Government City College (A)
Hyderabad-500002
(Affiliated to Osmania University)
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Department of Mathematics

MSc Mathematics
Course Outcomes

COURSE TITLE: Abstract Algebra

After completing the course students are expected to be able to:

S.No.	Course Outcomes	Blooms Taxonomy Classification
CO1	Recall the definitions and properties of isomorphism, automorphisms in group theory and Ring theory. To remember the structure theorems of groups, including the fundamental theorem of finite abelian groups and the Sylow theorems.	Remembering
CO2	Grasp the implications and applications of structure theorems of groups in understanding the classification and properties of groups. Understand the concept of unique factorization domains and their importance in algebraic number theory and ring theory.	Understanding
CO3	Apply the definitions and properties of ideals and homomorphisms to solve problems in ring theory and algebraic structures. Apply the concept of unique factorization domains to analyze factorization properties of elements in algebraic structures.	Applying
CO4	Analyze the relationships between ideals, homomorphisms, and other algebraic structures within rings and other algebraic systems.	Analyzing
CO5	Design proofs and arguments to establish new results and theorems related to isomorphism, group structure theorems, ideals and homomorphisms, and unique factorization domains. Create examples and counterexamples to illustrate abstract algebraic concepts and properties.	Creating

COURSE TITLE: Mathematical Analysis

After completing the course students are expected to be able to:

S. No.	Course Outcomes	Blooms Taxonomy Classification
CO1	Recall the definitions and properties of metric spaces, including metric functions, Riemann-Stieltjes integrals and their applications in real analysis, properties of sequences and series of functions, including convergence tests and properties of convergence.	Remembering
CO2	Understand the concept of metric spaces and their role in defining distances and topologies on sets. Understand the convergence properties of sequences and series of functions and their implications for analysis.	Understanding
CO3	Apply the techniques of Riemann-Stieltjes integrals to compute integrals of functions with respect to different measures. Apply convergence tests and criteria to analyze the convergence behavior of sequences and series of functions.	Applying
CO4	Analyze the properties and structures of metric spaces, including completeness, compactness, and connectedness. Analyze the behavior of functions using limits and continuity concepts.	Analyzing
CO5	Design proofs and arguments to establish new results and theorems related to metric spaces, limits of functions, Riemann-Stieltjes integrals, sequences, and series of functions. Design proofs and arguments to establish new results and theorems related to metric spaces, limits of functions, Riemann-Stieltjes integrals, sequences, and series of functions	Creating

COURSE TITLE: ORDINARY DIFFERENTIAL EQUATIONS

After completing the course students are expected to be able to:

S. No.	Course Outcomes	Blooms Taxonomy Classification
CO1	Recall the fundamental concepts related to the existence and uniqueness of solutions for ordinary differential equations (ODEs), properties of linear differential equations of higher order, including homogeneous and non-homogeneous equations.	Remembering
CO2	Grasp the theory behind linear differential equations of higher order and their solutions, including the concepts of linear independence and Wronskian.	Understanding
CO3	Apply stability analysis techniques to analyze the behavior of solutions to second-order differential equations. Apply differential equations theory to solve problems and model dynamical systems in various scientific and engineering contexts.	Applying
CO4	Analyze the conditions under which solutions to differential equations exist and are unique. Analyze proofs and derivations of key theorems and results related to ordinary differential equations to understand their significance and implications.	Analyzing
CO5	Design proofs and arguments to establish new results and theorems related to existence, uniqueness, and stability of solutions to ordinary differential equations. Create connections between ordinary differential equations and other areas of mathematics and science to explore interdisciplinary applications and relationships.	Creating

COURSE TITLE: LINEAR ALGEBRA

After completing the course students are expected to be able to:

S. No.	Course Outcomes	Blooms Taxonomy Classification
CO1	Remember the concepts and properties of direct sum decomposition theorem and its applications in vector spaces, the definitions and properties of bilinear forms and their representation using matrices.	Remembering
CO2	Grasp the concept of direct sum decomposition theorem and its role in decomposing vector spaces into simpler subspaces. Understand the concept of cyclic decompositions and their relationship to eigenvalues, eigenvectors, and minimal polynomials.	Understanding
CO3	Apply the direct sum decomposition theorem to decompose vector spaces and analyze linear transformations. Apply techniques for working with bilinear forms to solve problems and analyze geometric properties.	Applying
CO4	Analyze the properties and implications of Primary decomposition theorem, the Rational and Jordan forms Analyze the structure and behavior of cyclic decompositions and their connections to eigenvalues and eigenvectors.	Analyzing
CO5	Design proofs and arguments to establish new results and theorems related to elementary canonical forms, direct sum decomposition theorem, cyclic decompositions, and bilinear forms. Design exercises and problems to test understanding and proficiency in linear algebraic techniques.	Creating

COURSE TITLE: GALOIS THEORY

After completing the course students are expected to be able to:

S. No.	Course Outcomes	Blooms Taxonomy Classification
CO1	Recall the definitions and properties of algebraic extensions of fields, including Algebraic extensions and algebraically closed fields. Remember the definitions and properties of normal and separable extensions, including splitting fields and finite fields	Remembering
CO2	Understand the statement and proof of the Fundamental Theorem of Galois Theory and Fundamental theorem of Algebra. Understand Ruler and compass constructions.	Understanding
CO3	Apply abstract algebraic concepts to solve problems and prove theorems related to Galois Theory. Apply techniques for analyzing algebraic extensions of fields and determining their properties.	Applying
CO4	Analyze the properties and behaviors of normal and separable extensions and their relationships with Galois Theory. Analyze the implications of the Fundamental Theorem of Galois Theory for understanding field extensions and their Galois groups.	Analyzing
CO5	Design proofs and arguments to establish new results and theorems related to algebraic extensions of fields and Galois Theory.	Creating

COURSE TITLE: LEBESGUE MEASURE& INTEGRATION

After completing the course students are expected to be able to:

S. No.	Course Outcomes	Blooms Taxonomy Classification
CO1	Recall the definitions and basic properties of Lebesgue measure, Lebesgue integral, and their relationship with the Riemann integral. Remember the fundamental concepts of Borel sets, Outer measure, Littlewood's Principle	Remembering
CO2	Understand the algebraic structure of sets and its relevance in measure theory, including properties such as closure under countable unions and intersections.	Understanding
CO3	Apply techniques of differentiation under the integral sign to compute derivatives of integrals depending on parameters, employing tools like the Lebesgue dominated convergence theorem. Apply knowledge of convergence in measure to establish convergence properties of sequences of functions and to solve problems related to integration.	Applying
CO4	Analyze the interplay between sets and functions in the context of Lebesgue measure and integration, exploring how properties of sets influence integration. Analyze the limitations of the Riemann integral compared to the Lebesgue integral, particularly in dealing with unbounded functions and non-measurable sets.	Analyzing
CO5	Develop new methods for solving integration problems involving complex functions or domains, leveraging the tools and insights gained from the course.	Creating

COURSE TITLE: COMPLEX ANALYSIS

After completing the course students are expected to be able to:

S. No.	Course Outcomes	Blooms Taxonomy Classification
CO1	Recall the definition and basic properties of regions in the complex plane, including open, closed, connected, and simply connected regions. Recall the definition and properties of definite integrals of functions $w(t)$ along curves in the complex plane, such as contour integration along curves.	Remembering
CO2	Grasp the theoretical underpinnings of definite integrals of complex functions along curves, including understanding the connection to line integrals and the Cauchy Integral Formula. Understand the convergence criteria for sequences and series of complex numbers and functions, including properties like absolute convergence and uniform convergence.	Understanding
CO3	Apply techniques for finding derivatives of complex functions to solve problems involving analyticity, singularities, and mapping properties of complex functions. Apply methods of contour integration to evaluate definite integrals of complex functions, including using techniques like the Residue Theorem and the Cauchy Integral Formula.	Applying
CO4	Analyze the Rouche's theorem, Linear Transformations and Fractional Transformations	Analyzing
CO5	Design and develop strategies for evaluating complex integrals over non-trivial contours, demonstrating creativity and problem-solving skills.	Creating

COURSE TITLE: TOPOLOGY

After completing the course students are expected to be able to:

S. No.	Course Outcomes	Blooms Taxonomy Classification
CO1	Recall the definitions and basic properties of topological spaces, including open sets, closed sets, neighborhoods, and basis elements. Remember the definitions and key characteristics of fundamental concepts such as compactness, separation axioms (like Hausdorff and regular spaces), and connectedness.	Remembering
CO2	Understand the foundational concepts of topology, including the notion of continuity, homeomorphisms, and topological equivalence. Comprehend the significance of T1 spaces, Completely regular spaces, normal spaces.	Understanding
CO3	Apply techniques of compactness to prove results in analysis and geometry, such as the existence of maxima and minima of continuous functions on compact domains. Apply separation axioms to distinguish between different types of topological spaces and to prove specific properties of interest.	Applying
CO4	Analyze the Ascolli's theorem,Urysohn's Lemma, The Tietze extension theorem and The Urysohn imbedding theorem.	Analyzing
CO5	Create proofs for important theorems in topology, synthesizing definitions, lemmas, and logical reasoning to construct rigorous arguments.	Creating

COURSE TITLE: Functional Analysis

After completing the course students are expected to be able to:

S. No.	Course Outcomes	Blooms Taxonomy Classification
CO1	Recall the definitions and basic properties of normed spaces, including the triangle inequality and the completeness axiom and key properties of linear operators, such as boundedness, continuity, and compactness, orthonormal sequences and sets, including orthogonality relations and convergence in normed spaces.	Remembering
CO2	Understand the properties of Hilbert spaces, such as completeness, orthogonality, and the existence of orthogonal projections. Comprehend the significance of Linear functionals, Dual space, Total Orthonormal sets and sequences	Understanding
CO3	Apply knowledge of orthonormal sequences and sets to approximate functions, solve integral equations, or derive Fourier series expansions. Apply techniques of functional analysis to analyze the behavior of operators on normed and Hilbert spaces, such as the spectral theorem or the properties of compact operators.	Applying
CO4	Analyze the proofs of fundamental theorems in functional analysis, such as the Hahn-Banach theorem or the Riesz representation theorem, to understand their underlying logic and assumptions. Also analyze Reflexive spaces, Category Theorem, Open Mapping Theorem, Closed Graph Theorem	Analyzing
CO5	Design examples and counterexamples illustrating Norms& Equivalent norms and relationship between normed and inner product space.	Creating

COURSE TITLE: Elementary Number Theory

After completing the course students are expected to be able to:

S. No.	Course Outcomes	Blooms Taxonomy Classification
CO1	Remember the definitions and basic properties of arithmetic functions, such as the divisor function, Euler's totient function, and the Möbius function. Recall the statement and proof of the Fundamental Theorem of Arithmetic, understanding that every integer greater than 1 can be uniquely factored into primes, the Chinese Remainder Theorem.	Remembering
CO2	Understand the theory behind quadratic residues and non-residues, including their relationship to quadratic congruences and the quadratic reciprocity law.	Understanding
CO3	Apply techniques of congruences to solve equations modulo a prime or a composite number, and to analyze properties of congruence classes. Apply the properties of arithmetic functions and Dirichlet convolution to solve problems related to prime factorization, divisibility, and the distribution of prime numbers.	Applying
CO4	Analyze the properties of congruences and modular arithmetic, investigating the behavior of congruence classes under addition, multiplication, and exponentiation. Analyze the proof of the Quadratic Reciprocity Law and its consequences, understanding the techniques used, such as Gauss's lemma and the law of quadratic reciprocity.	Analyzing
CO5	Create proofs for theorems and propositions in elementary number theory, synthesizing definitions, lemmas, and logical reasoning to construct rigorous arguments.	Creating

COURSE TITLE: Discrete Mathematics

After completing the course students are expected to be able to:

S. No.	Course Outcomes	Blooms Taxonomy Classification
CO1	Remember the fundamental concepts of Boolean algebra, such as Boolean operations (AND, OR, NOT), De Morgan's laws, and Boolean identities. Recall the definition and basic properties of recurrence relations, including linear and non-linear recurrence relations, and their applications in counting and analyzing sequences.	Remembering
CO2	Understand the fundamental principles of combinatorics, including counting techniques, binomial coefficients, and the combinatorial interpretation of Pascal's triangle. Understand the concept of recurrence relations and their solutions, including methods such as iteration, substitution, generating functions, and characteristic roots.	Understanding
CO3	Apply the laws and properties of Boolean algebra to simplify Boolean expressions, design logical circuits, and analyze the behavior of digital systems. Apply combinatorial principles and techniques to solve problems involving counting, arrangements, and selections, as well as analyzing the structure of combinatorial objects.	Applying
CO4	Analyze the correctness and efficiency of Prim's and Kruskal's algorithms for finding minimum spanning trees, understanding their underlying principles and complexities.	Analyzing
CO5	Design and analyze graphs and trees for specific applications, including modeling real-world problems and applying graph algorithms to solve optimization problems.	Creating

COURSE TITLE: Operations Research

After completing the course students are expected to be able to:

S. No.	Course Outcomes	Blooms Taxonomy Classification
CO1	Recall the definitions and basic concepts of linear programming, including decision variables, objective function, constraints, feasible region, and optimality criteria, the formulation and solution methods for transportation problems, including the initial basic feasible solution, optimization algorithms like the North-West Corner Rule and Vogel's Approximation Method.	Remembering
CO2	Understand the theoretical foundations of linear programming, including the geometric interpretation of the simplex method and the simplex tableau. Comprehend the concept of duality in linear programming and its significance in providing alternative perspectives for solving optimization problems.	Understanding
CO3	Apply solution methods for transportation problems to optimize transportation costs and routes in logistics and supply chain management scenarios. Apply dynamic programming techniques to solve optimization problems with sequential decision-making, such as shortest path problems, inventory management, and resource allocation.	Applying
CO4	Analyze the relationships between primal and dual problems in linear programming, examining the economic interpretations of dual variables and the implications of duality theorems.	Analyzing
CO5	Create new applications or extensions of operations research techniques, exploring innovative ways to apply linear programming, duality, transportation, and dynamic programming to address emerging challenges in optimization and decision-making.	Creating

COURSE TITLE: Integral Equations and Calculus of Variations

After completing the course students are expected to be able to:

S. No.	Course Outcomes	Blooms Taxonomy Classification
CO1	Recall the definitions and basic properties of Volterra and Fredholm integral equations, including their classification, kernel functions, and solutions. Remember the methods and techniques used to solve different types of integral equations, such as the method of successive approximations, convolution, and eigenfunction expansions.	Remembering
CO2	Understand the principles and methods of the calculus of variations, including the variational principles, necessary and sufficient conditions for extrema, and the role of boundary conditions.	Understanding
CO3	Apply techniques of the calculus of variations to solve optimization problems with fixed endpoints, such as finding extremals for functionals subject to given constraints, Euler's equations and variational principles to solve classical problems in physics and engineering, including motion planning and optimal control problems.	Applying
CO4	Analyze the Convolution type equations, Solution of Integro-Differential Equations, Abel's integral equations and Hammerstein type equation. Analyze the Construction of Green's Function, the Problem of minimum surface of revolution, Euler Poisson equation.	Analyzing
CO5	Design optimization problems in the calculus of variations, considering various constraints and boundary conditions, and applying appropriate solution techniques to find extremals.	Creating

COURSE TITLE: Partial Differential Equations

After completing the course students are expected to be able to:

S. No.	Course Outcomes	Blooms Taxonomy Classification
CO1	Recall the fundamental concepts and classifications of partial differential equations (PDEs), including first-order nonlinear equations and higher-order linear PDEs with constant coefficients. Remember the definitions and basic properties of Fourier transforms, including the transform pairs and properties such as linearity, shift, and scaling.	Remembering
CO2	Grasp the concepts and techniques used in solving PDEs, such as separation of variables, Fourier transforms, and the method of characteristics, and their applications in different problem domains.	Understanding
CO3	Apply techniques for solving higher-order linear PDEs with constant coefficients to model and analyze wave phenomena, diffusion processes, and other phenomena governed by wave equations.	Applying
CO4	Analyze the D' Alembert's solution of wave equation, Dirichlet Problem and Neumann Problem.	Analyzing
CO5	Develop new solution techniques or algorithms for solving specific classes of PDEs, exploring alternative methods or extensions to existing techniques. Design applications of Fourier transforms and separation of variables methods to solve PDEs in novel problem domains, such as image processing, signal analysis, or quantum mechanics.	Creating

COURSE TITLE: Numerical Analysis

After completing the course students are expected to be able to:

S. No.	Course Outcomes	Blooms Taxonomy Classification
CO1	Recall the methods and algorithms for solving transcendental and polynomial equations, including the bisection method, Newton-Raphson method, and secant method and Muller's Method. Remember the techniques for solving systems of linear algebraic equations, such as Gaussian elimination, LU decomposition, and iterative methods like Jacobi and Gauss-Seidel.	Remembering
CO2	Understand the principles of interpolation and approximation, including error analysis and the choice of appropriate interpolation or approximation methods for different scenarios. Understand the numerical integration techniques and their convergence properties, including the concepts of numerical quadrature and error estimation.	Understanding
CO3	Apply numerical methods for solving ODEs to simulate and analyze dynamic systems in engineering, physics, and biology, and to predict their behavior over time.	Applying
CO4	Analyze the accuracy and stability of techniques for solving systems of linear algebraic equations, investigating the effects of matrix conditioning, round-off errors, and algorithmic choices.	Analyzing
CO5	Design new interpolation or approximation methods tailored to specific problem domains or data sets, considering factors such as noise, sparsity, or irregular data spacing.	Creating