COURSE OUTCOMES

BIRPARA COLLEGE

DEPARTMENT OF MATHEMATICS

(REVISED FYUGP)

SEMESTER-I

Course Outcome

Course Name: CLASSICAL ALGEBRA & MATRIX THEORY

Course Type: Multidisciplinary Course

After completing this course, students will be able to:

1. **Understand the Fundamentals of Algebra**

Learn basic concepts of classical algebra including equations, surds, and complex numbers.

2. **Solve Polynomial Equations**

Understand the nature of roots, relationships between roots and coefficients, and techniques to solve quadratic and cubic equations.

3. **Explore Theory of Equations**

Apply methods like synthetic division, Descartes' rule of signs, and transformations of equations.

4. **Understand and Apply Matrix Theory**

Learn the types of matrices, matrix operations, inverse of a matrix, and use matrices to solve systems of linear equations.

5. **Use Determinants in Problem Solving**

Understand determinants and their properties, and apply them in solving linear systems and finding matrix inverses.

6. **Apply Algebra and Matrices in Real Life and Other Disciplines**

Use concepts of algebra and matrices in subjects like economics, physics, computer science, and data analysis.

SEMESTER-II

Course Name: CALCULUS & GEOMETRY

Course Type: Multidisciplinary Course

After completing this course, students will be able to:

1. **Apply Advanced Integration Techniques**

Understand and use reduction formulae to evaluate integrals involving powers of trigonometric, logarithmic, and exponential functions.

2. **Calculate Areas and Volumes Using Calculus**

Find arc lengths, areas under curves, areas between curves, and volumes and surface areas of solids formed by the revolution of plane curves.

3. **Use Successive Derivatives and Leibnitz Rule**

Apply higher-order derivatives and Leibnitz rule in solving advanced calculus problems.

4. **Solve Indeterminate Forms Using L'Hospital's Rule**

Use L'Hospital's Rule to evaluate limits of indeterminate forms.

5**. Understand Curves and Their Properties**

Study and analyze the parameterization of curves, envelopes, asymptotes, radius of curvature, concavity, convexity, and points of inflection.

6. **Solve Problems in 2D Geometry**

Analyze second-degree equations, rotate axes, study pairs of straight lines, and classify conic sections using the discriminant and polar equations.

7. **Understand Basic 3D Geometry**

Learn about 3D shapes including spheres, cones, cylinders, ellipsoids, paraboloids, and hyperboloids. Understand classification of quadrics.

8. **Apply Calculus and Geometry in Real-World Contexts**

Use the combined knowledge of calculus and geometry in practical applications in physics, engineering, and other sciences.

FYUGP-I

SEMESTER-I

Course Outcome

Course Name: CLASSICAL & LINEAR ALGEBRA

Course Type: Major Course

After completing this course, students will be able to:

1. **Understand and Use Complex Numbers**

Represent complex numbers in polar form, and apply De Moivre's theorem and exponential, trigonometric, logarithmic, and hyperbolic functions of complex variables.

2. **Work with Equations and Roots**

Understand the theory of equations, including relations between roots and coefficients, transformation of equations, and methods for solving cubic and biquadratic equations.

3. **Apply Algebraic Inequalities**

Use important inequalities like AM ≥ GM ≥ HM, weighted means, m-th power inequality, and Cauchy-Schwartz inequality (with applications).

4. **Understand and Work with Matrices**

Learn matrix operations, types of matrices, inverse of a matrix, echelon forms, rank, normal forms, and conditions for invertibility and equivalence.

5. **Solve Systems of Linear Equations**

Analyze and solve both homogeneous and non-homogeneous systems using row-reduced echelon form and matrix techniques.

6. **Use Eigenvalues and Eigenvectors** Understand eigenvalues, eigenvectors, and their applications. Use the characteristic equation and apply Cayley-Hamilton theorem to find the inverse of a matrix.

Course Name: LOGIC, INTEGERS & BOOLEAN ALGEBRA

Course Type: Skill Enhancement Course

After completing this course, students will be able to:

1. **Understand Basic Logical Concepts**

Learn about propositions, truth tables, negation, conjunction, disjunction, implications, and logical equivalence.

2. **Work with Quantifiers and Logical Forms**

Understand predicates, quantifiers, converse, contrapositive, inverse statements, and precedence of logical operators.

3. **Apply Number Theory Concepts**

Use mathematical induction, division algorithm, Euclidean algorithm, and Fundamental Theorem of Arithmetic (statement only).

4. **Solve Problems Using Modular Arithmetic**

Understand and solve linear congruence equations and apply the Chinese Remainder Theorem.

5. **Work with Boolean Expressions and Circuits**

Simplify Boolean polynomials, use Karnaugh maps and Quine–McCluskey method, and understand minimal/maximal forms.

6. **Understand Logic Gates and Circuits**

Learn about logic gates, design switching circuits, and apply Boolean algebra in digital systems.

SEMESTER-II

Course Name: CALCULUS & GEOMETRY

Course Type: Major Course

After completing this course, students will be able to:

1. **Integrate Complex Functions**

Use reduction formulae to evaluate integrals of trigonometric, logarithmic, and exponential functions, including those with powers and products.

2. **Calculate Area and Curve Length**

Find arc length of curves (including parametric ones), area enclosed by a curve, and area between two curves.

3. **Understand Higher Derivatives and Applications**

Apply the Leibnitz rule and L'Hospital's rule to solve problems involving higher order derivatives.

4. **Analyze Curves**

Study curves using concepts like envelopes, pedal equations, asymptotes, curvature, concavity, convexity, cusps, and inflection points.

5. **Explore 2D Geometry and Conics**

Understand reflection properties, rotation of axes, second-degree equations, discriminant methods, and polar equations of conics.

6. **Understand 3D Geometry**

Study 3D shapes like spheres, cones, cylinders, ellipsoids, paraboloids, hyperboloids, and classify quadrics using generating lines and plane sections.

Course Name: GRAPH THEORY

Course Type: Skill Enhancement Course

After completing this course, students will be able to:

1. **Understand Basic Concepts of Graphs**

Define and identify types of graphs including pseudo graphs, complete graphs, bipartite graphs, and explore paths, cycles, and graph isomorphism.

2. **Analyze Special Graphs and Representations**

Describe Eulerian circuits, Hamiltonian cycles, and represent graphs using matrices (adjacency and incidence), including analysis of weighted graphs.

3. **Solve Real-Life Problems Using Graph Algorithms**

Apply algorithms such as Dijkstra's, Warshall's, and Kruskal's to solve the shortest path problem, traveling salesman's problem, and spanning tree generation.

4. **Explore Advanced Graph Structures**

Study properties of trees and forests, and understand graph matching in bipartite and general graphs, enhancing problem-solving in network theory and optimization.

SEMESTER-III

Course Name: REAL ANALYSIS

Course Type: Major Course

After completing this course, students will be able to:

1. **Understand the Fundamental Properties of Real Numbers**

Explain the algebraic and order properties of $\mathbb{R}$, concepts of bounds, supremum, infimum, and completeness. Analyze open, closed, compact, and derived sets, including the Bolzano-Weierstrass and Heine-Borel theorems.

2. **Analyze Sequences and Their Convergence**

Define and determine the convergence of sequences using limit theorems and Cauchy's criterion. Understand monotone sequences, the Sandwich theorem, and the Bolzano-Weierstrass theorem for sequences.

3. **Examine Limits and Continuity of Functions**

Apply the ε-δ definition of limits and continuity, evaluate infinite limits, and identify continuous functions. Use sequential and intermediate value criteria to analyze continuity over intervals.

4. **Study Infinite Series and Convergence Tests**

Assess convergence and divergence of infinite series using various tests such as comparison test, ratio test, root test, and Cauchy's test. Understand absolute and conditional convergence, including alternating and rearranged series.

Course Name: DIFFERENTIAL EQUATIONS

Course Type: Major Course

After completing this course, students will be able to:

1. **Understand and Solve Various Types of Differential Equations**

Identify and solve general, particular, explicit, implicit, and singular solutions of differential equations. Apply methods such as integrating factors, transformations, and exact equations. Analyze first and second-order differential equations including Clairaut's and Bernoulli equations.

2. **Apply Techniques to Higher Order and Homogeneous Equations**

Solve higher-order linear differential equations using complementary functions, particular integrals, and methods like undetermined coefficients and variation of parameters. Utilize the principle of superposition, Wronskian properties, and normal form reduction techniques.

3. **Analyze Linear Systems of Differential Equations**

Classify and solve systems of linear differential equations with constant coefficients using matrix methods and operator techniques. Represent systems in normal form and understand solutions in two-variable systems.

4. **Explore Theoretical and Qualitative Aspects**

Understand the Lipschitz condition and Picard's theorem (statement only), analyze autonomous systems, equilibrium points, and interpret phase planes.

5. **Solve Equations Using Power Series and Eigenvalue Methods**

Solve differential equations near ordinary and regular singular points using power series. Address simple eigenvalue problems to understand system dynamics.

Course Name: GROUP THEORY

Course Type: Major Course

After completing this course, students will be able to:

1. Understand and apply the fundamental concepts of equivalence relations, functions, permutations, and the structure of various algebraic systems such as semigroups, monoids, and groups.

2. Identify and analyze various types of groups including cyclic, symmetric, alternating, dihedral, and matrix groups, along with their structural properties.

3. Demonstrate a deep understanding of subgroups, centralizers, normalizers, and centers of groups, and determine conditions under which subsets form subgroups.

4. Apply Lagrange's theorem and its consequences such as Fermat's Little Theorem and Cauchy's theorem to solve theoretical and applied problems in group theory.

5. Examine the concepts of normal subgroups, cosets, quotient groups, and isomorphisms, and assess conditions for subgroup normality and group isomorphism.

6. Prove and apply the First, Second, and Third Isomorphism Theorems and Cayley's theorem in various algebraic contexts.

7. Develop logical reasoning and proof-writing skills essential for advanced study in abstract algebra and related mathematical areas.

Course Name: C-PROGRAMMING LANGUAGE

Course Type: Major Course

After completing this course, students will be able to:

1. Learn how computers work and understand what programming languages are, especially the C language.

2. Know how to use basic parts of C like variables, data types, and operators to write small programs.

3. Use if-else and loops (like for, while) to control how a program runs.

4. Work with arrays and create your own functions to make programs better and easier to manage.

5. Use built-in C functions and understand how to write functions with or without inputs and outputs.

SEMESTER-IV

Course Name: THEORY OF REAL AND COMPLEX FUNCTIONS

Course Type: Major Course

After completing this course, students will be able to:

1. Understand how functions change and behave using the ideas of derivatives and mean value theorems.

2. Learn how to use Taylor's and Maclaurin's series to write functions as sums, especially for exponential and trigonometric functions.

3. Know what it means for a sequence of functions to converge, and understand the continuity and differentiability of such sequences.

4. Understand complex numbers and functions, and learn important ideas like analytic functions, conformal mapping, and transformations.

Course Name: MECHANICS

Course Type: Major Course

After completing this course, students will be able to:

1. Understand how particles move in straight lines and in space, including ideas like velocity, acceleration, and forces.

2. Learn about central forces, planetary motion, and laws like Kepler's and Newton's laws.

3. Understand how a system of particles behaves, including center of mass and motion about the center of mass.

4. Study the balance of forces on bodies (statics), including virtual work, moments, couples, and equilibrium.

5. Understand different types of forces (like wrenches and screws), and learn about energy in mechanical systems.

Course Name: RING THEORY AND LATTICE THEORY

Course Type: Major Course

After completing this course, students will be able to:

1. Understand the basic properties of rings and learn about special types of rings like matrix rings, polynomial rings, and fields.

2. Study ideals in rings, including prime and maximal ideals, and how they behave under operations like sum and product.

3. Learn about ring homomorphisms and isomorphisms, and use isomorphism theorems in simple problems.

4. Understand the structure of lattices, including ordered sets, sublattices, and different types like modular and distributive lattices.

CBCS

SEMESTER-I

Course Name: CALCULUS & GEOMETRY

Course Type: DSC

After completing this course, students will be able to:

1. Understand and apply derivatives, L'Hospital's rule, and curve tracing in Cartesian and polar forms.

2. Use integration techniques and calculate arc length, area under curves, and volumes of revolution.

3. Learn 2D geometry concepts like conics, their properties, and classification using second-degree equations.

4. Understand 3D geometry including spheres, cones, cylinders, and other 3D shapes and their equations.

SEMESTER-II

Course Name: REAL ANALYSIS

Course Type: DSC

After completing this course, students will be able to:

1: Understand the basic structure of real numbers and different types of sets (open, closed, bounded, etc.).

2. Explain the concepts of supremum, infimum, and completeness of real numbers.

3. Understand and use important theorems like Bolzano-Weierstrass and Heine-Borel.

4. Learn about sequences and their types (bounded, convergent, divergent), and calculate their limits.

5. Apply different theorems for sequences like Cauchy's criterion and monotone convergence theorem.

6. Understand infinite series, test their convergence or divergence using various methods.

7. Use comparison test, ratio test, root test, and integral test to check convergence of series.

8. Analyze alternating series and understand absolute and conditional convergence.…

SEMESTER-III

Course Name: ALGEBRA

Course Type: DSC

After completing this course, students will be able to:

1. Understand and apply the polar form of complex numbers and De Moivre's theorem.

2. Solve problems involving trigonometric, exponential, logarithmic, and hyperbolic functions of complex variables.

3. Explore the fundamental theorem of classical algebra and its applications to solving polynomial equations.

4. Analyze roots of polynomial equations using symmetric functions, transformations, and Descartes' Rule of Signs.

5. Understand and apply Cardan's and Ferrari's methods for solving cubic and biquadratic equations.

6. Use mathematical inequalities like AM ≥ GM ≥ HM, m-th power mean inequality, and Cauchy-Schwartz inequality in problem solving.

7. Work with equivalence relations, partitions, and partial orders, and understand permutations and invertible functions.

8. Apply the division algorithm, Euclidean algorithm, and modular arithmetic to solve problems related to integers.

9. Understand the Fundamental Theorem of Arithmetic and solve linear congruence equations.

10. Work with matrices including row and column operations, echelon forms, and normal forms.

11. Understand the concepts of rank, equivalence, and congruence of matrices.

12. Compute eigenvalues and eigenvectors and use the Cayley-Hamilton theorem to find the inverse of matrices.

13. Solve systems of linear equations using matrix methods including row-reduced echelon form.

14. Build a foundation for further studies in linear algebra, number theory, and abstract algebra.

SEMESTER-IV

Course Name: DIFFERENTIAL EQUATION & VECTOR CALCULUS

Course Type: DSC

After completing this course, students will be able to:

1. Classify and solve first-order differential equations using standard methods (exact, separable, Bernoulli, and integrating factors).

2. Solve second-order linear differential equations and apply methods like undetermined coefficients and variation of parameters.

3. Analyze and solve systems of linear differential equations using operators and matrix methods.

4. Understand and interpret key theoretical concepts such as the Wronskian, Lipschitz condition, Picard's Theorem, and phase plane analysis.

5. Perform operations on vector-valued functions, including limits, continuity, differentiation, and integration.

6. Apply vector calculus concepts (dot, cross, triple products) in solving physical and engineering problems

SEMESTER-V

Course Name: GROUP THEORY & LINEAR ALGEBRA

Course Type: DSE

After completing this course, students will be able to:

1. Understand algebraic structures such as groupoids, semigroups, monoids, and groups, along with important examples like symmetric and dihedral groups.

2. Analyze properties of subgroups and apply concepts such as centralizers, normalizers, and subgroup products.

3. Examine element and group orders, cyclic groups, cosets, and apply Lagrange's theorem and Fermat's Little Theorem.

4. Develop understanding of vector spaces, subspaces, linear combinations, basis, and dimension.

5. Explore linear transformations, including null space, rank, and range, and perform matrix representation of linear maps.

6. Establish connections between linear maps and isomorphisms using matrix algebra and transformation properties.

SEMESTER-VI

Course Name: GROUP THEORY & LINEAR ALGEBRA

Course Type: DSE

After completing this course, students will be :

1. Able to formulate LPP and can solve LPP by graphical method, simplex method, two-phase method, Big-M method.

2.Able to explain Duality theory, can formulate dual problems and will have a clear concept on economic interpolation of the dual.

3.Eligible in formulating and solving Transportation problems and Assignment problems.

4.Able to formulate and solve two person zero sum game, graphical solution of game theory, linear programming solution of games.