Semester – I

19MMP101 **ALGEBRA** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- The fundamental concepts of algebraic ring theory and fields.
- The basic central ideas of Polynomial ring.
- How to test if a polynomial is irreducible Finite Field (Galois Fields).
- How to convert the various matrix forms.
- Develop capabilities with an axiomatic treatment of transformation.
- Develop an understanding of the structure of sets with operations on them.

Course Outcomes (COs)

After successful completion of this course the students will be able to

1. Understand the concept and the properties of finite abelian groups.
2. Get pre-doctoral level knowledge in ring theory.
3. Attain good knowledge in field theory.
4. Define and study in details the properties of linear transformations.
5. Analyze the concept of trace and transpose.
6. Demonstrate capacity for mathematical reasoning through analyzing, proving and explaining concepts quadratic forms.

UNIT I

A counting principle - Normal subgroups and quotient groups – Homomorphisms– Automorphisms - Cayley’s theorem - Permutation groups.

UNIT II

Another counting principle - Sylow’s theorems - Direct product - Finite abelian groups.

UNIT III

Euclidean rings - A particular Euclidean ring - Polynomial rings – Polynomials over the rational field - Polynomial rings over commutative rings.

UNIT IV

Extension fields - Roots of polynomials - More about roots - Finite fields.

UNIT V

The elements of Galois theory - Solvability by radicals - Galois group over the rational.

SUGGESTED READINGS

1. Herstein.I. N.,(2006). Topics in Algebra, Second edition, Wiley and sons Pvt. Ltd, Singapore.
2. Artin. M., (2015).Algebra, Pearson Prentice-Hall of India, New Delhi.
3. Fraleigh. J. B., (2013). A First Course in Abstract Algebra, Seventh edition, Pearson Education Ltd, New Delhi.
4. Kenneth Hoffman., Ray Kunze., (2015). Linear Algebra, Second edition, Prentice Hall of India Pvt Ltd, New Delhi.
5. Vashista.A.R., (2014). Modern Algebra, KrishnaPrakashan Media Pvt Ltd, Meerut.

Semester – I

19MMP102 **REAL ANALYSIS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- The basic principles of Riemann – Stieltjes Integral.
- Apply mathematical concepts and principles to infinite series.
- How to identify sets with various properties such as convergence.
- Have the knowledge of Lebesgue integral of functions and their properties.
- Understand the importance of undefined terms, definitions, and axioms.
- Use a variety of proof techniques to prove theorems using axioms, definitions, and previous results.

Course Outcomes (COs)

On successful completion of this course, students will be able to

1. Get specific skill in Riemann Stieltjes integral and Lebesgue integral.
2. Attain knowledge in infinite series.
3. Demonstrate an understanding of the uniform convergence and differentiation.
4. Enrich their knowledge of measure theory and extremum problems.
5. Solve given problems at a high level of abstraction based on Implicit function.
6. Describe the fundamental properties of the real numbers that underpin the formal development of real analysis.

UNIT I

THE RIEMANN – STIELTJES INTEGRAL

Introduction – Basic Definitions – Linear Properties – Integration by parts – Change of variable in a Riemann – Stieltjes Integral – Reduction to a Riemann Integral – Step functions as integrators – Reduction of a Riemann – Stieltjes Integral to a finite sum – Monotonically increasing – Additive and linear properties – Riemann condition – Comparison theorems – Integrators of bounded variation – Sufficient condition for Riemann Stieltjes integral.

UNIT II

INFINITE SERIES AND INFINITE PRODUCTS

Introduction – Basic definitions – Ratio test and root test – Dirichlet test and Able's test – Rearrangement of series – Riemann's theorem on conditionally convergent series – Sub series - Double sequences – Double series – Multiplication of series – Cesaro summability.

UNIT III

SEQUENCES OF FUNCTIONS

Basic definitions – Uniform convergence and continuity - Uniform convergence of infinite series of functions – Uniform convergence and Riemann – Stieltjes integration – Non uniformly convergent sequence – Uniform convergence and differentiation – Sufficient condition for uniform convergence of a series.

UNIT IV

THE LEBESGUE INTEGRAL

Introduction- The class of Lebesgue – integrable functions on a general interval- Basic properties of the Lebesgue integral- Lebesgue integration and sets of measure zero- The Levi monotone convergence theorem- The Lebesgue dominated convergence theorem-Applications of Lebesgue dominated convergence theorem- Lebesgue integrals on unbounded intervals as limit of integrals on bounded intervals- Improper Riemann integrals- Measurable functions.

UNIT V

IMPLICIT FUNCTIONS AND EXTREMUM PROBLEMS

Introduction – Functions with non zero Jacobian determinant – Inverse function theorem – Implicit function theorem – Extrema of real valued functions of one variable and several variables

SUGGESTED READINGS

1. Rudin. W., (2013) .Principles of Mathematical Analysis, Tata Mcgraw Hill, New York.
2. Balli. N.P., (2017). Real Analysis, Laxmi Publication Pvt Ltd, New Delhi.
3. Gupta.S.L. and Gupta.N.R.,(2003).Principles of Real Analysis, Second edition, Pearson Education Pvt.Ltd, Singapore.
4. Royden .H.L., (2002). Real Analysis, Third edition, Prentice hall of India,New Delhi.
5. Sterling. K. Berberian., (2004).A First Course in Real Analysis, Springer Pvt Ltd, New Delhi.

Semester – I

19MMP103 **NUMERICAL ANALYSIS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- To develop the working knowledge on different numerical techniques.
- To solve algebraic and transcendental equations.
- Appropriate numerical methods to solve differential equations.
- To provide suitable and effective methods for obtaining approximate representative numerical results of the problems.
- To solve complex mathematical problems using only simple arithmetic operations. The approach involves formulation of mathematical models of physical situations that can be solved with arithmetic operations.
- Provide a basic understanding of the derivation, analysis, and use of these numerical methods, along with a rudimentary understanding of finite precision arithmetic and the conditioning and stability of the various problems and methods.

Course Outcomes (COs)

On successful completion of this course, students will be able to

1. Identify the concept of numerical differentiation and integration.
2. Provide information on methods of iteration.
3. Solve ordinary differential equations by using Euler and modified Euler method.
4. Study in detail the concept of boundary value problems.
5. Attain mastery in the numerical solution of partial differential equations.
6. Apply numerical methods to obtain approximate solutions to mathematical problems.

UNIT I

SOLUTIONS OF NON LINEAR EQUATIONS

Newton's method-Convergence of Newton's method- Bairstow's method for quadratic factors. Numerical Differentiation and Integration: Derivatives from difference tables – Higher order derivatives – divided difference. Trapezoidal rule– Romberg integration – Simpson's rules.

UNIT II

SOLUTIONS OF SYSTEM OF EQUATIONS

The Elimination method: Gauss Elimination and Gauss Jordan Methods – LU decomposition method. Methods of Iteration: Gauss Jacobi and Gauss Seidal iteration-Relaxation method.

UNIT III

SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS

One step method: Euler and Modified Euler methods–Rungekutta methods. Multistep methods: Adams Moulton method – Milne's method

UNIT IV

BOUNDARY VALUE PROBLEMS AND CHARACTERISTIC VALUE PROBLEMS

The shooting method: The linear shooting method – The shooting method for non-linear systems. Characteristic value problems –Eigen values of a matrix by Iteration-The power method.

UNIT V

NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS

Classification of Partial Differential Equation of the second order – Elliptic Equations. Parabolic equations: Explicit method – The Crank Nicolson difference method. Hyperbolic equations – solving wave equation by Explicit Formula.

SUGGESTED READINGS

1. Gerald, C. F., and Wheatley. P. O., (2009). Applied Numerical Analysis, Seventh edition, Dorling Kindersley (India) Pvt. Ltd. New Delhi.
2. Jain. M. K., Iyengar. S. R. K. and R. K. Jain., (2012). Numerical Methods for Scientific and Engineering Computation, New Age International Publishers, New Delhi .
3. Burden R. L., and Douglas Faires.J,(2014). Numerical Analysis, Seventh edition, P. W. S. Kent Publishing Company, Boston.
4. Sastry S.S., (2009). Introductory methods of Numerical Analysis, Fourth edition, Prentice Hall of India, New Delhi.

Semester – I

19MMP104 **ORDINARY DIFFERENTIAL EQUATIONS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- The formulation and solutions of second order ordinary differential equations and get exposed to physical problems with applications.
- The concept of solve the system of first order equations.
- Linear homogeneous and non homogeneous equations with constant coefficients.
- Understanding the elementary linear oscillations.
- Understand all of the concepts relating to the order and linearity of ordinary differential equations, analytic and computational solution methods for ordinary differential equations, and the real-world applications of ordinary differential equations.
- Apply your understanding of the concepts, formulas, and problem solving procedures to thoroughly investigate relevant physical models.

Course Outcomes (COs)

On successful completion of this course, students will be able to

1. Model a simple physical system to obtain a first and second order differential equation.
2. Understand the basic notions of linearity, superposition, existence and uniqueness of solution to differential equations and use these concepts in solving linear differential equations.
3. Identify homogeneous equations, homogeneous equations with constant coefficients and exact linear differential equations**.**
4. Solve higher order and system of differential equations of Successive approximation.
5. Understand the difficulty of solving problems for elementary linear oscillations.
6. Identify, analyze and subsequently solve physical situations whose behavior can be described by ordinary differential equations.

UNIT I
SECOND ORDER LINEAR EQUATIONS

Second order linear equations with ordinary points – Legendre equation and Legendre polynomial – Second order equations with regular singular points – Bessel equation.

UNIT II

EXISTENCE AND UNIQUENESS SOLUTIONS

System of first order equations – existence and uniqueness theorems – fundamental matrix.

UNIT III

NON HOMOGENEOUS EQUATIONS

Non homogeneous linear system – linear systems with constant coefficient – Linear systems with periodic coefficients.

UNIT IV

SUCCESSIVE APPROXIMATIONANDNON UNIQUENESS SOLUTIONS

Successive approximation – Picard's theorem – Non uniqueness of solution – Continuation and dependence on initial conditions – Existence of solution in the large existence and uniqueness of solution in the system.

UNIT V

OSCILLATION THEORY

Fundamental results – Sturms comparison theorem – Elementary linear oscillations – Comparison theorem of Hille winter – Oscillations of $x'' + a(t)x = 0$ elementary non linear oscillations.

SUGGESTED READINGS

1. Earl A. Coddington, (2004). An introduction to Ordinary differential Equations, Prentice Hall of India Private limited, New Delhi.
2. Deo. S. G, Lakshmikantham, V. and Raghavendra, V. (2005). Ordinary Differential Equations and Stability Theory, Second edition, Tata McGraw Hill Publishing Company limited, New Delhi.
3. Rai. B, Choudhury, D. P. and Freedman, H. I. (2004). A course of Ordinary differential Equations, Narosa Publishing House, New Delhi.
4. George F. Simmons, (2017). Differential Equations with application and historical notes, 3rd edition by Taylor & Francis Group, LLC.

Semester – I

19MMP105A **ADVANCED DISCRETE MATHEMATICS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- The concept of algebraic structures, lattices and its special categories which plays an important role in the field of computers.
- The fundamental concepts in graph theory, with a sense of some its modern applications.
- Some fundamental mathematical concepts and terminology.
- Learn some different types of discrete structures.
- Introduce students to the techniques, algorithms, and reasoning processes involved in the study of discrete mathematical structures.
- Introduce students to set theory, inductive reasoning, elementary and advanced counting techniques, equivalence relations, recurrence relations, graphs, and trees.

Course Outcomes (COs)

On successful completion of this course, students will be able to

1. Develop new algebraic structures.
2. Think critically and analytically by modeling problems form social and natural sciences with the help of theory of graphs.
3. Apply discrete mathematics in formal representation of various computing constructs
4. Work effectively in groups on a project that requires an understanding of graph theory.
5. Demonstrate different traversal methods for trees and graphs.
6. Recognize the importance of analytical problem-solving approach.

UNIT I

ALGEBRAIC STRUCTURES

Introduction- Algebraic Systems: Examples and General Properties: Definition and examples - Some Simple Algebraic Systems and General properties - Homomorphism and isomorphism - congruence relation - Semigroups and Monoids: Definitions and Examples - Homomorphism of Semigroups and Monoids.

UNIT II

LATTICES

Lattices as Partially Ordered Sets: Definition and Examples - Principle of duality - Some Properties of Lattices - Lattices as Algebraic Systems – Sublattices - Direct product, and Homomorphism.

UNIT III

BOOLEAN AND SOME SPECIAL LATTICES

Complete, Complemented and Distributive Lattices - Boolean Algebra: Definition and Examples - Subalgebra - Direct product and Homomorphism - Join irreducible - Atoms and anti atoms.

UNIT IV

GRAPH THEORY

Definition of a graph - applications, Incidence and degree - Isolated and pendant vertices - Null graph, Path and Circuits: Isomorphism - Subgraphs, Walks -Paths and circuits - Connected graphs, disconnected graphs – components - Euler graph.

UNIT V

TREES

Trees and its properties - minimally connected graph - Pendant vertices in a tree - distance and centers in a tree - rooted and binary tree. Levels in binary tree - height of a tree - Spanning trees - rank and nullity.

SUGGESTED READINGS

1. Tremblay J. P. and Manohar, R., (2017). Discrete Mathematical Structures with Applications to Computer Science, McGraw-Hill Book Co.
2. Deo N., (2007). Graph Theory with Applications to Engineering and Computer Sciences, Prentice Hall of India.
3. Liu C.L., (2012). Elements of Discrete Mathematics, Fourth edition McGraw-Hill Publishing Company Ltd, New Delhi.
4. Wiitala S., (2003),Discrete Mathematics- A Unified Approach, McGraw-Hill Book Co, New Delhi.
5. Seymour Lepschutz, (2007),Discrete Mathematics, Schaum Series, McGraw-Hill Publishing Company Ltd, New Delhi.

Semester – I

19MMP105B **NUMBER THEORY** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- Mathematical concepts and principles to perform numerical and symbolic computations.
- Investigate and solve mathematical and statistical problems.
- Write clear and precise proofs.
- Communicate effectively in both written and oral form.
- Some foundational ideas in number theory without the technical baggage often associated with a more advanced courses.
- The opportunity to develop an appreciation of pure mathematics while engaged in the study of number theoretic results.

Course Outcomes (COs)

On successful completion of this course, students will be able to

1. Identify and apply various properties of and relating to the integers including the Well-Ordering Principle, primes, unique factorization, the division algorithm, and greatest common divisors.
2. Identify how number theory is related to and used in cryptography.
3. Identify certain number theoretic functions and their properties.
4. Understand the concept of a congruence and use various results related to congruences including the Chinese Remainder Theorem.
5. Solve certain types of Diophantine equations.
6. Acquire a broad knowledge in Greatest Integer Function.

UNIT I
DIVISIBILITY

Introduction - Divisibility - Primes - The Bionomial Theorem

UNIT II
CONGRUENCES

Congruences - Solutions of Congruences - The Chinese Remainder Theorem - Techniques of Numerical Calculation - Public-Key Cryptography - Prime Power Moduli - Prime Modulus

UNIT III
CONGRUENCES (CONTINUITY)

Primitive Roots and Power Residues - Congruences of Degree Two, Prime Modulus - Number Theory from an Algebraic Viewpoint - Groups, Rings, and Fields

UNIT IV

QUADRATIC RECIPROCITY AND QUADRATIC FORMS

Quadratic Residues - Quadratic Reciprocity - The Jacobi Symbol - Binary Quadratic Forms - Equivalence and Reduction of Binary Quadratic Forms - Sums of Two Squares - Positive Definite Binary Quadratic Forms

UNIT V

SOME FUNCTIONS OF NUMBER THEORY

Greatest Integer Function - Arithmetic Functions - The Mobius Inversion Formula - Recurrence Functions - Combinatorial Number Theory

SUGGESTED READINGS

1. Ivan Nivan and Herberts Zucherman., (2008)., An Introduction to Theory of Numbers,5th Edition, Wiley Eastern Limited, New Delhi.
2. ApostolT.M., (1998). Introduction to Analytic Number Theory, Springer Verlag,.
3. Kennath and Rosan, (1986).Elementary Number Theory and its Applications, Addison Wesley Publishing Company.
4. George E. Andrews., (2012).Number Theory, Dover Publications, Inc,Newyork.

Semester – I

19MMP105C **COMBINATORICS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- Improve mathematical proof writing skills.
- Cater mathematical verbal communication skills.
- Afford problem-solving skills.
- Combinatorial proofs of identities and inequalities.
- Model and analyze computational processes using analytic and combinatorial methods.
- Structures to represent mathematical and applied questions, and they will become comfortable with the combinatorial tools commonly used to analyze such structures.

Course Outcomes (COs)

On successful completion of this course, students will be able to

1. Cognition in various combinatorial methods.
2. Solve recurrence relations through computational skills.
3. Apply the inclusion/exclusion principle.
4. Develop fundamental knowledge of combinatorics and Euler function.
5. Analyze combinatorial objects satisfying certain properties and answer questions related to Necklace problem.
6. Know the concept of Burnside's lemma.

UNIT I
PERMUTATIONS AND COMBINATIONS

The rules of sum and product - Distributions of distinct objects - Distributions of Non distinct objects – Stirling's formula.

UNIT II
GENERATING FUNCTIONS

Generating functions for combinations - Enumerators for permutations- Distributions of distinct objects into non distinct cells - Partitions of integers – Ferrers graph - Elementary relations.

UNIT III
RECURRENCE RELATIONS

Linear recurrence relations with constant coefficients - Solutions by the technique of generating functions - A special class of nonlinear difference equations - Recurrence relations with two indices.

UNIT IV

THE PRINCIPLE OF INCLUSION AND EXCLUSION

General formula - Permutations with restrictions on relative positions - The Rook polynomials - Permutations with forbidden positions.

UNIT V

POLYA'S THEORY OF COUNTING

Polya's Theory of Counting - Equivalence classes under a permutation group - Equivalence classes of functions - Weights and inventories of functions - Polya's fundamental theorem.

SUGGESTED READINGS

1. Liu C. L. , (2000). Introduction of Combinatorial Mathematics, McGraw Hill, Singapore.
2. Marshall Hall JR., (1998). Combinatorial Theory, John Wiley & Sons, New York.
3. Ryser H.J.,(1978). Combinatorial Mathematics, The Mathematical Association of America, John Wiley & Sons, Inc, New York.

Semester – I

19MMP106 **MECHANICS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- How to use Newton's laws of motion to solve advanced problems involving the dynamic motion of classical mechanical systems.
- Applications of differential equations in advanced mathematical problems.
- To solve dynamics problems such as conservation of energy and linear and angular momentum.
- Parameters defining the motion of mechanical systems and their degrees of freedom.
- The components of a force in rectangular or nonrectangular coordinates. ÿ Determine the resultant of a system of forces.
- Complete and correct free-body diagrams and write the appropriate equilibrium equations from the free-body diagram.

Course Outcomes (COs)

On successful completion of this course students will be able to

1. Understand the concept of the D'Alembert's principle.
2. Derive the Lagrange's equation for holomonic and non holomonic constraints.
3. Classify Scleronomic and Rheonomic systems.
4. Solve the problems of Hamilton equations of motion.
5. Study of the canonical transformations.
6. Know the concept of Hamilton Jacobi Theory.

UNIT I
SURVEY OF ELEMENTARY PRINCIPLES

Constraints - Generalized coordinates, Holonomic and non- holonomic systems, Scleronomic and Rheonomic systems. D'Alembert's principle and Lagrange's equations – Velocity – dependent potentials and the dissipation function – some applications of the Lagrange formulation.

UNIT II
VARIATION PRINCIPLES AND LAGRANGE'S EQUATIONS

Hamilton's principle – Some techniques of calculus of variations – Derivation of Lagrange's Equations from Hamilton's principle – Extension of Hamilton's principle to non-holonomic systems – Conservation theorems and symmetry properties.

UNIT III
HAMILTON EQUATIONS OF MOTION
Legendre Transformations and the Hamilton Equations of motion-canonical equations of Hamilton – Cyclic coordinates and conservation theorems – Routh's procedure - Derivation of Hamilton's equations from a variational principle – The principle of least action.

UNIT IV
CANONICAL TRANSFORMATIONS
The equations of canonical transformation – Examples of Canonical transformations – Poission Brackets and other Canonical invariants – integral invariants of Poincare, Lagrange brackets.

UNIT V
HAMILTON JACOBI THEORY
Hamilton Jacobi equations for Hamilton's principle function – Harmonic oscillator problem - Hamilton Jacobi equation for Hamilton's characteristic function – Separation of variables in the Hamilton-Jacobi equation.

SUGGESTED READINGS

1. Goldstein. H. (2011), Classical Mechanics Third Edition, Narosa Publishing House, New Delhi.
2. Gantmacher, F., (2013). Lectures in Analytic Mechanics, MIR Publishers, Moscow.
3. Gelfand, I. M., and Fomin, S. V., (2003), Calculus of Variations, Prentice Hall, New Delhi.
4. Loney, S. L., (2015). An elementary treatise on Statics, Kalyani Publishers, New Delhi.

Semester – I

19MMP111 NUMERICAL ANALYSIS - PRACTICAL 4H – 2C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- In-depth understanding of functional, logic, and programming paradigms.
- How to implement several programs in languages other than the one emphasized in the core curriculum.
- This course provides an introduction to the basic concepts and techniques of numerical solution of algebraic equation.
- This course is to provide students with an introduction to the field of numerical analysis.
- Understand the concept of Gauss elimination method.
- How to find the differential equation in numerical method.

Course Outcomes (COs)

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

1. Know the concepts for problem solving.
2. Acquire new knowledge in computing, including the ability to learn about new ideas and advances, techniques, tools, and languages, and to use them effectively; and to be motivated to engage in life-long learning
3. Comprehend important issues related to the development of computer-based systems in a professional context using a well-defined process.
4. Be familiar with programming with numerical packages.
5. Be aware of the use of numerical methods in modern scientific computing.
6. To develop the mathematical skills of the students in the areas of numerical methods.

List of Practical

1. Solution of non-linear equation-Bairstow's method for quadratic factors.
2. Solution of simultaneous equations-Gauss Elimination.
3. Solution of simultaneous equations-Gauss Jordan.
4. Solution of simultaneous equations-Gauss Jacobi.
5. Solution of simultaneous equations-Gauss Seidal.

6. Solution of simultaneous equations-Triangularisation.
7. Numerical integration-Trapezoidal rule.
8. Numerical integration-Simpson's rules.
9. Solution for ordinary differential equation-Euler method.
10. Solution for ordinary differential equation- RungeKutta Second order.
11. Solution for parabolic equation - Explicit method.
12. Solution for parabolic equation - The Crank Nicolon method.

Semester – II

19MMP201 **LINEAR ALGEBRA** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- Be able to use and understand matrix and vector notation, addition, scalar multiplication, the dot product, matrix multiplication, and matrix transposition.
- Some important concepts of vector spaces.
- To develop student's mathematical maturity and enables to build mathematical thinking and use results from canonical forms and inner product spaces to solve contemporary problems.
- Construct visualizations of matrices related to vector fields. Explain how eigenvalues and eigenvectors relate to vector fields.
- Gaussian elimination to solve systems of linear equations and write the solution in parametric and vector form.
- Normalize vectors, obtain vectors of a given length in a given direction, and explain how to tell if two vectors are orthogonal.

Course Outcomes (COs)

On successful completion of this course, students will be able to

1. Recognize some advances of vector spaces and linear transformations.
2. Understand the concepts of linear algebra in geometric point of view.
3. Visualize linear transformations as a matrix form.
4. Decompose a given vector space in to certain canonical forms.
5. Know the concept of canonical transformation.
6. Understand the concept of Quadratic forms.

UNIT I

VECTOR SPACES

Elementary basic concepts - Linear independence and bases – Dual spaces.

UNIT II

LINEAR TRANSFORMATIONS

The algebra of linear transformations – Characteristic roots – Matrices.

UNIT III

CANONICAL FORMS

Triangular forms - Nilpotent transformations - A decomposition of vector spaces: Jordan form.

UNIT IV

INNER PRODUCT SPACE

Inner product spaces – Orthogonality – Orthogonalization – Orthogonal Complement – Trace and Transpose.

UNIT V

Hermitian - Unitary and Normal Transformations - Quadratic forms: Basic properties of quadratic forms – Diagonalization of quadratic forms.

SUGGESTED READINGS

1. N. Herstein, (2006),Topics in Algebra, 2nd Edition, John Wiley & Sons, Singapore.
2. Vivek Sahai&Vikas Bist (2013).Linear Algebra, Narosa Publishing House.
3. A. R. Rao& P. Bhimashankaram.(1992).Linear Algebra, Tata McGraw Hill.
4. J. S. Golan,(2010).Foundations of linear Algebra, Kluwer Academic publisher.
5. Kenneth Hoffman & Ray Kunze (2004).Linear Algebra, Prentice-Hall of India Pvt.
6. S. Kumaresan, Linear Algebra (2006). A Geometric Approach, Prentice Hall of India.

Semester – II

19MMP202 **COMPLEX ANALYSIS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- To learn the concepts of Oriented circles and level curves.
- Fundamental concepts of complex integration.
- To know the concepts of harmonic function.
- To develop the skill of contour integration to evaluate complicated real integrals via residue calculus.
- The development of the complex variable in boundary behaviour.
- Contour integral using parametrization, fundamental theorem of calculus and Cauchy's integral formula.

Course Outcomes (COs)

On successful completion of this course, students will be able to

1. Explain the role of the Conformal mapping.
2. Evaluate complex contour integrals and some of their consequences.
3. Determine the Taylor series or the Laurent series of an analytic function in a given region
4. Describe the convergence properties of a power series.
5. Know the basic properties of singularities of analytic functions.
6. Demonstrate familiarity with a range of examples of these concepts of conformal mapping.

UNIT I
CONFORMALITY

Conformal mapping-Linear transformations- cross ratio- symmetry- Oriented circles-families of circles-level curves.

UNIT II
FUNDAMENTAL THEOREMS ON COMPLEX INTEGRATIONS

Complex integration-rectifiable Arcs- Cauchy's theorem for Rectangle and disc-Cauchy's integral formula-higher derivatives.

UNIT III
HARMONIC FUNCTIONS

Harmonic functions-mean value property-Poisson's formula-Schwarz theorem, Reflection principle-Weierstrass theorem- Taylor series and Laurent series.

UNIT IV
ENTIRE FUNCTIONS

Partial Fractions- Infinite products – Canonical products-The gamma function – Stirling's Formula – Entire functions – Jensen's formula.

UNIT V
CONFORMAL MAPPINGS

Riemann Mapping Theorem – Boundary behaviour – Use of Reflection Principle – Analytical arcs – Conformal mapping of polygons- The Schwartz - Christoffel formula.

SUGGESTED READINGS

1. Lars V .Ahlfors., (1979). Complex Analysis, Third edition, Mc-Graw Hill Book Company, New Delhi.
2. Ponnusamy, S., (2005). Foundation of Complex Analysis, Second edition, Narosapublishing house, New Delhi.
3. Choudhary, B., (2005). The Elements of Complex Analysis ,New Age International Pvt. Ltd , New Delhi.
4. Vasishtha, A. R., (2014). Complex Analysis, Krishna Prakashan Media Pvt. Ltd., Meerut.
5. Walter Rudin., (2017) .Real and Complex Analysis,3rd edition, McGraw Hill Book Company, New York.

Semester – II

19MMP203 **OPTIMIZATION TECHNIQUES** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- The basic concepts of integer linear programming.
- How to solve quadratic programming problems, dynamic programming problems and non-linear programming problems.
- Classical optimization techniques and numerical methods of optimization.
- Know the basics of different evolutionary algorithms.
- Explain Integer programming techniques and apply different optimization techniques to solve various models.
- Enumerate the fundamental knowledge of Linear Programming and Dynamic Programming problems.

Course Outcomes (COs)

After successful completion of this course the students will be able to

1. Understand the concept of linear programming and integer programming.
2. Develop optimal decision policy skill.
3. Familiarize with real life applications of inventory models.
4. Skill in decision analysis.
5. Mastery in Beale's method and simplex method.
6. Use classical optimization techniques and numerical methods of optimization.

UNIT I

INTEGER LINEAR PROGRAMMING

Types of Integer Linear Programming Problems - Concept of Cutting Plane - Gomory's All Integer Cutting Plane Method - Gomory's mixed Integer Cutting Plane method Branch and Bound Method. - Zero-One Integer Programming – Real life application in Integer Linear Programming.

UNIT II

DYNAMIC PROGRAMMING

Characteristics of Dynamic Programming Problem - Developing Optimal Decision Policy - Dynamic Programming under Certainty - DP approach to solve LPP.

UNIT III

PROBABILISTIC INVENTORY MODEL

Real life application -Continuous review models- Probabilistic Economic order quantity (EOQ) Model. Single-period models – No setup model – setup model. Multi Period model.

UNIT IV

DECISION ANALYSIS

Real life application - Decision making under certainty- Analytic hierarchy process.Decisions under Risk- Decision Trees-based expected value criterion, variations of the expected value criterion. Decisions under Uncertainty Real life application in Decision Analysis

UNIT V

NON-LINEAR PROGRAMMING METHODS

Examples of NLPP - General NLPP - Graphical solution - Quadratic Programming - Wolfe's modified Simplex Methods - Beale's Method.

SUGGESTED READINGS

1. Sharma, J. K., (2017). Operations Research Theory and Practice, Third edition, Macmillan India Ltd.
2. Handy, A. Taha.(2007). Operations Research, Eighth edition, Prentice Hall of India Pvt Ltd, New Delhi.
3. Kantiswarup., Gupta, P. K. and Manmohan., (2006). Operations Research, Twelfth edition, Sultan Chand & Sons Educational Publishers, New Delhi.
4. Panneerselvam, R., (2007). Operations Research, Second edition, Prentice Hall of India Private Ltd, New Delhi.
5. Singiresu, S. Rao., (2006). Engineering Optimization Theory and Practice, Third edition New Age International Pvt Ltd, New Delhi.
6. Sivarethina Mohan. R., (2008). Operations Research, First edition, Tata McGraw Hill Publishing Company Ltd, New Delhi.

Semester – II

19MMP204 **PARTIAL DIFFERENTIAL EQUATIONS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- The basic concepts of solution of first order partial differential equation and its applications.
- About initial and boundary value problems for PDEs of first and second order which includes Laplace Equation, Diffusion Equation and Wave Equation.
- Introduce students to how to solve linear Partial Differential with methods.
- Technique of separation of variables to solve PDEs and analyze the behavior of solutions in terms of eigen function expansions.
- Solutions of PDEs are determined by conditions at the boundary of the spatial domain and initial conditions at time zero.
- Basic questions concerning the existence and uniqueness of solutions, and continuous dependence of initial and boundary data.

Course Outcomes (COs)

After successful completion of this course the students will be able to

1. Classify linear and Nonlinear first order differential equations with constant coefficients.
2. Solve the linear partial differential equations with constant coefficient equations.
3. Describe the method of separable variables and integral transforms.
4. Solve the elementary Laplace equation with symmetry.
5. Acquire the knowledge of wave equation and vibrating membranes.
6. Enrich their knowledge about diffusion equations with sources.

UNIT I
FIRST ORDER PARTIAL DIFFERENTIAL EQUATIONS

Non linear partial differential equation of first order –Compatible systems of first order equations – Special type of first order equations- Partial differential equations of second order – The origin of second order equations – Linear partial differential equations with constant coefficient equations with variable coefficients.

UNIT II
SEPARATION OF VARIABLES

Method of separation of variables –The method of integral transforms.

UNIT III

LAPLACE EQUATION

Elementary solutions of Laplace equations- Families of Equi-potential surfaces - Boundary Value problems-separation of variables-problems with axial symmetry.

UNIT IV

WAVE EQUATION

Elementary solutions of one dimensional wave equation-Vibrating membrane - Applications of calculus of variations-Green’s functions for the wave equation.

UNIT V

DIFFUSION EQUATION

The resolution of Boundary value problems for the Diffusion equation- Elementary solutions of diffusion equation - Separation of variables- use of Green’s functions- Diffusion with Sources.

SUGGESTED READINGS

1. Sharma, J. N, Keharsingh, (2009). Partial Differential Equations for Engineering and Scientists, Narosa Publishing House, New Delhi.
2. Ian. N. Sneedon, (2006). Elementary Partial differential equations, Tata Mcgraw Hill Ltd.
3. Geraold. B. Folland, (2001). Introduction to Partial Differential Equations, Prentice Hall of India Private limited, New Delhi.
4. SankaraRao. K, (2010). Introduction to Partial Differential Equations, Third edition, Prentice Hall of India Private limited, New Delhi.
5. Veerarajan, T, (2004). Partial Differential Equations and Integral Transforms, Tata McGraw-Hill Publishing Company limited, New Delhi.
6. John, F, (1991). Partial Differential equations, Third edition, Narosa publication co, New Delhi.
7. Tyn-Myint-U andLokenathDebnath(2008). Linear Partial Differential Equations for Scientists and Engineers, Fourth Edition, Birkhauser, Berlin.

Semester – II

19MMP205A **GRAPH THEORY** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- The fundamental concepts in Graph Theory and some of its modern applications.
- The use of these methods in subsequent courses in the design and analysis of algorithms, computability theory, software engineering, and computer systems.
- Apply graph-theoretic terminology and notation.
- Analyze new networks using the main concepts of graph theory.
- Central theorems about trees, matching, connectivity, colouring and planar graphs.
- Know the concept of domination in graphs.

Course Outcomes (COs)

On successful completion of this course, students will be able to

1. Applied the knowledge of graphs to solve the real-life problem.
2. Overview of properties of trees and a minimal spanning tree for a given weighted graph.
3. Understanding the basic concepts of graphs, directed graphs, and weighted graphs and able to present a graph by matrices.
4. Understand Eulerian and Hamiltonian graphs.
5. Determine whether graphs are Planer and/or non planer.
6. Identify induced subgraphs, cliques, matchings, covers in graphs.

UNIT I

GRAPHS

Graphs – Introduction – Isomorphism – Sub graphs – Walks, Paths, Circuits – Connectedness – Components – Euler Graphs – Hamiltonian Paths and Circuits – Trees – Properties of trees – Distance and Centers in Tree – Rooted and Binary Trees - Spanning trees – Fundamental Circuits.

UNIT II

SPANNING TREES

Spanning Trees in a Weighted Graph – Cut Sets – Properties of Cut Set – All Cut Sets – Fundamental Circuits and Cut Sets – Connectivity and separability – Network flows – 1-Isomorphism – 2-

Isomorphism – Combinational versus Geometric Graphs – Planer Graphs – Different Representation of a Planer Graph.

UNIT III

MATRIX REPRESENTATION OF A GRAPH

Incidence matrix – Sub matrices – Circuit Matrix – Path Matrix – Adjacency Matrix – Chromatic Number – Chromatic partitioning – Chromatic polynomial - Matching - Covering – Four Color Problem.

UNIT IV

COUNTING TREE

Directed Graphs – Types of Directed Graphs - Types of enumeration, counting labeled trees, counting unlabelled trees, Polya's counting theorem, graph enumeration with Polya's theorem.

UNIT V

DOMINATION IN GRAPHS

Introduction – Terminology and concepts – Applications – Dominating set and domination number – Independent set and independence number – History of domination in graphs.

SUGGESTED READINGS

1. Deo N, (2007). Graph Theory with Applications to Engineering and Computer Science, Prentice Hall of India Pvt Ltd, New Delhi.
2. Teresa W. Haynes, Stephen T. Hedetniemi and Peter J.Slater, (1998), Fundamentals of Domination in Graphs, Marcel Dekker,New York.
3. Jonathan L Gross, Jay Yellen, (2014). Handbook of Graph Theory, CRC Press LLC. Taylor &Francis Group,Boca Rotan.
4. Diestel. R Springer-Verlag, (2012). Graph Theory. Springer-Verleg,New York.
5. Jensen.TR and Toft.B., (1995). Graph Coloring Problems. Wiley-Interscience , , New York.
6. Fred Buckley and Frank Harary, (1990). Distance in Graphs, Addison - Wesley Publications. Redwood City, California.
7. Flouds C. R., (2009). Graph Theory Applications, Narosa Publishing House. New Delhi,India.
8. Arumugam. S, Ramachandran. S ,(2006). Invitation to graph theory, Scitech publications, Chennai.
9. Harary F, (2001).Graph Theory, Addison- Wesley Publishing Company Inc USA.

Semester – II

19MMP205B **DIFFERENTIAL GEOMETRY** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- Basics of space curves, surfaces and their properties.
- The concept of curvature of a space curve and signed curvature of a plane curve.
- Understand the fundamental theorem for plane curves. involutes and evolutes of space curves with the help of examples.
- Compute the curvature and torsion of space curves. coefficients and their derivatives.
- Understand the fundamental theorem for plane curves.
- Compute the curvature and torsion of space curves. coefficients and their derivatives.

Course Outcomes (COs)

On successful completion of this course the students will be able to

1. Obtain in depth knowledge of problems and properties of curves and surfaces based on vector methods in geometrical view point
2. Understand fundamental existence theorem for space curves
3. Discuss the Involutes and evolutes.
4. Mastery in canonical geodesic equations
5. Find geodesic curvature for various surfaces
6. Determine and calculate curvature of curves in different coordinate systems.

UNIT I

THEORY OF SPACE CURVES

Unique parametric representation of a space curve - Arclength - tangent and osculating plane - principal normal and binormal - curvature and torsion - contact between curves and surfaces - osculating circle and osculating sphere - locus of centres of spherical curvature.

UNIT II

TANGENT SURFACES

Involutes and evolutes – Betrand curves - Spherical indicatrix - Intrinsic equations of space curves - Fundamental existence theorem for space curves - Helices.

UNIT III

THE FIRST FUNDAMENTAL FORM AND LOCAL INTRINSIC PROPERTIES OF A SURFACE

Definition of a surface - Nature of points on a surface - Representation of a surface - Curves on surfaces - Tangent plane and surface normal - The general surfaces of revolution – Helicoids - Metric on a surface - The first fundamental form - Direction coefficients on a surface.

UNIT IV

FAMILIES OF CURVES

Orthogonal trajectories - Double family of curves - Isometric correspondence - Intrinsic properties - Geodesics on a surface: Geodesics and their differential equations - Canonical geodesic equations - Geodesics on surface of revolution - Normal property of geodesics - Differential equations of geodesics using normal property.

UNIT V

EXISTENCE THEOREMS

Geodesic parallels - Geodesic polar coordinates - Geodesic curvature - Gauss-Bonnet theorem- Gaussian curvature.

SUGGESTED READINGS

1. T.J. Willmore, (2006).An Introduction to Differential Geometry, Oxford University Press, New Delhi.
2. J. N. Sharma & A. R. Vasistha,(1998).Differential Geormetry, KedarNath Ram Nath, Meerut.
3. D. Somasundaram,(2006).Differential Geometry: A first course, Narosa Publishing House,New Delhi, India.

Semester – II

19MMP205C FUNDAMENTALS OF ACTUARIAL MATHEMATICS **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- The fundamental theories of actuarial science as they apply in life insurance, general insurance and superannuation.
- How to assess the suitability of actuarial, financial and economic models in solving actuarial problems
- Interpretation and critically evaluating the articles in the actuarial research literature.
- About the concept of educational annuity plan.
- Understand the Premium Conversion tables for calculation of Policy values.
- The concept of Premiums for Annuity Plans.

Course Outcomes (COs)

On successful completion of this course the student will be able

1. Explain the basic concepts of accounts and calculations of interest rates in banking / financial institution system.
2. Describe about Premiums of Life Insurance and Endowment Assurance (Pure, Double and Marriage) and Educational Annuity plan.
3. Define Annuity and Summarize / calculate different values Annuities.
4. Find the Annuity values for various Annuities.
5. Calculation of Net Premiums for Assurance Plans.
6. Leant about how to read Mortality Table and from that how to calculate the Probability of Survival and Death.

UNIT I

BASIC CONCEPTS OF ACTUARIAL MATHEMATICS

Accumulated Value – Present Value – Formula for present value- Annuities Certain- present Values- Amounts - Deferred Annuities –Perpetuities - Present Value of an Immediate Annuity Certain – Accumulated Value of Annuity – Relation between Sn and a_n – Present Value of Deferred Annuity Certain – Accumulated Value of a term of n years – Perpetuity – Present Value of an Immediate Perpetuity of 1p.a. – Present Value of a Perpetuity due of 1 p.a. – Deferred Perpetuity with Deferment Period of m years – Mortality Table – The Probabilities of Survival and Death.

UNIT II

CALCULATION OF DIFFERENT INSURANCE PREMIUMS

Life Insurance Premiums – General considerations - Assurance Benefits – Pure Endowment Assurance – Endowment Assurance – Temporary Assurance or Term Assurance - Whole Life Assurance – Pure Endowment Assurance – Endowment Assurance – Double Endowment Assurance Increasing Temporary Assurance – Increasing Whole Life Assurance – Fixed Term (Marriage) Endowment – Educational Annuity Plan.

UNIT III

VARIOUS VALUES OF ANNUITIES

Life Annuities and Temporary Annuities – Commutation Functions Nx – To Find the Present Value of an Annuity Due of Re.1 p.a. for Life – Temporary Immediate Life Annuity – Expression for ax : n – Deferred Temporary Life Annuity – Variable Life Annuity – Increasing Life Annuity – Variations in the Present Values of Annuities – Life Annuities Payable at Frequent Intervals.

UNIT IV

ANNUAL PREMIUMS AND ANNUITY PLANS

Net Premiums for Assurance Plans – Natural Premiums – Level Annual Premium – Symbols for Level Annual Premium under Various Assurance Plans – Mathematical Expressions for level Annual Premium under Level Annual Premium under Various Plans for Sum Assure of Re. 1 – Net Premiums – Consequences of charging level Premium – Consequences of withdrawals – Net Premiums for Annuity Plans – Immediate Annuities – Deferred Annuities.

UNIT V

POLICYVALUE AND ITS CALCULATION

Premium Conversion tables – Single Premium Conversion tables – Annual Premium Conversion Tables – Policy Values – Two kinds of Policy values – Policy value in symbols – Calculation of Policy Value for Unit Sum Assure – Other Expressions for Policy Value – Surrender Values – Paid up Policies – Alteration of Policy Contracts.

SUGGESTED READING

1. Mathematical Basis of Life Insurance - Insurance Institute of India

Semester – II

19MMP206 **FLUID DYNAMICS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- The concepts of fluid, its properties and behavior under various conditions of internal and external flows.
- The fundamentals of Fluid Dynamics, which is used in the applications of Aerodynamics, Hydraulics, Marine Engineering, Gas dynamics etc.
- To imbibe basic laws and equations used for analysis of static and dynamic fluids
- About the Two-Dimensional Motion of the fluid.
- Identify the fundamental kinematics of a fluid element.
- State the conservation principles of mass, linear momentum, and energy for fluid flow.

Course Outcomes (COs)

On successful completion of this course, students will be able to

1. Classify and exploit fluids based on the physical properties of a fluid.
2. Compute correctly the kinematical properties of a fluid element.
3. Apply the concept of Bernoulli's theorem in steady motion.
4. Understand both flow physics and mathematical properties of governing Navier-Stokes equations and define proper boundary conditions for solution.
5. Provide the student with the basic mathematical background and tools to model fluid motion.
6. Develop a physical understanding of the important aspects that govern incompressible flow that can be observed in a variety of situations in everyday life.

UNIT I
INTRODUCTORY NOTIONS

Velocity – Stream Lines and Path Lines – Stream Tubes and Filaments – Fluid Body – Density – Pressure. Differentiation following the Fluid – Equation of continuity – Boundary conditions – Kinematical and physical – Rate of change of linear momentum – Equation of motion of an in viscid fluid.

UNIT II

EQUATION OF MOTION OF A FLUID

Euler's momentum Theorem – Conservative forces – Bernoulli's theorem in steady motion – Energy equation for in viscid fluid – Circulation – Kelvin's theorem – Vortex motion – Helmholtz equation.

UNIT III

TWO DIMENSIONAL FLOW

Two Dimensional Motion – Two Dimensional Functions – Complex Potential – Basic singularities – Source – Sink – Vortex – Doublet – Circle theorem. Flow past a circular cylinder with circulation – Blasius Theorem – Lift force. (Magnus effect)

UNIT IV

VISCOUS FLOWS

Viscous flows – Navier-Stokes equations – Vorticity and circulation in a viscous fluid – Steady flow through an arbitrary cylinder under pressure – Steady Couettc flow between cylinders in relative motion – Steady flow between parallel planes.

UNIT V

LAMINAR BOUNDARY LAYER IN INCOMPRESSIBLE FLOW

Boundary Layer concept – Boundary Layer equations – Displacement thickness, Momentum thickness – Kinetic energy thickness – Integral equation of boundary layer – Flow parallel to semi infinite flat plate – Blasius equation and its solution in series.

SUGGESTED READINGS

1. Milne Thomson .L.M., (2011). Theoretical Hydrodynamics, Fifth edition, Dover Publications INC, NewYork.
2. Curle.N., and Davies H.J., (1971). Modern Fluid Dynamics Volume-I , D Van Nostrand Company Ltd., London.
3. Yuan, S.W, (1976). Foundations of Fluid Mechanics, Prentice- Hall, India.
4. Shanthiswarup, (2014).Fluid dynamics, Krishna Prakasan media Pvt Ltd, Meerut.

Semester – II

19MMP211 **OPTIMIZATION TECHNIQUES – PRACTICAL** **4H – 2C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

- To provide the students an exposure to develop well-structured optimization techniques knowledge arising process in various level of science.
- The course aims at building capabilities in the students for analyzing different situations in the industrial/ business scenario involving limited resources and finding the optimal solution within constraints.
- This module aims to introduce students to use Probabilistic Model and techniques.
- The course aims at providing fundamental knowledge and exposure of the concepts, theories and practices in the field of management.
- Study the basic components of an optimization problem.
- Formulation of design problems as mathematical programming problems.

Course Outcomes (COs)

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

1. Use the object oriented concepts for implementation of Optimization Techniques.
2. Implement the data structure concepts for Optimization Techniques problems.
3. Acquire skills to solve various multivariable optimization problems
4. Solve of different optimization problems.
5. Identify and develop operational research models from the verbal description of the real system. Understand the mathematical tools that are needed to solve optimization problems.
6. Use mathematical software to solve the proposed models.

List of Practical:

1. Solution for a system of equations- Simplex method.
2. EOQ for purchasing model without shortage
3. EOQ for manufacturing model without shortage
4. EOQ for manufacturing model with shortage
5. EOQ for purchasing model with shortage
6. Probabilistic Model-EOQ.
7. Decision making with minimax criterion.

8. Decision making with maximin criterion.
9. Decision making under risk.
10. Decision making with Hurwicz criterion.

Semester – III

19MMP301 **TOPOLOGY** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- Topological properties of sets.
- The properties of compact spaces and connected spaces.
- To explore the foundations of linear subspace.
- The concepts of metric spaces and topological spaces.
- Metric spaces and metrizability of topological spaces; separation axioms.
- Interior, closure and boundary: applications to geographic information systems

Course Outcomes (COs)

On successful completion of this course, students will be able to

1. Know concept of metric spaces.
2. Acquire knowledge about various types of topological spaces and their properties.
3. Know the result of Compactness problems and theorems.
4. Admire the deep mathematical results like Urysohn's lemma.
5. Create examples and counterexamples in the fundamental concepts of separation space.
6. Formulate and analyze topological problems in connected space.

UNIT I
TOPOLOGY OF METRIC SPACES
Topological spaces-Basis for a topologies-The order topology-The product topology X x Y-The subspace topology.

UNIT II
TOPOLOGICAL PROPERTIES
Closed set and limit points-Continuous functions-The product topologies-The metric topologies.

UNIT III
CONNECTEDNESS
Connected spaces-Connected subspaces of the real line-Components and local connectedness.

UNIT IV

COMPACTNESS

Compact spaces-Compact subspaces of the Real line-Limit point compactness-Local compactness.

UNIT V

COUNTABILITY AND SEPARATION AXIOMS

The countability axioms-The separation axioms-Normal spaces-The Urysohn lemma, The Urysohnmetrization theorem-The Tietze Extension theorem.

SUGGESTED READINGS

1. James R.Munkres., (2008). Topology, Second edition, Pearson Prentice Hall, New Delhi.
2. Simmons, G. F., (2017). Introduction to Topology and Modern Analysis, Tata McGraw Hill, New Delhi.
3. Deshpande, J. V., (1990). Introduction to topology, Tata McGraw Hill, New Delhi.
4. James Dugundji., (2002). Topology, Universal Book Stall, New Delhi.
5. Joshi, K. D.(2017). Introduction to General Topology, New Age International Pvt Ltd, New Delhi.

Semester – III

19MMP302 **FUZZY SETS AND FUZZY LOGIC** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives:

The student should be made to:

- Understand the basic knowledge of fuzzy sets and fuzzy logic.
- To gain knowledge in fuzzy relations and fuzzy measures.
- Be exposed to basic fuzzy system applications.
- The basic concepts of modeling in systems using fuzzy sets.
- The concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic control and other machine intelligence applications of fuzzy logic.
- The importance of tolerance of imprecision and uncertainty for design of robust & low cost intelligent machines.

Course Outcomes (COs)

On successful completion of this course, students will be able to

1. Comprehend the fuzzy logic and the concept of fuzziness involved in various systems and fuzzy set theory.
2. Understand the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic.
3. Understand basic knowledge of the fuzzy sets, operations and their properties.
4. Understand the fundamental concepts of Fuzzy functions and Fuzzy logic
5. Apply the concepts of Fuzzy sets in image processing, Pattern reorganization and Decision making.
6. Understand the concept of Fuzzy measures.

UNIT - I CRISP SETS AND FUZZY SETS:

Introduction-Crisp sets: An over view-The Notion of Fuzzy Sets-basic concepts of Fuzzy sets. Classical Logic: complement-Fuzzy Union-Fuzzy interaction – Combination of operations– general aggregation of operations.

UNIT – II FUZZY RELATIONS

Crisp and Fuzzy relations – Binary relations – Binary relations on a single set – Equivalence and similarity relations – Compatibility on Tolerance Relations-Orderings – Morphism – fuzzy relations Equations.

UNIT- III FUZZY MEASURES

General discussion – Belief and plausibility Measures –Probability measures – Possibility and Necessity measures.

UNIT- IV FUZZY MEASURES

Relationship among Classes of Fuzzy Measures.

UNIT – V UNCERTAINTY AND INFORMATION

Types of Uncertainty – Measures of Fuzziness Classical Measures of Uncertainty – Measures of Dissonance-Measures of Confusion – Measures of Non-Specificity – Uncertainty and Information – Information and Complexity – Principles of Uncertainty and information.

SUGGESTED READINGS

1. George J. Klir and Bo Yuan,(1988).Fuzzy Sets and Fuzzy Logic, Prentice Hall of India.
2. George J. Klir and Tina A. Folger,(2015).Fuzzy Sets, Uncertainty and Information, pearson publications.
3. H.J. Zimmerman, (2006).Fuzzy Set Theory and Its Applications, Kluwer Academic publishers.
4. D. DuBois and H. M. Prade,(1994).Fuzzy Sets and Systems: Theory and Applications, AcademicPress.
5. T. J. Ross,(2016).Fuzzy Logic with Engineering Applications, 4th edition,Willey Publications.

Semester – III

19MMP303 **MEASURE THEORY** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- Perspective on the broader impact of measure theory in ergodic theory.
- To apply the general principles of measure theory and integration.
- About the concept of Measurable spaces.
- To understand the basic concepts Riemann integral and Lebesgue integral.
- Basic knowledge of measure theory needed to understand probability theory, statistics and functional analysis.
- Develop the ideas of Lebesgue integration and its properties.

Course Outcomes (COs)

After successful completion of this course the students will be able to:

1. Get a clear view of the fundamentals of measure theory.
2. Acquaint with the proofs of the fundamental theorems underlying the theory of Lebesgue integration.
3. Identify the broader impact of measure theory in ergodic theory and ability to pursue further studies in this area.
4. Mastery in the measure spaces and its properties.
5. Apply the theorems of monotone and dominated convergence and Fatou's lemma.
6. Apply Lebesgue decomposition and the Radon-Nikodym theorem.

UNIT I
MEASURES

Introduction – Outer measure – Measurable sets and Lebesgue Measure – A non measurable set – Measurable set – Measurable functions – Littlewoods's three principles.

UNIT II
FUNCTIONS AND INTEGRALS

The Riemann integral – The Lebesgue integral of a bounded function over a set finite measure – The integral of a non negative function – The general Lebesgue integral – Convergence in measure.

UNIT III
DIFFERENTIATION

Differentiation of monotone function, Functions of bounded variation-differentiation of an integral-Absolute continuity.

UNIT IV

MEASURE SPACES

Measure spaces-Measurable functions-Integration-General convergence Theorems.

UNIT V

SIGNED MEASURES

Signed measures-The Radon-Nikodym theorem-the L^P spaces.

SUGGESTED READINGS

1. Royden, H. L, (2008). Real Analysis, Third Edition, Prentice – Hall of India Pvt.Ltd, New Delhi.
2. Keshwa Prasad Gupta, (2005). Measure Theory, Krishna Prakashan Ltd, Meerut.
3. Donald L. Cohn, (2013). Measure Theory, United States.
4. Paul R. Halmos, (2008). Measure Theory, Princeton University Press Dover Publications,New York .
5. Rudin W, (2017). Real and Complex Analysis, 3 rd Edition, Mcgraw – Hill Education India Pvt Ltd, New Delhi.

Semester – III

19MMP304 **MATHEMATICAL STATISTICS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- To understand the basic concepts in probability generating functions, sample moments and their functions, sampling, significance tests and statistical measures
- Probability distributions, significance of testing hypothesis and its interpretation,
- Estimation, ANOVA and their applications in various disciplines.
- Understand the concept of distribution functions.
- The knowledge of fixed-sample and large-sample statistical properties of point and interval estimators.
- Understanding of how to design experiments and surveys for efficiency.

Course Outcomes (COs)

After successfully completed this module the students will be able to

1. Explain the concepts of probability, including conditional probability.
2. Explain the concepts of random variable, probability distribution, distribution function, expected value, variance and higher moments, and calculate expected values and probabilities associated with the distributions of random variables.
3. Summarize the main features of a data set and test statistical hypotheses.
4. Define basic discrete and continuous distributions, be able to apply them and simulate them in simple cases.
5. Explain the concepts of analysis of variance and use them to investigate factorial dependence.
6. Describe the main methods of estimation and the main properties of estimators, and apply them.

UNIT I
PROBABILITY

Random Events – Preliminary remarks – random events and operations performed on them – the system of axioms of the theory of probability – conditional probability – Bayes theorem – Independent Events –functions of random variables –Introduction to hypothesis testing, type of errors, standard errors, confidence interval, confidence limits. Significance level.

UNIT II

SAMPLE MOMENTS AND THEIR FUNCTIONS

Notion of a sample and a statistic - Distribution functions of X, S^2 and (X , S^2) -Chi-square distribution -Student t-distribution -Fisher's Z-distribution -Snedecor's F -distribution -Distribution of sample mean from non-normal populations.

UNIT III

SIGNIFICANCE TEST

Concept of a statistical test -Parametric tests for small samples and large samples Chi-square test -Kolmogorov Theorem-Smirnov Theorem-Tests of Kolmogorov and Smirnov type The Wald-Wolfovitz and Wilcoxon-Mann-Whitney tests -Independence Tests by contingency tables.

UNIT IV

ESTIMATION

Preliminary notion -Consistency estimation -Unbiased estimates -Sufficiency - Efficiency -Asymptotically most efficient estimates -methods of finding estimates -confidence Interval.

UNIT V

ANALYSIS OF VARIANCE

One way classification and two-way classification. Hypotheses Testing: Poser functions -OC function-Most Powerful test -Uniformly most powerful test -unbiased test.

SUGGESTED READINGS

1. MarekFisz, (1980). Probability Theory and Mathematical Statistics, John Wiley and Sons, New York.
2. Meyer, (2006). Introduction to Probability and Statistical applications, Oxford and IBH Publishing Co. Pvt Ltd. New Delhi.
3. Sheldon M. Ross, (2009). Introduction to probability and statistics for engineers and scientists, Third edition, Academic press.
4. Heinz Bauer,(1996), Probability Theory, Narosa Publishing House, London.
5. Parimal Mukhopadhyay, (2012). Theory of Probability, New central book agency, Calcutta.

Semester – III

19MMP305A FORMAL LANGUAGES AND AUTOMATA THEORY **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- The basic concepts in automata theory and theory of computation.
- To identify different formal language classes and their relationships.
- This course focuses on the basic theory of Computer Science and formal methods of computation like automata theory, formal languages, grammars.
- Design automata, regular expressions and context free grammars for accepting or generating a certain language.
- Design grammars and recognizers for different formal languages
- Determine the decidability and intractability of computational problems.

Course Outcomes (COs)

On successful completion of this course the students will be able to:

1. Understand the definition of Automata.
2. Know about the different concepts in automata theory and formal languages such as formal proofs, non-deterministic automata, regular expressions, regular languages context-free grammars, context-free languages.
3. Discuss the acceptability of a string by finite automation.
4. Applications of Pumping Lemma.
5. Design automata, regular expressions and context-free grammars accepting or generating certain languages.
6. Acquire concepts relating to the theory of computation and computational models including decidability and intractability.

UNIT I
FINITE AUTOMATA

Definition of an Automation - Description of Finite Automaton – Transition systems - Property of transition functions - Acceptability of a string by a finite Automaton - Non deterministic finite automaton - The equivalence of DFA and NDFA.

UNIT II

FROMAL LANGUAGES

Formal Languages - Basic Definitions and examples - Chomsky classification of Languages - Languages and their relation - Recursive and Recursively Enumerable sets- Operations on Languages.

UNIT III

REGULAR EXPRESSIONS AND LANGUAGES

Regular expressions - Finite Automata and Regular expressions.

UNIT IV

REGULAR SETS

Pumping Lemma for Regular sets - Applications of Pumping Lemma - Closure Property of Regular sets - Regular sets and Regular grammars.

UNIT V

CONTEXT FREE GRAMMARS

Context free Languages and Derivation trees - Ambiguity in Context free grammars - Simplification of Context free grammars (examples only).

SUGGESTED READINGS

1. Mishra, K. L. P and Chandrasekaran, N.,(2008). Theory of Computer Science, Automata Languages and Computation, Prentice Hall of India, New Delhi.
2. John E. Hopcroft, Rajeev Motwani and J.D. Ullman, (2006). Introduction to Automata theory, Languages and Computation, Third Edition, Prentice Hall of India,New Delhi.
3. Aho A.V., and Ullman J.D., (2002). Principles of compiler design, Narosa Publishing Company, London.
4. Rakesh Duke, Adesh Pandey and Ritu Gupta, (2007).Discrete Structures and Automata theory.Narosa Publishing Company, New Delhi.

Semester – III

19MMP305B MAGNETOHYDRODYNAMICS 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- To understand fundamentals of magnetohydrodynamics which describes the dynamics of electrically conducting fluids
- To figure out the applications of magnetohydrodynamics to the various science and engineering fields
- Basics of electromagnetic theory and vector calculus.
- Able to understand the concept of flow and Stability.
- The basic properties of electrically-conducting fluids.
- The role of the Lorentz force and its relevance to plasma confinement, dynamo theory and the dynamics of magnetic waves.

Course Outcomes (COs)

On successful completion of this course the student will be able to:

1. Provide the details of the derivation of ideal and resistive MHD equations.
2. Demonstrate the basic properties of ideal MHD.
3. Describe electromagnetic boundary conditions.
4. Explain MHD waves.
5. Describe the derivation of fluid equations, energy equation.
6. Describe electromagnetic fields in the energy and momentum fluxes.

UNIT I

Review of equation of motions of viscous compressible fluid flow –Introduction of MHD-Electromagnetic field equations-Maxwell’s equations and their Physical significance- Maxwell’s equations in the moving frame of reference-Invariance under Galilean Transformation-Electromagnetic effects and the magnetic Reynolds number-induction equation –Alfven’s Theorem-Physical Significance-Consequence of Alfven’s Theorem-Ferraro’s Law of irritation-The magnetic Energy- the mechanical equations and the mechanical effects-Electromagnetic stresses.

UNIT II

Magneto hydrostatics and steady states-Hydro magnetic equilibrium and forces free magnetic fields-boundary conditions – Boundary conditions in the case of force free magnetic fields-free surface of an isolated fluid mass- Chandrasekhar's theorem-General solution of force free magnetic field when is constant-some examples of force free fields.

UNIT III

Hydromagnetics of the laboratory- steady laminar motion-Hartmann flow (MHD Poiseuille's flow)-Domination of viscous forces over magnetic forces and vice versa-physical significance- Important dimensionless of MHD and their physical significance-electromagnetic boundary conditions-tensor electrical conductivity, Hall current and ion slip – simple flow problems with tensor electrical conductivity.

UNIT IV

Magneto hydrodynamic waves- Waves in an infinite fluid of infinite electrical conductivity- Alfven waves in incompressible fluid in viscid fluid of infinite electrical conductivity-Waves of finite amplitude –propagation of velocity and current density with Alfven velocity-MHD waves in incompressible fluid- Alfven wave and two magneto acoustic waves- the limit of zero magnetic Prandtlnumber of significance.

UNIT V

Stability of hydro magnetic systems- theory and applications-methods of investigation-small perturbations and instability-Energy principle-normal mode analysis-simple illustrative examples-the stability of Hartman layer-Squire's theorem-Orr-Summerfield equation-Instability of linear pinch-methods of stabilize- Flute Instability- A general criterion for satiability-Bernstein's method of small oscillations(normal mode analysis) for hydro magnetic stability-jeans criterion for Gravitational stability- Chandrasekhar's generalization for MHD and rotating fluids.

SUGGESTED READINGS

1. Ferraro, V. A. C and Plumpton, C., (1966). An Introduction to Magneto-Fluid Mechanics., Clarendon press, oxford.
2. Crammer M.R., and Shi-l pai.,(1973). Magneto-Fluid Mechanics for engineers and applied physicists, Scripta publishing company, Washington D.C.
3. Roberts P. H., (1967). An Introduction to Magneto hydrodynamics., Longmans, Green and Co Ltd., London.
4. Sutton G.W., and Sherman A., (1965). Engineering Magneto hydrodynamics., McGraw HillBook Co., New Delhi.
5. Chandrasekhar S., (1961). Hydro dynamic and Hydro dynamic stability, Oxford university press. Cambridge, UK.

Semester – III

19MMP305C **NEURAL NETWORKS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives:
The student should be made to:

- To introduce the neural networks for classification and regression
- To give design methodologies for neural networks
- Understand the differences between networks for supervised and unsupervised learning.
- The introduction and different architectures of neural networks.
- The applications of neural networks.
- The fundamental concepts artificial neural networks.
- Develop and train radial-basis function networks.

Course Outcomes (COs)
On successful completion of this course the student will be able to

1. Comprehend the concepts of feed forward neural networks
2. Analyze the various Linear Associator..
3. Analyze the various Back Propagation Algorithm
4. Supervised learning and unsupervised learning.
5. Design single and multi-layer feed-forward neural networks
6. Analyse the performance of neural networks in directional derivatives.

UNIT- I
Mathematical Neuron Model- Network Architectures- Perceptron-Hamming Network-Hopfield Network-Learning Rules.

UNIT – II
Perceptron Architectures and Learning Rule with Proof of Convergence. Supervised Hebbian Learning -Linear Associator.

UNIT I- III
The Hebb Rule-Pseudo inverse Rule-Variations of Hebbian Learning-BackPropagation - Multilayer Perceptrons.

UNIT - IV
Back propagation Algorithm-Convergence and Generalization –PerformancesSurfaces and Optimum Points-Taylor series.

UNIT V

Directional Derivatives - Minima-Necessary Conditions for Optimality-Quadratic Functions-Performance Optimizations-Steepest Descent-Newton's Method-Conjugate Gradient.

SUGGESTED READINGS

1. Martin T.Hagan, Howard B. Demuth and Mark Beale,(2014).Neural Network Design,Vikas Publishing House, New Delhi,
2. James A. Freeman, David M. Skapura,(2011). Neural Networks Algorithms, Applications and Programming Techniques, Pearson Education.
3. Robert J. Schalkoff,(2000). Artificial Neural Network, McGraw-Hill International Edition.

Semester – III

19MMP306 **MATHEMATICAL METHODS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- Range of mathematics tools with emphasis on engineering applications.
- To think quantitatively and analyse problems critically.
- Understand the concept of Volterra integral and Fredholm theory.
- The concepts of Functional dependent on higher order derivatives.
- Understand and be able to use the language, symbols and notation of mathematics.
- Develop mathematical curiosity and use inductive and deductive reasoning when solving problems.

Course Outcomes (COs)

On successful completion of this course the students will be able to,

1. Calculate the Fourier transform of elementary functions from the definition.
2. Find the Fourier transforms of functions of one variable.
3. Calculate the Laplace equation in half plane of standard functions both from the definition and by using tables.
4. Equation with separable kernel and Fredholm alternative approximation Method.
5. Select and combine the necessary Laplace transform techniques to solve second-order ordinary differential equations.
6. Understand the concept of Functionals of the integral forms

UNIT I

Fourier Transforms – Definition of Inversion theorem –Fourier cosine transforms - Fourier sine transforms – Fourier transforms of derivatives -Fourier transforms of some simple functions - Fourier transforms of rational function.

UNIT II

The convolution integral – convolution theorem – Parseval's relation for Fourier transforms – solution of PDE by Fourier transform – Laplace's Equation in Half plane – Laplace's Equation in an infinite strip - The Linear diffusion equation on a semi-infinite line - The two-dimensional diffusion equation.

UNIT III

Types of Integral equations–Equation with separable kernel- Fredholm Alternative Approximate method – Volterra integral equations–Classical Fredholm theory – Fredholm's First, Second, Third theorems.

UNIT IV

Application of Integral equation to ordinary differential equation – initial value problems – Boundary value problems – singular integral equations – Abel Integral equation .

UNIT V

Variation and its properties – Euler's equation – Functionals of the integral forms - Functional dependent on higher order derivatives – functionals dependent on the functions of several independent variables – variational problems in parametric form.

SUGGESTED READINGS

1. Sneedon. I. N, (1974). The Use of Integral Transforms, Tata McGraw Hill, New Delhi.
2. Kanwal, R. P, (2013). Linear integral Equations Theory and Technique, Academic press, New York.
3. Elsgots, L., (2003). Differential Equations and Calculus of Variation, Mir Publication Moscow.
4. Gelfand, I. M and Francis, S.V. (2000). Calculus of Variation, Prentice Hall, India.
5. Tricomi.F.G, (2012). Integral Equations, Dover, New York.
6. Larry C. Andrews and Bhimson K. Shivamoggi, (2000). The Integral transforms for Engineers ,Spie Press, Washington.

Semester – III

19MMP311 MATHEMATICAL STATISTICS– PRACTICAL 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- It is well recognized nowadays the importance of Statistics as an indispensable tool for obtaining and spreading information.
- Importance has been enhanced by the use of computational resources and particularly the software SPSS, that showed, during the last decades, to be an effective tool for treating and analyzing statistical data.
- Ability to use SPSS procedures in handling data files and performing statistical analysis, and to interpret the outputs provided by the program.
- Acquiring sensitivity and critical thinking towards arguments and conclusions based on statistical studies.
- Understanding the fundamental principles underlying descriptive and inferential statistical reasoning.

Course Outcomes (COs)

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

1. Describe and classify data using statistical terminology.
2. Use SPSS to conduct basic descriptive analyses and graphical presentations.
3. Define the null hypothesis and the alternative hypothesis and Interpret P values and confidence intervals.
4. Understand different measures of effect (e.g. mean difference).
5. Know when to use basic statistical hypothesis tests (t-tests, chi-squared tests, correlation) and how to carry out these tests using SPSS.
6. Appreciate how to present and interpret these results in scientific reports.

List of Practical:

1. Introduction to SPSS Package
2. Working with windows in SPSS
3. Defining variables in variable view window in SPSS
4. Drawing of graphs and diagrams in SPSS Package
5. Standard deviation for individual and discrete series using SPSS Package.
6. Standard deviation continuous series using SPSS Package.
7. Coefficient of variation for individual and discrete series using SPSS Package.
8. Calculation of Mean and variance for binomial distribution using SPSS Package.
9. Calculation of Mean and variance for Poisson distribution using SPSS Package.
10. Karl Pearson's Correlation using SPSS Package.
11. Rank Correlation Coefficient using SPSS Package.
12. Testing Hypothesis using t - test in SPSS Package.
13. Testing Hypothesis using Z - test in SPSS Package.
14. Testing Hypothesis using chi-square - test in SPSS Package.
15. Interpretation of results in the SPSS output viewer.

Semester – IV

19MMP401 **FUNCTIONAL ANALYSIS** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- The concept of Banach spaces and related properties.
- Pure concepts on open mapping and closed graph theorem.
- The specific techniques for bounded operators over normed and Hilbert spaces.
- The demonstrate significant applications of the theory of operators.
- Understand how to use the main properties of compact operators.
- Apply the spectral analysis of compact self-adjoint operators to the resolution of integral equations.

Course Outcomes (COs)

After successful completion of this course the students will be able to

1. Develop Banach spaces from vector spaces.
2. Describe the open mapping theorem.
3. Discuss Hilbert spaces and its properties.
4. Study in detail about the adjoint of an operator.
5. Handle complex problems concerning topics within the area of Functional Analysis.
6. Understand and apply fundamental theorems from the theory of normed and Banach spaces.

UNIT I

BANACH SPACES

Banach Spaces-Normed linear space – Definitions and Examples-Theorems. Continuous Linear Transformations – Some theorems- Problems. The Hahn- Banach Theorem – Lemma and Theorems. The Natural imbedding of N in N**- Definitions and Theorems.

UNIT II

OPEN MAPPING THEOREM

The Open Mapping Theorem- Theorem and Examples –Problems. The closed graph theorem. The conjugate of an operation- The uniform boundedness theorem- Problems.

UNIT III

HILBERT SPACES

The Definition and Some Simple Properties – Examples and Problems. Orthogonal Complements - Some theorems. Ortho-normal sets – Definitions and Examples- Bessel's inequality- The conjugate space H*.

UNIT IV

THE ADJOINT OF AN OPERATOR

Definitions and Some Properties-Problems. Self- adjoint operators – Some Theorems and Problems. Normal and Unitary operators –theorems and problems. Projections - Theorems and Problems.

UNIT V

BANACH ALGEBRAS

The definition and some examples of Banach algebra – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius.

SUGGESTED READINGS

1. Simmons. G. F., (2015). Introduction to Topology & Modern Analysis, Tata McGraw-Hill Publishing Company Ltd, New Delhi.
2. Balmohan V. and Limaye.,(2004). Functional Analysis, Second edition, New Age International Pvt.Ltd, Chennai.
3. ChandrasekharaRao, K., (2004). Functional Analysis,Narosa Publishing House, Chennai.
4. Choudhary, .B and Sundarsan Nanda. (2003). Functional Analysis with Applications, New Age International Pvt. Ltd, Chennai.
5. Ponnusamy, S., (2002).Foundations of functional analysis, Narosa Publishing House, Chennai.

Semester – IV

19MMP402 STOCHASTIC PROCESSES 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

This course enables the students to learn

- The mathematical theory of random variables and random processes
- How queueing theory are used as tools and mathematical models in the study of networks.
- The theoretical concepts and techniques for solving problems that arises in practice
- Markov processes in discrete and continuous time.
- The essential mathematical tools for handling random processes.
- The familiarize the students with the stochastic simulation techniques.

Course Outcomes (COs)

On successful completion of the course, students will be able to:

1. Capable to expose the students to different types mathematical models with a view of random processes.
2. Understanding in the concept of birth and death process.
3. Solve the Kolmogrov equations problems.
4. Compute probabilities of transition between states and return to the initial state after long time intervals in Markov chains.
5. Identify classes of states in Markov chains and characterize the classes.
6. Stochastic Processes in Queuing Systems.

UNIT I
STOCHASTIC PROCESSES

Definition of Stochastic Processes – Markov chains: definition, order of a Markov Chain – Higher transition probabilities – Classification of states and chains.

UNIT II
MARKOV PROCESS WITH DISCRETE STATE SPACE

Poisson process – and related distributions – Properties of Poisson process, Generalizations of Poisson Processes – Birth and death Processes – continuous time Markov Chains.

UNIT III

MARKOV PROCESSES WITH CONTINUOUS STATE SPACE

Introduction, Brownian motion – Weiner Process and differential equations for Weiner process, Kolmogrov equations – First passage time distribution for Weiner process – Ornstein – Uhlenbech process.

UNIT IV

BRANCHING PROCESSES

Introduction – properties of generating functions of Branching process– Distribution of the total number of progeny, Continuous- Time Markov Branching Process, Age dependent branching process: Bellman-Harris process.

UNIT V

STOCHASTIC PROCESSES IN QUEUING SYSTEMS

Concepts – Queuing model M/M/1 – transient behavior of M/M/1 model – Birth and death process in Queuing theory: M/M/1 – Model related distributions – M/M/1 - M/M/S/S – loss system - M/M/S/M – Non birth and death Queuing process: Bulk queues – M(x)/M/1.

SUGGESTED READINGS

1. Medhi, J., (2006). Stochastic Processes, 2nd Edition, New age international Private limited, New Delhi.
2. Basu, K., (2003). Introduction to Stochastic Process, Narosa Publishing House, New Delhi.
3. Goswami and Rao, B. V., (2006). A Course in Applied Stochastic Processes, Hindustan Book
   Agency, New Delhi.
4. Grimmett, G. and Stirzaker D., (2001). Probability and Random Processes, 3rd Ed., Oxford University Press, New York.
5. Papoulis.A and UnnikrishnaPillai, (2002). Probability, Random variables and Stochastic Processes, Fourth Edition, McGraw-Hill, New Delhi.
6. V.Sundarapandian.,(2009).Probability statistics and Queuing theory, PHI learning private limited, New Delhi.

		Semester – IV
19MMP491	**PROJECT**	**– 8C**
Instruction Hours / week: L: 0 T: 0 P: 0	**Marks: Internal: 80**	**External: 120 Total: 200**
		End Semester Exam: -