DAYALBAGH EDUCATIONAL INSTITUTE
FACULTY OF SCIENCE
DEPARTMENT OF MATHEMATICS

Course Type	Course Code	Name of Course	Lectures/Week (of 55Min each)	Credits
Major	**MAM 701**	**Measure and Integration**	**4**	**4**

Introduction:

This course offers a rigorous foundation in measure theory and Lebesgue integration, covering the essential aspects needed for advanced studies in real analysis and functional analysis.

Objectives:

1. To develop a comprehensive understanding of Lebesgue measure, measurable sets, and measurable functions.
2. To learn the principles of Lebesgue integration and important convergence theorems.
3. To understand and apply the properties of L^p spaces and fundamental inequalities.
4. To develop skills for applying measure and integration theory to advanced mathematical problems.

Course Outcomes (CO):

This course is aimed at

CO1: Understanding the concept of Lebesgue outer measure, properties of measurable sets, and distinguishing between Borel and measurable sets.

CO2: Constructing the Lebesgue measure, analyzing measurable sets and functions, and applying regularity properties.

CO3: Understanding Lebesgue integration of various functions and applying convergence theorems such as Fatou's Lemma and the Monotone Convergence Theorem.

CO4: Applying the general properties of Lebesgue integration and using the Dominated Convergence Theorem in practical integration scenarios.

CO5: Exploring L^p spaces as metric spaces, proving fundamental inequalities, and demonstrating the completeness of L^p spaces.

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	Lebesgue Outer Measure, its properties, Measurable sets and their properties, Borel sets and their measurability	CO1	Understand, Apply
2.	Construction of Lebesgue Measure, Properties of Measurable Sets, Regularity, Measurable Functions and their Properties	CO2	Understand, Apply
3.	Lebesgue Integration: Simple Function, Lebesgue integral of Simple functions, Bounded and Non-Negative measurable functions, Fatou's Lemma, Monotone Convergence Theorem	CO3	Apply, Analyze
4.	General Lebesgue Integration, Dominated Convergence Theorem, Integration of Series	CO4	Apply, Analyze, Evaluate
5.	L^p Spaces: L^p as a vector and metric space, Hölder and Minkowski inequalities, Completeness of L^p spaces	CO5	Analyze, Create

Text Books and Reference Books:

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1.	Real Analysis |	H.L. Royden	4th Edition, 2010, Prentice Hall	USA
2.	Measure Theory and Integration,	G. de Barra	1st Edition, 1981, Elseveir	USA

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Course Type	Course Code	Name of Course	Lectures / Week (of 55 Min each)	Credits
Major	**MAM702**	**TOPOLOGY**	**4**	**4**

Introduction:

This is a first course on topology that motivates to think beyond metric spaces. This leads to classification of spaces, paving the way for further exploration in algebraic topology.

Objectives:

1. Learn fundamental concepts of topology through geometric visualization.
2. Understand difference between rubber sheet geometry and topology
3. Classify topological spaces upto homeomorphism.
4. Construct and visualize rigorous proofs.
5. Construct counter examples.
6. Develop appreciation for abstraction.

Course Outcomes (CO):

CO1: Introduce basic concepts of topology
CO2: Learn key examples-Euclidean space, Discrete Space, Indiscrete Space, Cofinite Space etc.
CO3: Study continuous maps and homeomorphism:
CO4: Construct new spaces: subspaces, product and quotient
CO6: Study topological properties- countability axioms, separation axioms, compactness, connectedness and path connectedness
CO7: Classify topological spaces upto homeomorphism

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	Topology, Closed Sets, Basis, Subbasis, Metric Topology, Subspace Topology, Interior Points, Exterior Points, Boundary Points and Limit Points of a Set, Derived set, Interior and Closure of a Set, Dense Sets, Real Line, Sorgenfrey Line	Basic Concepts and Key Examples	Interpreting, explaining, implementing, differentiating
2.	Continuous Map, Open Map, Closed Map, Projection Map, Homeomorphism	Homeomorphism, Spaces being Homeomorphic	Interpreting, explaining, implementing, differentiating
3.	Product space, Quotient Space, Quotient Map, Introduction to Countability Axioms	New spaces, Countability Axioms	Interpreting, explaining, implementing, differentiating
4.	T_1, T_2, Regular, T_3, Completely Regular, $T_{3½}$, Normal and T_4 Spaces, Compact Spaces	Topological Properties	Generating
5.	Connected Spaces, Components, Path Connected Spaces, Path Components, Applications of Connectedness	Connectedness, Classification of Topological Spaces	Classifying, generating

Text Books and Reference Books:

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1.	TOPOLOGY- A FIRST COURSE	J. R. Munkres	Second Edition, 2015, PHI Learning Private Limited	Delhi
2.	GENERAL TOPOLOGY	J. L. Kelley	Van Nostrand, 1955	New York

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Course Type	Course Code	Name of Course	Lectures/Week (of 55Min each)	Credits
Major	**MAM 703**	Theory of differential equations	**4**	**4**

Introduction:

This course covers essential concepts of differential equations, focusing on existence and uniqueness of solutions, stability analysis, and applications of linear and nonlinear differential equations.

Objectives:

- Introduce foundational concepts in differential equations.
- Study the behavior and solutions of linear and nonlinear systems.
- Analyze stability and oscillatory properties of differential equations.
- Explore advanced methods, such as Green's functions and integral equations.

Course Outcomes (CO):

- **CO1:** Understand basic concepts, conditions, and inequalities related to differential equations, including existence and uniqueness theorems.
- **CO2:** Solve linear differential equations with variable coefficients and analyze oscillatory behavior, Sturm-Liouville boundary conditions, and Green's functions.
- **CO3:** Develop solutions for non-homogeneous linear systems and systems with constant or periodic coefficients using the fundamental matrix.
- **CO4:** Assess stability and behavior of solutions in linear differential systems.
- **CO5:** Investigate stability in nonlinear differential equations, apply the Poincaré-Bendixson theorem, and understand basic methods for solving linear integral equations.

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	Elementary Concepts about Differential Equations, Lipschitz condition, Gronwall inequality, Existence and Uniqueness of solutions for scalar and systems of equations.	CO1	**Remembering:** Recall foundational concepts and conditions in differential equations. **Understanding:** Explain the significance of Lipschitz conditions and Gronwall inequality. **Applying:** Apply existence and uniqueness theorems to differential equations.
2.	Linear Differential Equations with Variable Coefficents, Linear Dependence and Independence of Solutions, Concept of Wronskian, Oscillatory and Non-oscillatory Behaviour of Solutions of Second Order Linear Differential Equations, Non-Homogenous Equations, Strum-Liouville Boundary Value Problem, Green's Function.	CO2	**Understanding:** Describe linear dependence and the Wronskian. **Applying:** Use methods to solve linear differential equations and apply Green's function. **Analyzing:** Examine oscillatory and non-oscillatory behavior in solutions.
3.	Fundamental matrix, Non-homogenous Linear Equations, Linear Systems with constant coefficients, Linear Systems with Periodic Coefficients.	CO3	**Understanding:** Explain fundamental matrix concepts in system solutions. **Applying:** Solve systems with constant and periodic coefficients. **Analyzing:** Analyze solution behaviors in non-homogeneous linear equations.

4.	Stability of Linear Systems, Behaviour of solutions of Linear Differential Equations.	CO4	**Understanding:** Explain the stability theory for linear systems. **Applying:** Analyze solution behaviors to assess system stability. **Evaluating:** Evaluate system stability under varying conditions.
5.	Stability of Nonlinear Differential Equations, Applications of Poincare Bendixon Theorem, Introductory Methods of Solution of Linear Integral Equations.	CO5	**Understanding:** Describe the Poincaré-Bendixson theorem and its applications. **Applying:** Apply stability analysis to nonlinear systems. **Creating:** Use introductory methods to formulate solutions for linear integral equations.

Text Books and Reference Books:

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1	Ordinary Differential Equations	E.L. Ince	Dover Publications,	USA
2.	Differential Equations and Dynamical Systems	Lawrence Perko	3rd Edition, Springer	USA

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Course Type	Course Code	Name of Course	Lectures / Week (of 55 Min each)	Credits
Major	**MAM704**	Analytical Mechanics	**4**	**4**

Introduction:

This is an advanced undergraduate course introducing the formalism of Lagrangian and Hamiltonian mechanics, emphasizing the variational principles of classical mechanics. The course provides a solid theoretical foundation necessary for further studies in theoretical physics, applied mechanics, and advanced mathematical modeling of dynamical systems.

Objectives:

1. 1. Understand and apply the principles of calculus of variations to mechanical systems.
2. Introduce Lagrangian mechanics through generalized coordinates and conservation laws.
3. Analyze conservative dynamical systems and small oscillations.
4. Explore variational principles such as Hamilton's principle and least action.
5. Develop Hamiltonian mechanics, including canonical equations and phase space.
6. Study rigid body motion using Euler's dynamical equations in rotating frames.

Course Outcomes (CO):

CO1	Understand the Euler-Lagrange equations and apply the calculus of variations to physical systems.
CO2	Apply generalized coordinates and velocities to derive Lagrange's equations for holonomic systems.
CO3	Analyze conservative systems in terms of kinetic energy, momentum, impulse, and small oscillations.
CO4	Formulate variational principles such as Hamilton's principle and the principle of least action.
CO5	Derive and solve Hamilton's equations, and apply canonical transformations and Poisson brackets.
CO6	Study rigid body motion using Euler's equations and analyze motion in rotating frames.

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	Euler-Lagrange equation, functionals (higher derivatives and multivariable), variational boundary value problems	Master variational calculus and its applications to differential equations	Understanding, Applying, Evaluating
2.	Generalized coordinates/velocities, virtual work, Lagrange's equations, momentum, impulse, small oscillations, equilibrium	Apply Lagrangian mechanics to conservative holonomic systems	Understanding, Applying, Analyzing
3.	Variational methods, Brachistochrone, Hamilton's principle, least action	Understand and distinguish key variational principles in physics	Understanding, Comparing, Applying
4.	Hamilton's equations, Hamiltonian to Lagrangian transition, Hamilton–Jacobi equation, Poisson brackets, Liouville's theorem	Analyze phase space dynamics and derive equations using Hamiltonian formalism	Generating
5.	Euler's dynamical equations, fixed-point motion, motion under no external forces, rotating axes	Apply rigid body dynamics concepts in rotating frames	Applying, Analyzing

Text Books and Reference Books:

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1.	Classical Mechanics	H. Goldstein, C. Poole, J. Safko	3rd Edition, 2002, Pearson Education	New Delhi
2.	Analytical Mechanics	G. R. Fowles and G. L. Cassiday	7th Edition, 2005, Thomson Brooks/Cole	USA
3.	Mechanics	L. D. Landau and E. M. Lifshitz	3rd Edition, 1976, Butterworth-Heinemann	Oxford

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Course Type	Course Code	Name of Course	Lectures/Week (of 55Min each)	Credits
Major	**MAM 704**	**Rings & Canonical Forms**	**4**	**4**

Introduction:

This course provides strong foundations of Rings & Canonical Forms enabling students to understand and apply the basic concepts required for advanced studies.

Objectives:

1. To understand polynomial rings, division algorithms, and irreducibility criteria.
2. To explore quadratic integer rings, Euclidean domains, principal ideal domains, and unique factorization domains.
3. To grasp concepts of eigenvalues, eigenvectors, and conditions for diagonalizability.
4. To study minimal polynomials, invariant subspaces, and their relation to diagonalizability and triangulability.
5. To understand generalized eigenspaces, cycles of generalized eigenvectors, and Jordan and rational canonical forms.
6. To develop rigorous proof construction and problem-solving abilities in algebra.

Course Outcomes (CO):

This course is aimed at

1. CO1: Develop a strong understanding of polynomial rings, including concepts like roots, division algorithm, and irreducibility. Gain proficiency in using tests like Mod p and Eisenstein's criterion to assess polynomial irreducibility and explore cyclotomic polynomials.
2. CO2: Understand the structure of quadratic integer rings and related properties, including Euclidean Domains, Principal Ideal Domains (PIDs), and Unique Factorization Domains (UFDs), gaining skills to identify and work within these domains.
3. CO3: Gain a deep understanding of eigenvalues, geometric and algebraic multiplicity, and the direct sum of subspaces and eigenspaces. Learn to determine conditions for diagonalizability of matrices and linear operators.
4. CO4: Master the minimal polynomial concept and its relationship with invariant subspaces, triangulability, and diagonalizability. Develop skills in working with cyclic subspaces, the Cayley-Hamilton theorem, and the companion matrix.
5. CO5: Explore advanced canonical forms, including generalized eigenspaces, cycles of generalized eigenvectors, and the Jordan and rational canonical forms. Acquire the ability to decompose matrices into direct sums of generalized eigenspaces and understand their applications.

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	Polynomial Rings, Roots of a Polynomial, Division Algorithm, Irreducibility of a Polynomial, Mod p Irreducibility Test, Eisenstein Criterion, Irreducibility of pth Cyclotomic Polynomial	CO1	• **Remembering**: Identify and recall definitions of polynomial rings, roots, and irreducibility. • **Understanding**: Explain the division algorithm and irreducibility tests (e.g., Eisenstein criterion). • **Applying**: Use Mod p irreducibility tests and apply the concepts to specific polynomials. • **Analyzing**: Compare different irreducibility criteria and analyze cyclotomic polynomials.
2.	Quadratic Integer Rings, Euclidean Domain, Principle Ideal Domain, Unique Factorization Domain.	CO2	• **Remembering**: Define quadratic integer rings, Euclidean domains, principal ideal domains, and unique factorization domains. • **Understanding**: Describe properties and relationships among different ring structures. • **Applying**: Solve problems involving Euclidean domains and demonstrate unique factorization. • **Analyzing**: Differentiate between various types of rings and analyze their structures.
3.	Geometric and Algebraic Multiplicity, Direct Sum of Subspaces, Direct Sum of Eigenspaces, Diagonalizability of Matrices and Linear Operators.	CO3	• **Remembering**: Recall definitions of eigenvalues, eigenvectors, and multiplicities. • **Understanding**: Explain the concepts of geometric and algebraic multiplicity. • **Applying**: Calculate eigenvalues and eigenvectors

			for given matrices.Analyzing: Examine conditions for diagonalizability and the direct sum of eigenspaces.
4.	Minimal Polynomial, Invariant Subspaces, Conductor, Minimal Polynomial & Diagonalizability, Minimal Polynomial &Triangulability, Cyclic Subspace, Cayley-Hamilton Theorem, Companion Matrix.	CO4	• **Remembering**: Identify minimal polynomials and invariant subspaces. • **Understanding**: Summarize the relationship between minimal polynomials and diagonalizability. • **Applying**: Use the Cayley-Hamilton theorem to find minimal polynomials. • **Analyzing**: Analyze how minimal polynomials relate to triangulability and cyclic subspaces.
5.	Generalized Eigenspace, Cycle of Generalized Eigenvectors, Direct Sum of Generalized Eigenspaces, Jordan Form, Rational Form.	CO5	• **Remembering**: Recall the definitions of generalized eigenspaces and Jordan form. • **Understanding**: Explain the significance of cycles of generalized eigenvectors. • **Applying**: Construct Jordan forms for given matrices. • **Analyzing**: Compare Jordan forms with rational forms and analyze their applications.

Text Books and Reference Books:

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1	LINEAR ALGEBRA	S. H. Friedberg, A. J. Insel and L. E. Spence	Fourth Edition, PHI, 2009	New Delhi

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Course Type	Course Code	Name of Course	Practical Labs/Week (of 55Min each)	Credits
Major	**MAM 706**	**Programming Lab I**	**4**	**2**

Introduction:

This lab course provides practical experience in object-oriented programming (OOP) concepts using modern programming languages such as Python or Java. It also introduces students to mathematical software tools like MATLAB and Python packages for computational tasks.

Objectives:

1. To understand the principles of object-oriented programming.
2. To develop skills in coding using modern OOP languages (Python/Java).
3. To apply mathematical software tools for data analysis and modeling.
4. To enhance problem-solving skills through programming and software applications.
5. To encourage collaboration and independent project work using programming and mathematical software.

Course Outcomes (CO):

By the end of the course, students will be able to:

CO1: Understand and implement key object-oriented programming concepts such as classes, objects, inheritance, and polymorphism.
CO2: Write and debug programs using MATLAB to solve mathematical problems.
CO3: Utilize mathematical software (MATLAB/R/Python packages) for data analysis and visualization.
CO4: Implement algorithms and numerical methods in programming environments to address real-world problems.
CO5: Collaborate on projects using programming and mathematical software to solve complex interdisciplinary challenges.

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	Introduction to Object-Oriented Programming Concepts	CO1	Understand, Apply
2.	Working with Mathematical Software: Introduction to MATLAB Package. Writing and debugging	CO2	Apply, Analyze
3.	Coding in MATLAB/Python	CO3	Apply, Analyze
4.	Data Analysis and Visualization with Mathematical Software MATLAB/ Python	CO4	Analyze, Evaluate
5.	Applying OOP and Mathematical Software to Solve Real-World Problems using MATLAB/Python	CO5	Create, Evaluate

Text Books and Reference Books:

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1.	MATLAB for Engineers	Holley Moore, et al.	4th Edition, 2016, Pearson	USA
2.	Python Programming: An Introduction to Computer Science .	John Zelle	2nd Edition, 2010, Franklin, Beedle &	USA

			Associates Inc	

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Course Type	Course Code	Name of Course	Lectures/Week (of 55Min each)	Credits
Major	**MAM801/DBD202**	**Advanced Optimization Techniques**	**4**	**4**

Introduction:

This course provides strong foundations of advanced optimization tecnhiques enabling students to understand and apply for advanced studies.

Objectives:

1. To understand advanced topics in queueing theory, non-linear programming, dynamic programming, and integer programming.
2. To develop the ability to solve complex optimization and decision-making problems using mathematical methods.
3. To explore the theoretical and practical aspects of queueing systems and optimization techniques.
4. To apply mathematical modeling to real-world scenarios in engineering, management, and operations.

Course Outcomes (CO):

This course is aimed at

CO1: Understand queueing models, their classifications, and solutions to Poisson queue systems.
CO2: Analyze and solve optimization problems involving non-linear functions with and without constraints.
CO3: Apply advanced methods such as Kuhn-Tucker conditions, Fibonacci search, and graphical techniques for solving non-linear programming problems.
CO4: Understand the principles of dynamic programming and solve multistage decision processes.
CO5: Solve integer programming problems using methods like Gomory's method and branch-and-bound techniques.

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	Queueing Theory: Introduction, Definitions and Notations, Classification of Queueing Models, Distribution of Arrivals (The Poisson Process): Pure Birth Process, Distribution of Inter Arrival Times, Distribution of Departures (Pure Death Process), Distribution of Service Time, Solution of Queueing Models, Poisson Queues- (M/M/1): (∞/FIFO), (M/M/1):(N/FIFO), (M/M/C): (∞/FIFO), (M/M/C): (N/FIFO).	CO1	**Remembering:** Define queueing terminologies such as Poisson process, arrival rates, departure rates, and service times. **Understanding:** Explain the classification of queueing models and the behavior of M/M/1M/M/1M/M/1, M/M/CM/M/CM/M/C systems. **Applying:** Solve problems involving Poisson queue models and calculate performance measures like average wait time and queue length. **Analyzing:** Compare the impact of different queue parameters on system performance.
2.	Non-Linear Programming Problem (NLPP): Introduction, Maxima and minima of functions of several variables and their solutions, Quadratic forms, Concave and convex functions, Unconstrained and constrained optimization.	CO2	**Remembering:** Recall definitions of concave and convex functions, quadratic forms, and optimization methods. **Understanding:** Explain the concepts of constrained and unconstrained optimization. **Applying:** Solve optimization problems involving multiple variables using given conditions. **Analyzing:** Evaluate the properties of functions (e.g., concavity or convexity) to determine feasible solutions.
3.	Constrained NLPP: Lagrange's method, Kuhn-Tucker conditions, Graphical Method, Concept of Quadratic programming, Frank-Wolfe method. Unconstrained NLPP: Fibonacci and Golden section search, Steepest Descent Method, Conjugate metric method.	CO3	**Remembering:** State methods like Lagrange multipliers, Kuhn-Tucker conditions, Fibonacci search, and Frank-Wolfe method. **Understanding:** Explain the theoretical basis of quadratic programming and search techniques. **Applying:** Solve constrained and unconstrained

			NLPPs using graphical, numerical, or iterative methods. **Analyzing:** Assess the effectiveness of methods like the steepest descent and conjugate metric techniques. **Evaluating:** Critique and compare solution approaches for optimization problems.
4.	Dynamic Programming: Multistage decision processes, Concept of sub-optimality, Principle of optimality, Calculus method of solution, Tabular method of solution, LPP as a case of dynamic programming.	CO4	**Remembering:** Define the principles of optimality and sub-optimality. **Understanding:** Explain multistage decision processes and how dynamic programming solves them. **Applying:** Solve problems using tabular and calculus methods in dynamic programming. **Analyzing:** Break down multistage problems into subproblems and analyze dependencies. **Evaluating:** Examine the suitability of dynamic programming approaches for specific types of problems.
5.	Integer programming: Gomory method for pure and mixed LPP, All pure and mixed integer programming, Algorithm and solution of numerical problems, Branch and bound method.	CO5	**Remembering:** Recall methods like Gomory's method and branch-and-bound. **Understanding:** Describe the differences between pure and mixed integer programming problems. **Applying:** Solve integer programming problems using algorithms like branch-and-bound. **Analyzing:** Analyze numerical solutions to integer programming problems for feasibility. **Evaluating:** Evaluate the performance of integer programming algorithms and their computational efficiency.

Text Books and Reference Books:

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1.	Operations Research: An Introduction	Taha H.A.	10th Edition, 2017,Pearson	USA
2.	Nonlinear Programming: Theory and Algorithms	Bazaraa M.S., Sherali H.D., Shetty C.M.	3rd Edition, 2013, Wiley	USA
3.	Dynamic Programming and Optimal Control	Dimitri P. Bertsekas	4th Edition, 2017, Athena Scientific	USA
4.	Queueing Theory and Stochastic Processes	Bhat U. N.	2nd Edition, 2015, Springer	USA

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Course Type	**Course Code**	**Name of Course**	**Lectures / Week (of 55 Min each)**	**Credits**
Major	**MAM802**	**FIELD THEORY**	**4**	**4**

Introduction:

This is a foundational course on field extensions leading to classification of finite fields and computation of group of automorphisms on field extensions.

Objectives:

1. Study finite and algebraic field extensions
2. Applications of algebraic tools to problems related to geometric constructions
3. Classification of finite fields
4. Finite Field as simple extension and splitting field
5. Computation of group of automorphisms

Course Outcomes (CO):

CO1: Study various field extensions and degree
CO2: Construction of a finite field having roots of a polynomial
CO3: Applications of field extensions to geometric constructions
CO4: Splitting field, roots of unity and cyclotomic extension
CO5: Classification of finite fields and subfields
CO6: Automorphisms of a field and computation of Galois group

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	Extension of a Field, Quadratic Extensions, Degree, Multiplicativity of Degrees, Finite Extension, Subfield Generated by a Subset, Simple Extension, Roots of a Polynomial in an Extension Field, Fundamental Theorem of Field Theory.	Finite Field Extension	Interpreting, explaining, implementing, differentiating
2.	Algebraic Elements, Finite Simple Extension, Algebraic Extension, Finite and Algebraic Extension, Operations on Algebraic Elements, Applications to Geometric Constructions.	Algebraic Extension, Applications to Geometric Constructions	Interpreting, explaining, implementing, differentiating
3.	Multiplicity of Roots of a Polynomial in an Extension Field, Roots of Unity over Q and over Z_n, Separability of Polynomials, Separable Extension, Splitting Field, Cyclotomic Polynomial, Cyclotomic Extension.	Roots of Unity, Cyclotomic Extension	Differentiating, Checking
4.	Finite Fields, Classification of Finite Fields, Finite Fields as Simple Extensions and their Degree, Structure of Finite Fields, Subfields of a Finite Field.	Classification and Structure of Finite Fields	Differentiating, Checking
5.	Group of Automorphisms of a Field, Fixed Field, Galois Group, Frobenius Automorphism, Applications of Fundamental Theorem of Galois Theory.	Group of Automorphisms	Differentiating, Checking

Text Books and Reference Books:

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1.	ABSTRACT ALGEBRA	D. S. Dummit and R. M. Foote	Second Edition, 2009, John Wiley & Sons	New Delhi
2.	GALOIS THEORY	Joseph Rotman	Second Edition, 2010, Springer (India)	New Delhi
3.	CONTEMPORARY ABSTRACT ALGEBRA	J. A. Gallian	Fourth Edition, 1999, Narosa Publishing House	New Delhi
4.	TOPICS IN ALGEBRA	I. N. Herstein	Second Edition, 2007, John Wiley & Sons	New Delhi

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Course Type	Course Code	Name of Course	Lectures/Week (of 55 min each)	Credits
Major	**MAM 803**	**Functional Analysis**	**4**	**2**

Introduction:

This course introduces the foundational concepts and theorems of functional analysis, with a focus on normed and inner product spaces, bounded linear operators, and spectral theory. It provides a framework for understanding advanced topics in analysis and its applications in mathematics and physics.

Objectives:

1. To develop a strong understanding of normed linear spaces and the concept of compactness in finite-dimensional spaces.
2. To explore the properties of dual spaces and the principles of weak topology.
3. To understand fundamental theorems of functional analysis, including the Hahn-Banach theorem, Open Mapping theorem, and Uniform Boundedness principle.
4. To examine the structure and properties of Hilbert spaces, including orthogonality and Fourier expansions.
5. To analyze the behavior of operators on Banach and Hilbert spaces, with a focus on spectral theory.

Course Outcomes (CO):

By the end of the course, students will be able to:

CO1: Understand the structure and properties of normed linear and Banach spaces, and analyze continuity and compactness in finite-dimensional spaces.

CO2: Finding dual spaces, Apply concepts of dual spaces, weak topology, and embeddings in advanced problems of functional analysis.

CO3: Demonstrate the application of central theorems such as Hahn-Banach, Open Mapping, and Closed Graph theorems in problem-solving.

CO4: Analyze the properties and representations of Hilbert spaces, including orthonormal sets and Fourier expansions.

CO5: Evaluate and apply the spectral theorem and the properties of self-adjoint, normal, and unitary operators in mathematical and physical contexts.

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	Normed Linear Space, Banach Space, Finite Dimensional Normed Linear Space, Compactness and Finite Dimension, Continuity of a Linear Map.	CO1	Understand, Analyze
2.	Dual Space, Natural Embedding, Weak Topology, Principle Conjugate of an Operator.	CO2	Apply, Analyze
3.	Hahn-Banach Theorem, Open Mapping Theorem, Closed Graph Theorem, Uniform Boundedness Principle.	CO3	Analyze, Evaluate
4.	Hilbert Space, Schwarz's Inequality, Orthogonal Complement, Orthonormal Sets, Bessel's Inequality, Fourier Expansion, Gram-Schmidt Process.	CO4.	Analyze, Apply
5.	Adjoint, Self-Adjoint, Normal, and Unitary Operators, Spectral Theorem.	CO5	Analyze, Evaluate

Text Books and Reference Books:

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1	Functional Analysis	B.V. Limaye	3rd Edition, 2014, New Age International	India
2	Introduction to Functional Analysis	E. Kreyszig	2nd Edition, 1989, Wiley	USA
3.	Functional Analysis: Principles and Applications	H.K. Pathak	1st Edition, 2009, Springer	India
4	Introductory Functional Analysis with Applications	E. Kreyszig	Revised Edition, 2007, Wiley	USA
5.	A First Course in Functional Analysis	C. Goffman and G. Pedrick	1st Edition, 1974, Prentice Hall	USA

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Course Type	Course Code	Name of Course	Lectures/Week (of 55Min each)	Credits
Major	**MAM 804**	**Fluid Dynamics**	**4**	**4**

Introduction:

This course provides a comprehensive understanding of the fundamental principles and equations governing the motion of fluids. It is designed to introduce students to the core concepts and mathematical formulations used to analyze fluid flow in various physical situations. From basic concepts like the equation of continuity to advanced topics such as boundary layer theory and vortex dynamics, this course equips students with the knowledge to model and solve complex fluid flow problems in engineering, physics, and applied sciences.

Objectives:

1. Develop an understanding of the equations of continuity, motion, and vorticity, and learn to apply them in various coordinate systems and boundary conditions.
2. Study the impact of viscosity on fluid flow, and solve problems using the Navier-Stokes, Euler, and Bernoulli's equations in steady flow situations.
3. Understand two-dimensional flow concepts and complex potentials, including the use of velocity potential and stream function for irrotational and incompressible flows.
4. Learn about vortex dynamics and solve problems involving complex potential theory for vortex systems and their images in different geometries.
5. Gain an understanding of boundary layers and the application of Prandtl's boundary layer theory, alongside solving problems using non-dimensional numbers.

Course Outcomes (CO):

This course is aimed at

CO1: Understand and apply the equation of continuity in different coordinate systems, and solve problems using the Lagrangian and Eulerian forms of the equation of motion.

CO2: Analyze and solve problems involving viscosity, steady flow in different geometries, and apply Navier-Stokes and Bernoulli's equations.

CO3: Understand the concepts of two-dimensional flow, velocity potential, stream function, and apply complex potential theory to various flow systems.

CO4: Analyze vortex dynamics and solve complex potential problems involving vortices and their images in different systems.

CO5: Understand the theory of boundary layers, apply Prandtl's boundary layer theory, and solve problems involving non-dimensional numbers.

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	The Equation of Continuity in Cartesian, Polar and Spherical coordinates, Boundary Surface, Eulerian and Lagrangian forms of equation of continuity. Symmetrical form of equation of continuity, Equation of Motion, Pressure equation, Lagrangian equation of motion, Helmholtz vorticity equation, Cauchy's integral.	CO1	
2.	Viscosity, The Navier-Stokes equations of motion, Euler's Equation, Bernoulli's Equation, steady motion between parallel planes, steady flow through a cylindrical pipe, steady flow between concentric rotating cylinders.	CO2	
3.	Meaning of two-dimensional flow, velocity potential and Stream function, Complex potential for irrotational, incompressible flow, complex potentials for line source, sinks and doublets, two dimensional image systems, circle theorem, the theorem of Blasius.	CO3	
4.	Vortex filaments, complex potential due to a vortex of strength +k, motion due to m vortices, two vortex filaments, image of vortex w.r.t. a plane, image of vortex w.r.t. a cylinder, complex potential due to vortex doublet, vortex sheet, infinite single row of vortices of equal strength, two infinite rows of vortices, Karman's vortex sheet.	CO4	

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5.	Non dimensional numbers, Prandtl's boundary layer theory, Karman's integral equation	CO5	

Text Books and Reference Books:

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1.	Fluid Mechanics	Frank M. White	8th Edition, 2016 McGraw-Hill Education	New York, USA
2.	Fundamentals of Fluid Mechanics	Bruce R. Munson, Donald F. Young, and Theodore H. Okiishi	Edition: 7th Edition, 2013 John Wiley & Sons	New Jersey, USA

DAYALBAGH EDUCATIONAL INSTITUTE FACULTY OF SCIENCE **DEPARTMENT OF MATHEMATICS**				
Course Type	Course Code	Name of Course	Lectures/Week (of 55Min each)	Credits
MAJOR	**MAM 805**	**STOCHASTIC PROC. & STAT. INFERENCE**	**4**	**4**

Introduction:

The course on **Stochastic Processes and Statistical Methods** provides a comprehensive understanding of key concepts in probability, estimation, hypothesis testing, reliability theory, and experimental design. It equips students with mathematical tools and statistical techniques for solving complex problems in various fields such as engineering, data science, and operational research.

Course Objectives:

1- To introduce fundamental concepts of stochastic processes and their real-world applications.
2- To develop a deep understanding of estimation theory, ensuring accurate parameter assessment from data.
3- To teach the principles and applications of hypothesis testing for decision-making.
4- To familiarize students with reliability theory, focusing on system performance and failure analysis.
5- To impart knowledge of designing and analyzing experiments to enhance efficiency in problem-solving.

Course Outcomes (CO):

CO1: Analyze and model stochastic processes including stationary and Markov processes.
CO2: Apply estimation theory to derive unbiased and consistent estimators for statistical data analysis.
CO3: Design and implement hypothesis tests to evaluate scientific and engineering problems.
CO4: Analyze reliability models to predict system performance and optimize maintenance strategies.
CO5: Apply the principles of experimental design to real-world problems for effective decision-making.

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	UNIT 1: STOCHASTIC PROCESSES Stationary processes, Markov chains with finite and countable state space, classification of states, limiting behavior of n-step transition probabilities, Markov processes in continuous time, Poisson process, birth and death process.	CO1	
2.	UNIT 2: THEORY OF ESTIMATION Point Estimation, Criterion of unbiasedness, Consistency, sufficiency, Cramer-Rao inequality, Uniformly minimum variance unbiased estimators, Methods of estimation: maximum likelihood moments, minimum chi-square, least square, confidence interval estimation	CO2	
3.	UNIT 3: TESTING OF HYPOTHESIS Basic concepts, types of errors, critical region, power function, most powerful and uniformly most powerful tests, likelihood ratio test, Wald's sequential probability ratio test.	CO3	

4.	UNIT 4: RELIABILITY THEORY Definition, Failure, Data Analysis, Hazard, Models, System Reliability Series, Parallel and Mixed Configurations.	CO4	
5.	UNIT 5: DESIGN OF EXPERIMENTS Basic principles of experimental design, randomization structure and analysis of completely randomized, randomized block and Latin-square designs. Factorial experiments. Analysis of 2^n factorial experiments in randomized blocks.	CO5	

Text Books and Reference Books:

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1-	Stochastic Processes	Sheledon M. Ross	1996, Second Edition, Wiley	USA
2.	Stochastic Processes	J. Medhi	2002, Second Edition New age International	India
3.	Reliability Engineering	L S Srinath	2005, 4th Edition EWP Publications	India

DAYALBAGH EDUCATIONAL INSTITUTE FACULTY OF SCIENCE **DEPARTMENT OF MATHEMATICS**				
Course Type	Course Code	Name of Course	Practical Labs/Week (of 55Min each)	Credits
Major	**MAM 806**	**Programming Lab II**	**4**	**2**

Introduction:

This lab course provides practical experience in solving optimization problems in graph theory and operations research using MATLAB. Students will learn to apply mathematical software tools to model and solve real-world optimization problems using graph theory and operations research methodologies.

Objectives:

1. To understand the principles of graph theory and operations research.
2. To formulate and solve optimization problems using MATLAB.
3. To implement graph algorithms and optimization techniques in MATLAB.
4. To utilize MATLAB's Optimization Toolbox for solving real-world problems.
5. To analyze and visualize results of optimization algorithms using MATLAB.

Course Outcomes (CO):

By the end of the course, students will be able to:

- CO1: Understand fundamental graph theory concepts and their application in optimization problems.
- CO2: Develop and formulate optimization problems in operations research for MATLAB implementation.
- CO3: Implement graph algorithms (e.g., Dijkstra's, Kruskal's) and optimization techniques using MATLAB.
- CO4: Utilize MATLAB's Optimization Toolbox to solve problems such as resource allocation and scheduling.
- CO5: Analyze the results and visualize network flows, graph structures, and optimization outcomes using MATLAB.

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	Introduction to Graph Theory and Operations Research	CO1	Understand, Apply
2.	Formulation of Optimization Problems in MATLAB	CO2	Apply, Analyze
3.	Graph Algorithms in MATLAB (Dijkstra, Kruskal)	CO3	Apply, Analyze
4.	Using MATLAB's Optimization Toolbox for Operations Research	CO4	Analyze, Evaluate
5.	Case Studies: Real-World Optimization Problems in Graph Theory and Operations Research	CO5	Create, Evaluate

Text Books and Reference Books:

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1.	MATLAB for Engineers	Holley Moore, et al.	4th Edition, 2016, Pearson	USA
2.	Introduction to Operations Research	Frederick Hillier, Gerald Lieberman	10th Edition, 2020, McGraw-Hill	USA
3.	Graph Theory and Optimization in MATLAB	David Joyner	1st Edition, 2018, CRC Press	USA

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Course Type	Course Code	Name of Course	Lectures/Week (of 55Min each)	Credits
MAJOR	**MAM 902**	MATHEMATICAL MODELLING	**3**	**3**

Introduction:

This course provides a comprehensive introduction to mathematical models across various fields, highlighting their importance in understanding complex systems. From physical systems to biological processes, mathematical models help us translate real-world problems into a form where we can use mathematics to gain insights, solve problems, and make informed decisions. The course emphasizes both the theoretical foundations and practical applications of these models.

Objectives:

1. Understand the fundamentals of mathematical modelling and the role it plays in various scientific and practical domains.
2. Understand the impact of environmental constraints on population size and how different factors influence population dynamics.
3. Gain a thorough understanding of basic epidemic models like the SIR and SEIR models.
4. Understand the role of probability in modelling uncertain systems where randomness plays a significant role.
5. Apply linear programming and nonlinear programming to solve optimization problems in fields like economics, engineering, and logistics.

Course Outcomes (CO):

After completion of the course, students will be able to:

CO1: Construct mathematical models for a wide range of real-world systems.
CO2: Analyze the behavior of different types of models using appropriate mathematical tools.
CO3: Make informed decisions and predictions based on the analysis of these models.
CO4: Solve complex optimization problems using both analytical and computational techniques.
CO5: Effectively communicate the results and implications of their models to stakeholders in various fields.

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	INTRODUCTION Mathematical Modelling Process, Types of Models, Modelling with Discrete Dynamical systems: Modelling change with Difference Equations, approximating change with Difference Equations, Systems of Difference Equations.	CO1	
2.	POPULATION MODELS Single Species, Non-age Structured Population Models, Two Species Population Models.	CO2	
3.	EPIDEMIC MODELS Deterministic models without removals, a simple deterministic model, SIS model, SIS model with specific rate of infection as a function of time, SIS models with constant number of carriers, general deterministic models with removal, approximate solution, asymptotic behaviour of the solution, general deterministic model with immigration-steady state solution.	CO3	
4.	PROBABILISTIC MODELLING Models in Genetics, Genetic Matrices, Hardy-Weinberg Law, Correlation between Genetic composition of Siblings, Genotype and Phenotype ratios, Models for genetic improvements-Selection and Mutation.	CO4	
5.	OPTIMIZATION MODELS Role of optimization model in biology and medicine, finding optimal classification schemes, survival of systems, medical diagnosis problem, optimization models for blood testing and patient care, models for optimal control of water pollution,	CO5	

	optimal air pollution control models, control models for solid waste disposal.		

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1	MATHEMATICAL MODELLING IN BIOLOGY AND MEDICINE	J. N. Kapur	1992, Affiliated East-West Press	New Delhi, India
2	INTRODUCTION TO MATHEMATICAL BIOLOGY	I. A. Rubinow	1975, Wiley-Interscience	New York, USA
3	A FIRST COURSE IN MATHEMATICAL MODELLING	Frank R. Giordano, Maurice D. Weir & William P. Fox	5th Edition, 2013, Cengage Learning	Boston, USA

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Course Type	Course Code	Name of Course	Lectures/Week (of 55Min each)	Credits
DS MAJOR/ MINOR	**MAM 903**	**INTRODUCTION TO RIEMANNIAN GEOMETRY**	**4**	**4**

Introduction:

This course introduces differentiable manifold, Riemannian manifold and related basic notions providing insight into Whitney Embedding Theorem and Normal Neighborhood Theorem

Objectives:

1. Study differentiable manifold, Riemannian manifold and related basic notions
2. Visualization of concepts through Examples
3. Develop analytical and computational skills
4. Understand Whitney Embedding Theorem
5. Understand Normal Neighborhood Theorem

Course Outcomes (CO):

CO1: Study and visualize notions of differentiable manifold and Riemannian manifold
CO2: Study Grassman Manifolds
CO3: Topological properties of differentiable manifold with manifold topology
CO4: Understand tangent spaces, differential and its properties
CO5: Understand regular submanifold and Whitney Embedding Theorem
CO6: Understand vector field and Normal Neighborhood Theorem

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	Charts, Atlas, Complete atlas, Equivalent atlases, Differentiable Manifolds, Product, Real Projective Space, Grassman Manifolds.	Visualization of notion of differentiable manifold	Interpreting, explaining, implementing, differentiating
2.	Induced Topology on a Manifold, Manifold Structure on a topological space, Open submanifold, Properties of the induced topology, Partitions of unity.	Manifold topology	Differentiating
3.	Differentiable Functions between manifolds, Diffeomorphisms, Tangent Space, Differential, Basis Theorem, Inverse Function Theorem for Manifolds.	Tangent spaces, differential and its properties	Differentiating
4.	Rank of a Differentiable Function, Immersion, Submanifold, Regular Submanifold, Submersion, Quotient Manifold, Whitney Embedding Theorem	Rank, regular submanifold and Whitney Embedding Theorem	Differentiating
5.	Vector Field, Lie Bracket, Lie Algebra of Vector Fields, Riemannian Manifold, Covariant Derivative, Geodesic, Normal Neighborhood Theorem	Vector Field, geodesic, normal neighborhood theorem	Differentiating

Text Books and Reference Books:

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1.	AN INTRODUCTION TO DIFFERENTIABLE MANIFOLDS AND RIEMANNIAN GEOMETRY	William M. Boothby	Second Edition, 2012, Elsevier India Pvt. Ltd.	New Delhi
2.	DIFFERENTIABLE MANIFOLDS	C. Brickell	1970, Van Nostrand Reinhold Company Ltd.	London
3.	RIEMANNIAN MANIFOLDS (AN INTRODUCTION TO CURVATURE)	John M. Lee	1997, Springer	New York

DAYALBAGH EDUCATIONAL INSTITUTE FACULTY OF SCIENCE **DEPARTMENT OF MATHEMATICS**				
Course Type	Course Code	Name of Course	Lectures/Week (of 55Min each)	Credits
DS Major	**MAM 705**	**Rings & Canonical Forms**	**4**	**4**

Introduction:

This course provides strong foundations of Rings & Canonical Forms enabling students to understand and apply the basic concepts required for advanced studies.

Objectives:

1. To understand foundational concepts of fuzzy sets, operations, and fuzzification techniques.
2. To develop skills in fuzzy arithmetic, defuzzification, and interval analysis.
3. To differentiate and apply fuzzy relations to model relational structures.
4. To apply fuzzy logic with propositions, inferencing, and linguistic modifiers.
5. To design and implement fuzzy expert systems and controllers for practical applications.

Course Outcomes (CO):

This course is aimed at

1. **CO1**: Understand the fundamental concepts of fuzzy sets, including fuzzy set operations, properties, and fuzzification techniques, and apply basic membership functions to represent uncertainty in various scenarios.
2. **CO2**: Perform arithmetic operations on fuzzy numbers and understand interval analysis, fuzzification, and defuzzification methods, enhancing computational skills with fuzzy numbers and vectors.
3. **CO3**: Distinguish between crisp and fuzzy relations, understand fuzzy relations' properties, and apply fuzzy Cartesian products, compositions, and equivalence relations in modeling relational structures.
4. **CO4**: Develop a foundational understanding of fuzzy logic systems, including multivalued logic, fuzzy propositions, and inferencing methods, and apply these concepts to construct and decompose canonical forms.
5. **CO5**: Apply fuzzy systems in real-world contexts, design fuzzy expert systems, use aggregation methods, and implement fuzzy controllers, gaining practical experience in fuzzy system applications.

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	Fuzzy Sets, Convex fuzzy set & Basic theorems, Basic Concepts, Fuzzy Set Operations, Properties Of Fuzzy Sets, Alpha Cuts, Extension Principle, Features Of Membership Functions, Fuzzification, Membership Value Assignments: Intuition, Inference.	CO1	• **Remembering**: Define fuzzy sets, convex fuzzy sets, and basic operations on fuzzy sets. • **Understanding**: Explain properties of fuzzy sets, alpha cuts, and the extension principle. • **Applying**: Use fuzzification and assign membership values using intuition and inference. • **Analyzing**: Differentiate between features of membership functions and evaluate properties of fuzzy sets.
2.	Fuzzy Arithmetic. Fuzzy Numbers, Fuzzy Operations On Fuzzy Numbers, Interval Analysis In Arithmetic, Fuzzy Vectors. Defuzzification & Arithmetic operations on fuzzy numbers.	CO2	• **Remembering**: Recall the definitions of fuzzy numbers, interval analysis, and fuzzy vectors. • **Understanding**: Describe arithmetic operations on fuzzy numbers and concepts of defuzzification. • **Applying**: Perform arithmetic operations on fuzzy numbers and use interval analysis in applications. • **Analyzing**: Compare different methods of defuzzification and analyze the results of fuzzy operations.
3.	Fuzzy Relations. Crisp Vs Fuzzy Relations, Operations On Fuzzy Relations, Properties Of Fuzzy Relations, Fuzzy Cartesian Product And Compositions, Fuzzy Tolerance And Equivalence Relations, Fuzzy Ordering Relations, Fuzzy Compatibility.	CO3	• **Remembering**: Identify differences between crisp and fuzzy relations. • **Understanding**: Summarize the properties of fuzzy relations, including tolerance and equivalence relations. • **Applying**: Apply fuzzy operations on fuzzy relations

			and perform compositions and Cartesian products. • **Analyzing**: Examine the properties of fuzzy compatibility and ordering relations.
4.	Fuzzy Logic. Bivalued And Multivalued Logic, Fuzzy Tautologies, Implication And Composition Operations, Decomposition of canonical form and canonical form, Fuzzy Propositions, Fuzzy Quantifiers, Linguistic Hedges, Inferencing from Various Propositions.	CO4	• **Remembering**: Recall the fundamentals of bivalued and multivalued logic, tautologies, and fuzzy propositions. • **Understanding**: Explain decomposition of canonical forms, fuzzy quantifiers, and linguistic hedges. • **Applying**: Use fuzzy logic for inferencing and manipulate fuzzy propositions. • **Analyzing**: Analyze implications and composition operations within fuzzy logic systems.
5.	Applications. Fuzzy Expert Systems, Fuzzy Systems, Aggregation of fuzzy rules & graphical method of inference, Fuzzy Controllers.	CO5	• **Remembering**: Identify applications of fuzzy systems, including expert systems and fuzzy controllers. • **Understanding**: Describe the process of aggregating fuzzy rules and the graphical method of inference. • **Applying**: Implement fuzzy control systems and use fuzzy aggregation methods in expert systems. • **Analyzing**: Evaluate different fuzzy system applications and compare methods of inference for real-world scenarios.

Text Books and Reference Books:

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1	FUZZY SETS AND FUZZY LOGIC	J Klir & Bo Yuan	Fifth Edition, 2001, PHI	New Delhi
2	FUZZY LOGIC WITH ENGINEERING APPLICATIONS	T J Ross	Third Edition, 2011, Wiley	

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Course Type	Course Code	Name of Course	Lectures/Week (of 55Min each)	Credits
DS Major	**MAM 954**	**ADV. SCIENTIFIC METHODOLOGY& ANALYSIS**	**4**	**4**

Introduction:

This course provides foundational skills in numerical methods and MATLAB-based computation, focusing on matrix-vector operations, error analysis, and solving real-world scientific problems. Students will learn techniques in polynomial interpolation, numerical integration, and matrix factorizations, preparing them for advanced applications in scientific research and engineering.

Objectives:

1. To familiarize students with matrix-vector methods and numerical problem-solving using MATLAB.
2. To develop skills in polynomial interpolation, numerical integration, and error analysis.
3. To implement and analyze numerical methods for matrix computations and solving linear systems.
4. To understand and apply MATLAB functions to practical scientific problems.

Course Outcomes (CO):

This course is aimed at

1. **CO1**: Understand floating-point systems, errors, MATLAB basics, and apply these concepts for evaluating functions, vectorization, and approximations.
2. **CO2**: Solve polynomial interpolation problems using various approaches (Vandermonde, Hermite, cubic spline) and evaluate accuracy through MATLAB implementations.
3. **CO3**: Apply numerical integration techniques (Newton-Cotes, Gauss, composite quadrature) and evaluate errors in MATLAB for various scenarios.
4. **CO4**: Conduct matrix computations, understand recursive operations, and perform Fourier transforms, applying these concepts to distributed systems and MATLAB.
5. **CO5**: Analyze and solve linear systems using triangular, banded, and full problem approaches, and apply LU, QR, and Cholesky factorizations in MATLAB.

Unit No	Topics to be Covered	Learning outcomes	Bloom's Taxonomy
1.	Part A: Introduction, matrix-vector approach (MATLAB), vectors and plotting, vectorization of scalar computations, evaluation of functions, scaling and superposition, approximations and error, floating point numbers, properties of floating point systems, machine precision, subnormals and underflow, floating point arithmetic, condition number, stability, writing MATLAB functions, examples. Part B: Mathematical and Logical Reasoning to Cover Part I of UGC NET Syllabus. Literature review, report writing and ethics in research.	CO1	• **Understanding** (floating-point, stability), **Applying** (MATLAB functions), **Analyzing** (approximation errors)
2.	The polynomial interpolation problem, Vandermonde approach, special and general case, piecewise interpolation – Hermit, cubic and spline, nested multiplication, Newton representation, properties, accuracy, MATLAB implementations.	CO2	• **Applying** (interpolation methods), **Analyzing** (accuracy), **Evaluating** (method effectiveness)
3.	Newton-Cotes integration and implementation, error, composite rules, Composite quadrature, adaptive quadrature, Gauss quadrature, MATLAB implementation examples.	CO3	• **Applying** (numerical integration), **Analyzing** (errors), **Evaluating** (integration method suitability)

4.	Matrix computations, simple i-j recipes, band and block structures, matrix-vector multiplications, matrix-matrix multiplications, errors and norms, recursive matrix operations, distributed memory matrix multiplication, discrete Fourier transform, fast Fourier transform, Introduction to MPI.	CO4	• **Applying** (matrix operations, Fourier transforms), **Analyzing** (errors, norms), **Understanding** (MPI basics
5.	Triangular problems, banded problems, full problems, stability, error, sensitivity, QR and Cholesky factorizations, system of linear equations, LU decomposition.	CO5	• **Applying** (factorizations), **Analyzing** (stability and error), **Evaluating** (solutions' robustness)

Text Books and Reference Books:

S. No.	Title	Author(s)	Edition, Year, Publisher	Place
1	*Scientific Computing: An Introductory Survey*	Michael Heath	McGraw Hill	USA
2	*Introduction to Scientific Computing: A Matrix-Vector Approach Using MATLAB*	CF Van Loan	2nd Edition	USA