First Course in Abstract Algebra by John. B. Farleigh, Narosa Publishing House.
2. Linear Algebra by Stephen. H. Friedberg and Others, Pearson Education India

Course Content:

Unit – I:

Rings and Fields:

Definition of a ring and Examples – Basic properties – Boolean rings - Fields – Divisors of 0 and Cancellation Laws – Integral Domains – Division ring - The Characteristic of a Ring, Integral domain and Field – Non-commutative Rings - Matrices over a field – The Quaternion ring.

Unit – II:

Subrings and Ideals:

Definition and examples of Subrings – Necessary and sufficient conditions for a subset to be a subring – Algebra of Subrings – Centre of a ring – left, right and two-sided ideals – Algebra of ideals – Equivalence of a field and a commutative ring without proper ideals

Unit-III:

Principal ideals and Quotient Rings:

Definition of a Principal ideal ring (Domain) – Every field is a PID – The ring of integers is a PID – Example of a ring which is not a PIR – Cosets – Algebra of cosets – Quotient rings – Construction of composition tables for finite quotient rings of the ring Z of integers and the ring Z_n of integers modulo

Unit – IV:

Homomorphism of Rings:

Homomorphism of Rings – Definition and Elementary properties – Kernel of a homomorphism – Isomorphism – Fundamental theorems of homomorphism of rings – Maximal and prime Ideals – Prime Fields

Unit – V:

Rings of Polynomials:

Polynomials in an indeterminate – The Evaluation morphism -- The Division Algorithm in $F[x]$ – Irreducible Polynomials – Ideal Structure in $F[x]$ – Uniqueness of Factorization $F[x]$.

Activities: Seminar/ Quiz/ Assignments/ Applications of ring theory concepts to Real life Problem /Problem Solving Sessions.

Text book:

Modern Algebra by A.R. Vasishta and A.K. Vasishta, Krishna Prakashan Media Pvt. Ltd.

Reference books:

1. A First Course in Abstract Algebra by John. B. Farleigh, Narosa Publishing House.
2. Linear Algebra by Stephen. H. Friedberg and Others, Pearson Education India

Course Objectives: To enable the students to

- CO1:** Analyse the algebraic and order properties of the set of real numbers, Understand the concept of completeness and its applications in real analysis. (K2 & K4)
- CO2:** Apply the concept of convergence of series, Understand the tests for convergence, including the P-test and nth root test. (K3)
- CO3:** Analyse the limits of real-valued functions, Understand the concept of infinite limits and limits at infinity. (K4)
- CO4:** Apply the concept of derivability of a function at a point and on an interval, Understand the significance of mean value theorems (Rolle's Theorem, Lagrange's Theorem, and Cauchy's Mean Value Theorem). (K2 & K3)
- CO5:** Analyse the concept of Riemann integral and integral functions, Understand the properties of integrable functions and the fundamental theorem of integral calculus. (K2 & K4)

Course Outcomes:

After successful completion of this course, the student will be able to

- CO1:** Apply the supremum property to intervals, Explore the properties of sequences, including boundedness and convergence. (K3)
- CO2:** Determine whether a series converges or diverges, Apply the Leibnitz Test to alternating series.
Course Contents (K3)
- CO3:** Evaluate limits of functions, Explore the continuity of functions on intervals and understand uniform continuity. (K6)
- CO4:** Compute derivatives and explore the relationship between continuity and derivability.
Apply mean value theorems to analyse functions. (K3 & K4)
- CO5:** Determine the integrability of functions using necessary and sufficient conditions, Apply the Riemann integral to compute areas and explore mean value theorems. (K3)

Course Content:

Unit – I:

REALNUMBERS, REAL SEQUENCES:

The algebraic and order properties of \mathbb{R} - Absolute value and Real line - Completeness property of \mathbb{R} -

Applications of supremum property - intervals. (No question is to be set from this portion)
Sequences and their limits - Range and Boundedness of Sequences - Limit of a sequence and
Convergent sequence - The Cauchy's criterion - properly divergent sequences - Monotone sequences -
Necessary and Sufficient condition for Convergence of Monotone Sequence - Limit Point of
Sequence - Sub sequences and the Bolzano-Weierstrass theorem - Cauchy Sequences - Cauchy's
general principle of convergence.

Unit – II:

INFINITE SERIES:

Introduction to series - convergence of series - Cauchy's general principle of convergence for series
tests for convergence of series - Series of non-negative terms - P-test - Cauchy's nth root test - D'
Alembert's Test - Alternating Series - Leibnitz Test.

Unit – III:

LIMIT & CONTINUITY:

Real valued Functions - Boundedness of a function - Limits of functions - Some extensions of the
limit concept - Infinite Limits - Limits at infinity (No question is to be set from this
portion). Continuous functions - Combinations of continuous functions - Continuous Functions on
intervals - uniform continuity.

Unit – IV:

DIFFERENTIATION AND MEAN VALUE THEOREMS:

The derivability of a function at a point and on an interval - Derivability and continuity of a
function - Mean value Theorems - Rolle's Theorem, Lagrange's Theorem, Cauchy's Mean value
Theorem

Unit – V:

RIEMANN INTEGRATION :

Riemann Integral - Riemann integral functions - Darboux theorem - Necessary and
Sufficient condition for R integrability - Properties of integrable functions - Fundamental theorem of
integral calculus - integral as the limit of a sum - Mean value Theorems.

Activities:

Seminar/ Quiz/ Assignments/ Applications of Real Analysis to Real life Problem /Problem Solving
Sessions.

Text Book: A Text Book of B.Sc Mathematics Real Analysis (IV Semester) by Authors : V. VENKATESWARA RAO, Dr. R. BHARAVI SHARMA, B.V.S.S. SARMA, N. KRISHNAMURTHY, S. ANJANEYA SASTRY & S. Ranganatham – S Chand Publications

Reference Books:

1. Elements of Real Analysis by Shanthi Narayan and Dr. M. D. Raisinghania, S. Chand & Company Pvt. Ltd., New Delhi.
2. Principles of Mathematical Analysis by Walter Rudin, McGraw-Hill Ltd.
3. An Introduction to Real Analysis by Robert G. Bartle and Donald R. Sherbert, John Wiley and sons Pvt. Ltd

Course Content:

Unit – I:

REALNUMBERS AND REAL SEQUENCES:

The algebraic and order properties of \mathbb{R} - Absolute value and Real line - Completeness property of \mathbb{R} - Applications of supremum property - intervals. (No question is to be set from this portion)
Sequences and their limits - Range and Boundedness of Sequences - Limit of a sequence and Convergent sequence - The Cauchy's criterion - properly divergent sequences - Monotone sequences - Necessary and Sufficient condition for Convergence of Monotone Sequence - Limit Point of Sequence - Sub sequences and the Bolzano-Weierstrass theorem – Cauchy Sequences – Cauchy's general principle of convergence.

Unit – II:

INFINITE SERIES:

Introduction to series - convergence of series - Cauchy's general principle of convergence for series tests for convergence of series - Series of non-negative terms - P-test - Cauchy's nth root test - D'Alembert's Test - Alternating Series - Leibnitz Test.

Unit – III:

LIMIT & CONTINUITY:

Real valued Functions - Boundedness of a function - Limits of functions - Some extensions of the limit concept - Infinite Limits - Limits at infinity (No question is to be set from this portion). Continuous functions - Combinations of continuous functions - Continuous Functions on intervals - uniform continuity.

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Unit – V:

RIEMANN INTEGRATION:

Riemann Integral - Riemann integral functions - Darboux theorem - Necessary and Sufficient condition for \mathbb{R} integrability - Properties of integrable functions - Fundamental theorem of integral calculus - integral as the limit of a sum - Mean value Theorems.

Activities:

Seminar/ Quiz/ Assignments/ Applications of Real Analysis to Real life Problem /Problem Solving Sessions.

Text Book: A Text Book of B.Sc Mathematics Real Analysis (IV Semester) by Authors : V. VENKATESWARA RAO, Dr. R. BHARAVI SHARMA, B.V.S.S. SARMA, N. KRISHNAMURTHY, S. ANJANEYA SASTRY & S. Ranganatham – S Chand Publications

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2. Principles of Mathematical Analysis by Walter Rudin, McGraw-Hill Ltd.
3. An Introduction to Real Analysis by Robert G. Bartle and Donald R. Sherbert, John Wiley and sons Pvt. Ltd.

Course Objectives: To enable the students to

- CO1:** Analyse the algebraic and order properties of the set of real numbers, Understand the concept of completeness and its applications in real analysis. (K2 & K4)
- CO2:** Apply the concept of convergence of series, Understand the tests for convergence, including the P-test and nth root test. (K3)
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Course Outcomes:

After successful completion of this course, the student will be able to

- CO1:** Apply theoretical / analytical /statistical knowledge gained in various courses of B.Sc to solve numerical problems based on real life situations during practical and Draw meaningful solutions to day-to-day problems
- CO2:** Apply the supremum property to intervals, Explore the properties of sequences, including boundedness and convergence. (K3)
- CO3:** Determine whether a series converges or diverges, Apply the Leibnitz Test to alternating series.
Course Contents (K3)
- CO4:** Evaluate limits of functions, Explore the continuity of functions on intervals and understand uniform continuity. (K6)
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Apply mean value theorems to analyse functions. (K3 & K4)
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Course Content:

Unit – I:

REALNUMBERS AND REAL SEQUENCES:

The algebraic and order properties of \mathbb{R} - Absolute value and Real line - Completeness property of \mathbb{R} - Applications of supremum property - intervals. (No question is to be set from this portion)
Sequences and their limits - Range and Boundedness of Sequences - Limit of a sequence and Convergent sequence - The Cauchy's criterion - properly divergent sequences - Monotone sequences - Necessary and Sufficient condition for Convergence of Monotone Sequence - Limit Point of Sequence - Sub sequences and the Bolzano-Weierstrass theorem – Cauchy Sequences – Cauchy's general principle of convergence.

Unit – II:

INFINITE SERIES:

Introduction to series - convergence of series - Cauchy's general principle of convergence for series tests for convergence of series - Series of non-negative terms - P-test - Cauchy's nth root test - D'Alembert's Test - Alternating Series - Leibnitz Test.

Unit – III:

LIMIT & CONTINUITY:

Real valued Functions - Boundedness of a function - Limits of functions - Some extensions of the limit concept - Infinite Limits - Limits at infinity (No question is to be set from this portion). Continuous functions - Combinations of continuous functions - Continuous Functions on intervals - uniform continuity.

Unit – IV:

DIFFERENTIATION AND MEAN VALUE THEOREMS:

The derivability of a function at a point and on an interval - Derivability and continuity of a function - Mean value Theorems - Rolle's Theorem, Lagrange's Theorem, Cauchy's Mean value Theorem

Unit – V:

RIEMANN INTEGRATION:

Riemann Integral - Riemann integral functions - Darboux theorem - Necessary and Sufficient condition for \mathbb{R} integrability - Properties of integrable functions - Fundamental theorem of integral calculus - integral as the limit of a sum - Mean value Theorems.

Activities:

Seminar/ Quiz/ Assignments/ Applications of Real Analysis to Real life Problem /Problem Solving Sessions.

Text Book: A Text Book of B.Sc Mathematics Real Analysis (IV Semester) by Authors : V. VENKATESWARARAO, Dr. R. BHARAVI SHARMA, B.V.S.S. SARMA, N. KRISHNAMURTHY, S. ANJANEYA SASTRY & S. Ranganatham – S Chand Publications

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1. Elements of Real Analysis by Shanthi Narayan and Dr. M. D. Raisinghania, S. Chand & Company Pvt. Ltd., New Delhi.
2. Principles of Mathematical Analysis by Walter Rudin, McGraw-Hill Ltd.
3. An Introduction to Real Analysis by Robert G. Bartle and Donald R. Sherbert, John Wiley and sons Pvt. Ltd

Unit – I: Application of Laplace Transform to solutions of Differential Equations:

Solutions of ordinary Differential Equations - Solutions of Differential Equations with constants coefficients - Solutions of Differential Equations with Variable coefficients.

Unit – II: Application of Laplace Transform to solutions of Differential Equations:

Solutions of Simultaneous Ordinary Differential equations - Solutions of Partial Differential Equations.

Unit – III: Application of Laplace Transforms to Integral Equations:

Definitions of Integral Equations - Abel's Integral Equation - Integral Equation of Convolution Type - Integral Differential Equations - Application of L.T. to Integral Equations.

Unit – IV: Fourier Transforms – I:

Definition of Fourier Transform - Fourier sine Transform - Fourier cosine Transform - Linear Property of Fourier Transform - Change of Scale Property for Fourier Transform - sine Transform and cosine transform shifting property - Modulation theorem.

Unit – V: Fourier Transforms – II:

Definition of Convolution - Convolution theorem for Fourier transform - Parseval's Identity - Relationship between Fourier and Laplace transforms - problems related to Integral Equations - Finite Fourier Transforms - Finite Fourier Sine Transform - Finite Fourier Cosine Transform - Inversion formula for sine and cosine transforms only - statement and related problems.

Activities: Seminar/ Quiz/ Assignments/Applications of Integral Transforms in real life problems /Problem Solving Sessions.

Text Book:

B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 44th Edition, 2017.

Reference Book:

1. Fourier Series and Integral Transformations by Dr. S. Sreenadh and others, published by S. Chand and Co, New Delhi
2. E. M. Stein and R. Shakarchi, Fourier analysis: An introduction, (Princeton University Press, 2003).
3. R.S. Strichartz, A guide to Distribution theory and Fourier transforms, (World scientific, 2003).

Course Content

Unit – I: Application of Laplace Transform to solutions of Differential Equations:

Solutions of ordinary Differential Equations - Solutions of Differential Equations with constants coefficients - Solutions of Differential Equations with Variable coefficients.

Unit – II: Application of Laplace Transform to solutions of Differential Equations:

Solutions of Simultaneous Ordinary Differential equations - Solutions of Partial Differential Equations.

Unit – III: Application of Laplace Transforms to Integral Equations:

Definitions of Integral Equations - Abel's Integral Equation - Integral Equation of Convolution Type - Integral Differential Equations - Application of L.T. to Integral Equations.

Unit – IV: Fourier Transforms – I:

Definition of Fourier Transform - Fourier sine Transform - Fourier cosine Transform - Linear Property of Fourier Transform - Change of Scale Property for Fourier Transform - sine Transform and cosine transform shifting property - Modulation theorem.

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Definition of Convolution - Convolution theorem for Fourier transform - Parseval's Identity - Relationship between Fourier and Laplace transforms - problems related to Integral Equations - Finite Fourier Transforms - Finite Fourier Sine Transform - Finite Fourier Cosine Transform - Inversion formula for sine and cosine transforms only - statement and related problems.

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Reference Book:

1. Fourier Series and Integral Transformations by Dr. S. Sreenadh and others, published by S. Chand and Co, New Delhi
2. E. M. Stein and R. Shakarchi, Fourier analysis: An introduction, (Princeton University Press, 2003).
3. R.S. Strichartz, A guide to Distribution theory and Fourier transforms, (World scientific, 2003).

Matrices, Elementary Properties of Matrices, Inverses of Matrices, Rank of Matrix, Linear Equations, Characteristic equations, Characteristic Values & Vectors of square matrix, Cayley – Hamilton Theorem.

UNIT –V : INNER PRODUCT SPACE :

Inner Product Spaces, Euclidean and Unitary Spaces, Norm or length of a Vector, Schwartz Inequality, Triangular Inequality, Parallelogram law, Orthogonality, Orthonormal Set, Complete Orthonormal set, Gram – Schmidt Orthogonalization Process, Bessel's inequality and Parseval's Identity.

PRESCRIBED TEXT BOOK : Linear Algebra by J.N. Sharma and A.R. Vasista, published by Krishna Prakashan Mandir, Meerut- 250002 (2020)

REFERENCE BOOKS :

1. A Textbook of B.Sc. Mathematics 3rd Year - Linear Algebra by S Chand Publications (V. VENKATESWARA RAO, B.V.S.S. SARMA,, N. KRISHNAMURTHY)(2020)
2. Matrices by Shanti Narayana, published by S.Chand Publications.(1998)
3. Linear Algebra by Kenneth Hoffman and Ray Kunze, published by Pearson Education (low priced edition),New Delhi. (1992)
4. Linear Algebra by Stephen H. Friedberg et al published by Prentice Hall of India Pvt. Ltd. 4th Edition (2007).

** ** *

Matrices, Elementary Properties of Matrices, Inverses of Matrices, Rank of Matrix, Linear Equations, Characteristic equations, Characteristic Values & Vectors of square matrix, Cayley – Hamilton Theorem.

UNIT –V: INNER PRODUCT SPACE:

Inner Product Spaces, Euclidean and Unitary Spaces, Norm or length of a Vector, Schwartz Inequality, Triangular Inequality, Parallelogram law, Orthogonality, Orthonormal Set, Complete Orthonormal set, Gram – Schmidt Orthogonalization Process, Bessel's inequality and Parseval's Identity.

PRESCRIBED TEXT BOOK: Linear Algebra by J.N. Sharma and A.R. Vasista, published by Krishna PrakashanMandir, Meerut- 250002 (2020)

REFERENCE BOOKS:

1. A Textbook of B.Sc. Mathematics 3rd Year - Linear Algebra by S Chand Publications
(V. VENKATESWARA RAO, B.V.S.S. SARMA,, N. KRISHNAMURTHY)(2020)
2. Matrices by Shanti Narayana, published by S.Chand Publications.(1998)
3. Linear Algebra by Kenneth Hoffman and Ray Kunze, published by Pearson Education (low priced edition),New Delhi. (1992)
4. Linear Algebra by Stephen H. Friedberg et al published by Prentice Hall of India Pvt. Ltd. 4thEdition (2007).

** ** *

COURSE OBJECTIVES: To enable the students to –

CO1: Analyze the fundamental properties of vector spaces and their subspaces, including linear independence and dependence.

CO2: Apply the concept of basis and dimension to determine the structure of finite-dimensional vector spaces.

CO3: Analyze the properties of linear transformations and their impact on vector spaces.

CO4: Apply the Cayley-Hamilton theorem to compute powers of matrices and solve matrix equations.

CO5: Analyze inner product spaces and their properties, including orthogonality and the Gram-Schmidt process.

COURSE OUTCOMES: At the end of the course student will be able to

CO1: Analyze the structure of vector spaces, determine subspaces, and assess linear dependence and independence of vectors.

CO2: Apply the dimension theorem to find the basis and coordinates of vector spaces and quotient spaces.

CO3: Analyze the Rank-Nullity Theorem and its applications in solving problems related to linear transformations.

CO4: Apply eigenvalues and eigenvectors to diagonalize matrices and solve characteristic equations.

CO5: Analyze the geometric interpretation of inner product spaces and construct orthonormal bases using the Gram-Schmidt process.

COURSE SYLLABUS :

UNIT – I : VECTOR SPACES-I :

Vector Spaces, General properties of vector spaces, Addition and Scalar multiplication of Vectors, Internal and External composition, Null space, Vector subspaces, Algebra of subspaces, Linear Sum of two subspaces, Linear combination of Vectors, Linear span Linear independence and Linear dependence of Vectors.

UNIT –II : VECTOR SPACES-II :

Basis of Vector Space, Finite Dimensional Vector spaces, Basis extension, Co-ordinates, Dimension of a Vector space, Dimension of a subspace, Quotient space and Dimension of Quotient Space.

UNIT –III : LINEAR TRANSFORMATIONS :

Linear transformations, Linear operators, Properties of L.T, Sum and Product of L.Ts, Algebra of Linear Operators, Range and Null space of Linear Transformation, Rank and Nullity of Linear transformations – Rank and Nullity Theorem.

UNIT –IV : MATRIX :

Matrices, Elementary Properties of Matrices, Inverses of Matrices, Rank of Matrix, Linear Equations, Characteristic equations, Characteristic Values & Vectors of square matrix, Cayley – Hamilton Theorem.

UNIT –V : INNER PRODUCT SPACE :

Inner Product Spaces, Euclidean and Unitary Spaces, Norm or length of a Vector, Schwartz Inequality, Triangular Inequality, Parallelogram law, Orthogonality, Orthonormal Set, Complete Orthonormal set, Gram – Schmidt Orthogonalization Process, Bessel's inequality and Parseval's Identity.

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4. Linear Algebra by Stephen H. Friedberg et al published by Prentice Hall of India Pvt. Ltd. 4th Edition (2007).

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COURSE OBJECTIVES: To enable the students to –

- CO1:** Apply double integrals to evaluate areas and compute integrals in different coordinate systems.
- CO2:** Analyze the concept of triple integrals and their applications in computing volumes and surface areas.
- CO3:** Apply vector differentiation to compute gradients, divergences, and curls in vector fields.
- CO4:** Analyze the concepts of line, surface, and volume integrals in vector fields.
- CO5:** Apply Gauss, Green, and Stokes' theorems to evaluate complex vector integrals.

COURSE OUTCOMES: At the end of the course student will be able to

- CO1:** Apply the concept of double integration to solve problems involving changes of variables and order of integration.
- CO2:** Analyze the use of multiple integrals to compute plane areas, surface areas, and volumes.
- CO3:** Apply vector differential operators to solve problems involving vector functions and field properties.
- CO4:** Analyze vector integration techniques and solve problems involving line, surface, and volume integrals.
- CO5:** Apply fundamental theorems of vector calculus to solve physical and engineering problems.

COURSE SYLLABUS:

Unit–I: Multiple Integrals-I

Introduction -Double integrals -Evaluation of double integrals –Properties of double integrals - Region of integration -double integration in Polar Co-ordinates – Change of variables in double integrals -change of order of integration.

Unit–II: Multiple Integrals-II

Triple integral -region of integration -change of variables -Plane areas by double integrals -surface area by double integral -Volume as a double integral, volume as a triple integral.

Unit–III: Vector Differentiation

Vector differentiation –ordinary - derivatives of vectors – Differentiability –Gradient –Divergence - Curl operators - Formulae involving these operators.

Unit–IV: Vector Integration

Line Integrals with examples - Surface Integral with examples - Volume integral with examples.

Unit–V: Vector Integration Applications

Gauss theorem and applications of Gauss theorem - Green's theorem in plane and applications of Green's theorem - Stokes's theorem and applications of Stokes theorem.

Activities:

Seminar/ Quiz/ Assignments/ Applications of Vector calculus to Real life Problems /Problem Solving Sessions.

Text Book:

A Text Book of Higher Engineering Mathematics by B.S.Grawal, Khanna Publishers, 46th Edition

Reference Books:

1. Vector Calculus by P. C. Matthews, Springer Verlag publications.
2. Vector Analysis by Murray Spiegel, Schaum Publishing Company, New York

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Activities:

Seminar/ Quiz/ Assignments/ Applications of Vector calculus to Real life Problems /Problem Solving Sessions.

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COURSE OBJECTIVES: To enable the students to –

- CO1:** Apply numerical differentiation techniques to approximate derivatives using finite difference formulas.
- CO2:** Analyze numerical integration methods for approximating definite integrals with different quadrature rules.
- CO3:** Apply direct methods to solve systems of linear equations efficiently.
- CO4:** Analyze iterative methods for solving linear systems and their convergence properties.
- CO5:** Apply numerical methods to approximate solutions of ordinary differential equations.

COURSE OUTCOMES: At the end of the course student will be able to

- CO1:** Apply Newton's forward, backward, and central difference formulas to compute numerical derivatives.
- CO2:** Analyze the accuracy and error estimation of Trapezoidal, Simpson's, and Weddle's rules in numerical integration.
- CO3:** Apply Gaussian elimination and Gauss-Jordan methods to find solutions for linear systems.
- CO4:** Analyze the performance of Jacobi and Gauss-Seidel methods in solving tridiagonal and large-scale systems.
- CO5:** Apply Euler's and Runge-Kutta methods to solve initial value problems in differential equations.

COURSE SYLLABUS:

UNIT – I: Numerical Differentiation

Derivatives using Newton's forward difference formula - Newton's backward difference formula - Derivatives using central difference formula - Stirling's interpolation formula - Newton's divided difference formula.

UNIT – II: Numerical Integration

General quadrature formula on errors - Trapezoidal rule – Simpson's 1/3 rule - Simpson's 3/8 rule - Weddle's rule - Euler-Maclaurin formula of summation and quadrature - The Euler transformation.

UNIT – III: Solution of Simultaneous Linear systems of Equations – I

Solution of linear systems - Direct Methods - Matrix inversion method – Gaussian elimination method - Gauss Jordan Method.

UNIT – IV: Solution of Simultaneous Linear systems of Equations – II

Method of factorization - solution of Tridiagonal systems - Iterative methods - Jacobi's method - Gauss - Siedal method.

UNIT – V: Numerical Solution of Ordinary Differential Equations

Introduction – solution of Taylor's series – Picard's method of successive approximations – Euler's method – Modified Euler's method – Runge-Kutta methods.

Activities:

Seminar/ Quiz/ Assignments/ Applications of Numerical methods to Real life Problem /Problem Solving Sessions.

Text Book:

Numerical Analysis by G. Shanker Rao, New Age International Publications

Reference Books:

1. Applied Numerical Analysis by Curtis F. Gerald and Patrick O. Wheatley, Pearson Publications.
2. Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S .R. K. Iyengar and R. K. Jain, New Age International Publishers.

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COURSE OBJECTIVES: To enable the students to –

CO1: Analyze the properties of divisibility, prime numbers, and the greatest common divisor using the fundamental theorem of arithmetic.

CO2: Apply arithmetic functions and Dirichlet multiplication to solve number-theoretic problems.

CO3: Analyze the asymptotic behavior of arithmetic functions using summation formulas.

CO4: Apply modular arithmetic techniques to solve congruences and system of congruences.

CO5: Analyze quadratic residues and the quadratic reciprocity law in number theory.

COURSE OUTCOMES: At the end of the course student will be able to

CO1: Analyze the structure of integers through prime factorization and apply the Euclidean algorithm to compute the greatest common divisor.

CO2: Apply the Mobius inversion formula and Dirichlet product to analyze and compute number-theoretic functions.

CO3: Analyze the average order of divisor functions, Euler's totient function, and the distribution of lattice points.

CO4: Apply the Chinese remainder theorem and Euler-Fermat theorem to solve linear and polynomial congruences.

CO5: Analyze Legendre's symbol, Gauss sums, and their applications in solving quadratic congruences.

COURSE SYLLABUS:

UNIT-I: The Fundamental Theorem of Arithmetic

Introduction, Divisibility, Greatest common divisor, Prime numbers, The fundamental theorem of arithmetic, The series of reciprocals of the primes, The Euclidean algorithm, The greatest common divisor of more than two numbers

UNIT-II: Arithmetical Functions And Dirichlet Multiplication

Introduction- The Mobius function $\mu(n)$ – The Euler quotient function $\varphi(n)$ - A relation connecting φ and μ - A product formula for $\varphi(n)$ - The Dirichlet product of arithmetical functions- Dirichlet inverses and the Mobius inversion formula- The Mangoldt function $\Lambda(n)$ - multiplicative functions- multiplicative functions and Dirichlet multiplication- The inverse of a completely multiplicative function-Liouville's function $\lambda(n)$ - The divisor functions $\sigma_\alpha(n)$

UNIT-III: Averages Of Arithmetical Functions

Introduction- The big oh notation. Asymptotic equality of functions- Euler's summation formula- Some elementary asymptotic formulas-The average order of $d(n)$ - The average order of the divisor functions $\sigma_\alpha(n)$ - The average order of $\varphi(n)$ - An application to the distribution of lattice points visible from the origin- The average order of $\mu(n)$ and $\Lambda(n)$ -The partial sums of a Dirichlet product- Applications to $\mu(n)$ and $\Lambda(n)$

UNIT-IV: Congruences

Definition and basic properties of congruences- Residue classes and complete residue systems- Linear congruences- Reduced residue systems and the Euler- Fermat theorem- Polynomial congruences modulo p . Lagrange's theorem- Applications of Lagrange's theorem- Simultaneous linear congruences. The Chinese remainder theorem- Applications of the Chinese remainder theorem

UNIT-V: Quadratic Residues and the Quadratic Reciprocity Law

Quadratic Residues, Legendre's symbol and its properties, Evaluation of $(-1/p)$ and $(2/p)$, Gauss lemma, The Quadratic reciprocity law, Applications of the reciprocity law, The Jacobi Symbol, Gauss sums and the quadratic reciprocity law, the reciprocity law for quadratic Gauss sums, Another proof of the quadratic reciprocity law.

Activities:

Seminar/ Quiz/ Assignments/ Applications of Number theory to Real life Problem /Problem Solving Sessions

Text Book:

Introduction to Analytic Number Theory by T.M.Apostol, Springer Verlag-New York, Heidelberg-Berlin-1976.

Reference Books:

1. Elementary Number Theory by G.A.Jones and J.M.Jones, , Springer
2. Elementary Number Theory by David, M. Burton, 2nd Edition UBS Publishers.
3. Number Theory by Hardy & Wright, Oxford Univ., Press.
4. Elements of the Theory of Numbers by Dence, J. B &Dence T.P, Academic Press

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CO2:Apply arithmetic functions and Dirichlet multiplication to solve number-theoretic problems.

CO3:Analyze the asymptotic behavior of arithmetic functions using summation formulas.

CO4: Apply modular arithmetic techniques to solve congruences and system of congruences.

CO5:Analyze quadratic residues and the quadratic reciprocity law in number theory.

COURSE OUTCOMES: At the end of the course student will be able to

CO1:Analyze the structure of integers through prime factorization and apply the Euclidean algorithm to compute the greatest common divisor.

CO2:Apply the Mobius inversion formula and Dirichlet product to analyze and compute number-theoretic functions.

CO3:Analyze the average order of divisor functions, Euler's totient function, and the distribution of lattice points.

CO4:Apply the Chinese remainder theorem and Euler-Fermat theorem to solve linear and polynomial congruences.

CO5:Analyze Legendre's symbol, Gauss sums, and their applications in solving quadratic congruences.

COURSE SYLLABUS:

UNIT-I: The Fundamental Theorem of Arithmetic

Introduction, Divisibility, Greatest common divisor, Prime numbers, The fundamental theorem of arithmetic, The series of reciprocals of the primes, The Euclidean algorithm, The greatest common divisor of more than two numbers

UNIT-II: Arithmetical Functions And Dirichlet Multiplication

Introduction- The Mobius function $\mu(n)$ - The Euler quotient function $\varphi(n)$ - A relation connecting φ and μ - A product formula for $\varphi(n)$ - The Dirichlet product of arithmetical functions- Dirichlet inverses and the Mobius inversion formula- The Mangoldt function $\Lambda(n)$ - multiplicative functions- multiplicative functions and Dirichlet multiplication- The inverse of a completely multiplicative function-Liouville's function $\lambda(n)$ - The divisor functions $\sigma_\alpha(n)$

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Introduction- The big oh notation. Asymptotic equality of functions- Euler's summation formula- Some elementary asymptotic formulas-The average order of $d(n)$ - The average order of the divisor functions $\sigma_\alpha(n)$ - The average order of $\varphi(n)$ - An application to the distribution of lattice points visible from the origin- The average order of $\mu(n)$ and $\Lambda(n)$ -The partial sums of a Dirichlet product- Applications to $\mu(n)$ and $\Lambda(n)$

UNIT-IV: Congruences

Definition and basic properties of congruences- Residue classes and complete residue systems- Linear congruences- Reduced residue systems and the Euler- Fermat theorem- Polynomial congruences modulo p . Lagrange's theorem- Applications of Lagrange's theorem- Simultaneous linear congruences. The Chinese remainder theorem- Applications of the Chinese remainder theorem

UNIT-V: Quadratic Residues and the Quadratic Reciprocity Law

Quadratic Residues, Legendre's symbol and its properties, Evaluation of $(-1/p)$ and $(2/p)$, Gauss lemma, The Quadratic reciprocity law, Applications of the reciprocity law, The Jacobi Symbol, Gauss sums and the quadratic reciprocity law, the reciprocity law for quadratic Gauss sums, Another proof of the quadratic reciprocity law.

Activities:

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